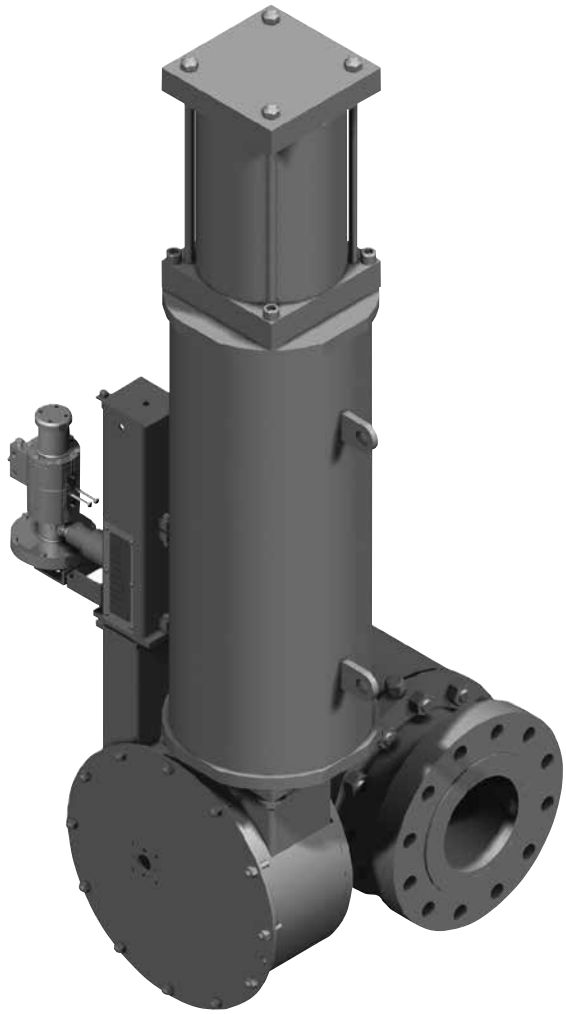
GE Oil & Gas

Ball Valve Regulator

Spring Acting, Spring Return

Maintenance and Operation Manual



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Introduction

The Becker Ball Valve Regulator (BVR) from GE is a high-capacity, single acting, spring return regulator designed specifically for natural gas regulation. The Becker BVR is built to exacting specifications accurate and reliable performance. The BVR is easy to operate, requires minimal maintenance, and is available in a variety of configurations and sizes to fit your specific application. To best maintain accuracy, efficiency, and safety, all BVR applications should be designed and engineered with GE's assistance. All Becker BVR assemblies are shipped ready for installation and startup without any further adjustment. All instruction manuals supplied with the BVR should be reviewed prior to installation and startup. Only properly experienced or trained personnel should install, operate, or maintain Becker from GE.

The Becker BVR has three major components:

- Control valve (ball valve type)
- Throttling valve actuator with a welded spring cartridge
- Control instrumentation

Information about the ball valve and the actuator is covered in this manual. For information about control instrumentation, refer to the instruction manual for the specific instrumentation supplied with your ball valve regulator.

Important Information for ATEX Approved Models

Every unit must be earth-ground before entering service. Use specified "Yellow-on-Green" CE wire for ground connection.

Ground wire must be attached to the location marked by the Earth-ground symbol.

Technical Assistance

Contact your local GE sales representative with any questions or for technical assistance.

Facilitate requests for technical assistance, please have the following information immediately available:

- BVR serial number (see ID tag affixed to BVR actuator)
- BVR model number (see ID tag affixed to BVR actuator)
- Invoice number (see upper right corner of first page of instruction manual)

Single Acting, Spring Return Valve Actuators

Technical Specifications	
Actuator Type	Pneumatic crank arm design (quarter turn) with spring return
Rotation Output	Fixed 90° (standard) 85° through 95° non-adjustable (available on request)
Installation	Indoors or outdoors Vertical or horizontal Safe in explosion-proof environments
Installation Orientation	Left hand mounting standard (valve and stem are in horizontal position, actuator is perpendicular to the valve on the left hand side when viewed from upstream) Other orientations available on request
Torque Output Ranges	2,200 in-lbs. to 120,000 in-lbs. (for Fail Open actuators) 1,500 in-lbs. to 60,000 in-lbs. (for Fail Open actuators)
Operating Temperature Range	-20°F to +160°F (standard)
Power Gas Minimum	100 psig (standard) 75 psig minimum (contact GE for technical assistance)
Power Gas Maximum	500 psig (actuator models 10L and smaller) 400 psig (actuator models 12L and larger)
Power Gas Filtration	100 micron nominal Free of excessive moisture Free of excessive liquid hydrocarbons
Pneumatic Buffer System	1/3 psig check valve ensures non-pressurized side of piston stays clean and dry
Power Gas Moisture Requirements	<7lb. per 1.0 MMscf if excessive moisture or hydrocarbon content for adequate filtratrion and elimination of moisture, a Becker FD-1500 Filter-Dryer should be installed. Refer to Becker FD-1500 literature to determine if a FD-1500 filter-dryer is necessary. For adequate filtration and elimination of liquid hydrocarbon, a Becker FACD-1500 filter deodizer should be installed.
Power Gas Heat Requirements	If ambient temperatures may fall below the specified temperature range, GE recommends that the BVR be installed in a heated enclosure. Any heating devices must be rated as “explosion proof for hazardous environment.” GE recommends the use of catalytic heaters when heat is required. The catalytic heater uses natural gas fuel and provides a safe, flameless heat.

Construction Construction	
Housing Linkage	Carbon steel
Spring Cartridge	Carbon steel welded construction
Spring	6150H steel 316 SS (available for low temperature applications)
Torque Arm Bearings	Duralon* (fiberglass weave with Teflon* coating) in steel shell
Linkage Bearings	316 SS spherical bearings
Cylinder Tube[1]	Chrome-plated hardened steel
Pneumatic Cylinder Tube Seals	Buna-N O-rings
Cylinder Piston	Nodular iron
Pneumatic Cylinder Piston Seals	Buna-N cups
Cylinder Piston Rod	Chrome-plated hardened steel
Pneumatic Cylinder Piston Rod Bearing	Duralon* (fiberglass weave with Teflon* coating) in steel shell
Pneumatic Cylinder Piston Rod Seal	Polyurethane U-cup
Cylinder Tailrod[2]	Chrome-plated hardened steel
Pneumatic Cylinder Tailrod Bearing[2]	Duralon* (fiberglass weave with Teflon* coating) in steel shell
Pneumatic Cylinder Tailrod Seals[2]	Buna-N U-cups
Pneumatic Cylinder Tailrod Static Seal	Buna-N-O-ring
Actuator Paint/ Coating	Above grade portion standard coating: Prime coat epoxy (6-10 mil) finish coat polyurethane Below grade portion standard coating: Tar Set*, coal tar epoxy (16 mil) Custom coatings: Epoxy, Polyester, coal tar and zinc-base coatings may be applied in-plant to customer specifications
Instrumentation Tubing	3/8 in. Seamless tubing 316 SS
Instrumentation Tubing Fitting	Double ferrule design 316 SS (standard)

Notes:

1. Cylinders are supplied with pneumatic cushions when stroking time is three (3) seconds or less.
2. Applicable only to actuators equipped with tailrod cylinder.

GE Approved Control Valves

Technical Specifications	
Design	Full bore trunnion mounted ball valve (reduced bore available upon request)
Construction	• For specific information on valve design and construction refer to valve manuals • Options available for valve construction and trim materials (contact GE for details)
Type 55	Consult GE for technical assistance
Type B5, B4	Consult GE for technical assistance
Type OF/MF	Consult GE for technical assistance
Valve Face to Face Dimensions	Per ANSI B16.10
Available Size Ranges	2 in. through 16 in. standard ANSI sizes
Available ANSI Ratings	150 ANSI through 2500 ANSI
Available End Connections	• RFFE standard • Weld end • RTJ (ring-joint)

Notes on Our Approved Control Valves:

GE has many years of experience in the design of Becker Ball Valve Regulators. GE generally recommends the use of standard control valves; however, customer preferences or application requirements sometimes dictate the need for an alternate valve. Becker throttling actuators from GE can be matched with almost any valve for various BVR applications. Consult GE for specific applications.

Control Valve Specifications:	
Type 55	Manufactured to API Spec 6D
Typel B5, B4	Manufactured to API Spec 6D
Type OF/MF	Manufactured to API Spec 6D

Leakage Rate Specifications	
Control Valve Leakage Class	
Type 55	API 6D Bubble Tight
Type B5, B4	API 6D Bubble Tight
Type OF/MF	API 6D Bubble Tight

Notes on Control Valve Leakage:

Regulating valves, or control valves, do not generally require shutoff capability. Regulating valves may experience leakage due to valve modulation and valve seat exposure to high velocity flow (erosion). Becker Full Port Design Ball Valve Regulators are built to maintain "bubble tight" shutoff (API Class VI) upon initial installation. After years of service, the leakage rate may increase to a level that you feel requires a valve rebuild or replacement..

The leakage rate of a BVR depends upon several variables, including:

- Flow rates
- Pressure drop across control valve
- Length of service
- Frequency of service
- Quality of gas

The following types of valve applications should not exhibit leakage because the valve seats are rarely exposed to erosive flow and usually should maintain API Class VI "bubble tight" shutoff:

- On-Off valve applications
- Monitor regulators (overpressure protection)
- Relief valves (overpressure protection)
- Standby regulators

When positive API Class VI "bubble tight" shutoff must be maintained, GE advises one of two possibilities:

- Automation of an upstream block valve
- Incorporation of the upstream monitor regulator to provide shutoff

Ball Valve Regulator Maintenance and Inspection

It is important to inspect and maintain Becker BVRs on a regular basis. The following section provides instructions for annual, five-year, and as-needed maintenance and a valve rebuild or replacement. Although GE designs and manufactures products of the highest quality, all physical components are subject to wear under normal operating conditions and potential breakage under extraneous conditions. To prevent further damage to the BVR and the surrounding environment, the following maintenance and inspection procedures are recommended.

Annual Maintenance and Inspection

Checking for Proper Ball Valve Regulator Stroking

When the BVR actuator is stroked from one end of travel to the other, the BVR should exhibit the following proper stroking characteristics:

- Relatively smooth, continuous stroking from one end of travel to the other (the spring may cause a slight hint of jumpiness across the stroke due to the restriction of the instrument exhaust)
- No stalling or stopping of the actuator in midstroke
- Consistent stroking speed
- No abnormal noises (scraping, chattering, or metallic sounds)

What causes improper valve and actuator stroking?

- Sticky valves or high torque valves.
- Damaged valves.
- Lost motion in the BVR assembly.
- Damaged actuator cylinder seals.
- Damaged actuator cylinders.
- Obstructions in the body of the valve.

Complete the following steps to ensure proper valve and actuator stroking:

1. Maintain full power supply gas at normal pressure.
2. If the BVR is equipped with a Becker Manual Control Valve (MCV) from GE, stroke the BVR from one end of travel to the other.
3. If the BVR is not equipped with an MCV, the actuator may be stroked by:
    - Adjusting the measured variable (VRP-Pilot) and producing a "false signal", or
    - Adjusting the instrument signal (Positioner), or
    - Triggering any override devices installed on the BVR.
4. As the actuator strokes from one end of travel to the other, the linear position indicator scale on the face of the actuator should be monitored for the stroking of the BVR.
5. If the BVR exhibits stroking difficulty or any of the aforementioned unusual characteristics, take the following corrective action as necessary:
    - First, check the ball valve lubrication (refer to Lubricating the Ball Valve procedure on pages 9-10).
    - If lubricating the ball valve does not fix the improper stroking, check the lubrication of the actuator cylinder (refer to the Applying Cylinder Lubrication procedure on page 9).

Inspecting the Actuator Housing for Venting Gas

GE recommends an annual inspection of the actuator housing in order to detect venting gas. If the actuator housing is venting gas, it is possible that there is a leak in the valve stem or the actuator cylinder piston seal.

Checking Actuator Housing for Venting Gas.

1. Make sure the actuator cover plate is installed and securely sealed with the gasket.
2. Make sure all actuator access covers and plates are properly installed and sealed.
3. Remove the vent elbow. (All of GE's Becker valve actuators are equipped with a single vent port to allow free exchange of air due to normal ambient temperature fluctuations.)
4. Put soap bubble across the vent hole.
5. If venting gas is detected, there is probably a leak in the valve stem or actuator cylinder piston seal. To determine which is the source of the venting gas, follow the inspection instructions listed below.

What is valve stem leakage?

Becker Ball Valves from GE are equipped with stem packing seals. These valve stem seals provide a seal between the valve stem (which protrudes from the valve) and the valve body (which is pressurized). Through abnormal stem side loading or excessive operation, valve stem seals can deteriorate, causing gas to leak through the stem seals and into the BVR actuator housing.

- *Excessive side loading of the valve stem by the actuator*
- *Excessive cycling of the BVR*
- *Many years of continuous BVR usage*
- *Applying the incorrect lubricant to the stem seal lubrication port or over pressurizing while applying the lubricant*

Inspect for valve stem seal leaks as follows

Note: What is Valve Stem Leakage?

1. If the cap (rod-less) side of the pneumatic cylinder is pressurized by the instrumentation, then the leak is from the valve stem seal. If the rod side of the cylinder is pressurized, then follow the next set of steps for inspecting the cylinder piston rod seal for leaks.
2. Shut off the power (supply) gas.
3. Depressurize the actuator.
4. Valve stem seal leakage allows gas to escape from the pressurized valve body into the BVR actuator housing that is normally maintained at atmospheric pressure. The leakage is apparent when gas escapes from the BVR actuator housing while power gas is shut off. Check for leakage using one of the following methods:
    - Minimal degrees of valve stem seal leakage can be visually detected by placing a soap bubble on the vent of the actuator access cover
    - Greater degrees of leakage may be detected by an audible flow of gas coming from the actuator access cover.
5. If leakage is detected, replace the valve stem seal (refer to the Replacing the Valve Stem Seal procedure on page 6).
6. If no valve stem seal leakage is detected, but the leak resumes when the power gas is turned on, there is leakage in the piston rod seal (refer to the Replacing Piston Rod Seals procedure on page 8).

Inspect for cylinder piston rod seal leaks (including piston rod static seal) as follows:

Note: The following steps should be performed only when the instrument signal is connected to the rod side of the actuator cylinder.

1. Make sure the valve is in full open or closed position.
2. Leave the cylinder under full power gas.
3. Isolate the control valve by closing the block valves.
4. Blow down the valve body.
5. Apply soap to the housing vent. Any leakage from the vent indicates cylinder rod seal wear.
6. If there is leakage, replace the piston rod seals (refer to the Replacing Piston Rod Seals procedure on page 8.)

Replacing the Valve Stem Seal

Complete the following steps to replace the valve stem sealing components:

1. Refer to related valve manuals or contact GE to obtain the necessary valve stem sealing replacement parts. GE can supply valve steam seal kits.
2. Remove the entire BVR actuator to gain access to the valve stem seals.
3. Consult the valve instructions manual for stem seal replacement procedures.
4. Do not apply sealant or attempt to lubricate the stem seal without contacting GE for proper instruction.
5. Inspect the BVR for lost motion in order to reduce the possibility of premature valve stem seal wear (refer to the Inspecting for Lost Motion procedure on page 8).

Inspecting Control Instrumentation

GE recommends inspecting control instrumentation annually. Refer to the technical manual included with each specific instrumentation application for further instructions.

5 Year Maintenance and Inspection

Inspecting for Actuator Cylinder Seal Leaks

Note: Refer to **Drawings 01-6779, 01-6780, 01-6851, and 01-6852**, on pages 28-31.

What is actuator cylinder seal leakage?

To ensure long life and excellent performance, GE uses high quality pneumatic cylinders. Over the course of normal operation, the actuator cylinder may wear and ultimately develop leakage through the following sealing mechanisms:

- Tube seal (O-rings)
- Piston seal (U-cup)
- Piston rod seals
- Tail rod seals

Note: Only one side of the cylinder is pressurized, therefore the other U-cup seal is not needed and can be used as a spare in the case of an emergency.

What causes actuator cylinder seal leakage?

Actuator cylinder seal leakage is not extremely common, but can lead to degradation in the performance of the BVR. Actuator cylinder seal leaks are typically attributed to wear over a very long period of time. However, actuator cylinder seals can wear prematurely due to excessive cycling (caused by BVR malfunction or improper adjustment). In addition, seal wear can result from contaminants or debris in the power gas supply. Some older actuator cylinders may contain rusted carbon steel tail rod or piston rod bearings, which can cause seal leakage. It is important to note that actuator cylinders are sensitive to low temperature effects. Worn actuator cylinders may appear normal, but will exhibit leakage only when ambient temperatures drop to freezing or below.

How do I check for actuator cylinder seal leakage?

GE recommends the inspection of all cylinder seals every five years. Begin by removing the pneumatic buffer system or desiccant canister, then complete the following procedures.

Check the tube seals (O-rings) as follows:

1. Pressurize the normally pressurized side of the cylinder with at least 100 psig of power supply gas.
2. Apply a leak-check solution around the perimeter of the cylinder tubing wall. Any leakage should be easily visible.
3. Replace tube seals if any leakage is noted (refer to the Replacing Tube Seals or Piston Seals on page 7).

Check the piston seals (U-cups) as follows:

1. The actuator cylinder is equipped with two (2) unidirectional U-cup seals. Only the seal on the pressurized side of the cylinder is necessary. The other is a spare.
2. If the piston U-cup seal is found to exhibit excessive leakage (see the following table), replace the seal (refer to the Replacing Tube Seals or Piston Seals on page 7).

   Note: In emergency situations, the U-cup seal from the non-pressurized side of the cylinder can be switched with the leaking U-cup seal to allow the actuator to be placed back into service immediately. New seals then can be installed at a later planned time.
3. Set power gas supply pressure to 100 psig.
4. Apply 100 psig power supply gas to the cylinder top port and ZERO pressure to the cylinder bottom port.
5. Remove the tubing fitting (and pneumatic buffer or desiccant canister) from the actuator cylinder bottom port.
6. Check for excessive piston seal leakage (see the following table).
7. Apply 100 psig power supply gas to the cylinder bottom port and ZERO pressure to the cylinder top port.
8. Remove the tubing fitting from the actuator cylinder top port.
9. Check for excessive piston seal leakage (see the following table).

TABLE - Excessive Piston Leakage Definition	
Ambient Temperature	**Excessive Piston Seal Leakage Defintion**
> +40˚F (Warm Conditions)	Soap bubble across "ZERO" pressure port breaks in five (5) seconds or less
< +40˚F (Cold Conditions)	> 10 SCFH measured leakage from "ZERO" pressure port

Note: For details about piston rod seal inspection, refer to the Inspecting for Cylinder Piston Rod Seal Leaks procedure on page 5.

Check for tail rod seals (including the tail rod static seal) as follows:

1. Pressurize the cylinder top with at least 100 psig power supply gas.
2. Remove the Lexan position indicator scale from the actuator cylinder topworks box in order to gain access to the actuator cylinder tail rod seals.
3. Apply light grade oil around the tail rod cylinder seal area. Any leakage should be easily visible.
4. If excessive leakage is found, replace the tail rod cylinder seals (refer to the Replacing Tail Rod Seals procedure on page 8).

Check the pneumatic buffer system and vent breather for leaks as follows:

Note: The pneumatic buffer system consists of a check valve installed on the non-pressurized side of the cylinder. When equipped with the check valve, the instrumentation's exhaust is run into the nonpressurized cylinder port and out through the check valve. The check valve "traps" 1/3 psig of gas pressure in the cylinder to help ensure that it remains clean, dry, and free of contaminants from the surrounding air (see drawing #Jan97-1 on page 32). The vent breather helps ensure that when the cylinder strokes, moisture from the surrounding atmosphere is not pulled into the non-pressurized side of the cylinder (see drawing #21-2542 on page 32).

1. For the pneumatic buffer system, check for leaks around the check valve and up to the cylinder port to help ensure the system is working.
2. For the vent breather, replace the unit at the first signs of moisture inside the canister. GE recommends annual replacement of the cartridge (part number 22-2542) for working regulators.

Correcting Actuator Cylinder Seal Leaks

Complete the following steps to replace tube seals (O-rings) or piston seals (U-cups):

Note: This procedure does not require the removal of the cylinder from the actuator.

1. Remove the power gas to allow the actuator cylinder to stroke to the spring position and depressurize all instrumentation.
2. Remove the instrumentation tubing and instrumentation from the actuator cylinder.
3. Make a vertical reference mark between the actuator cylinder bottom mounting flange and the actuator cylinder tubing wall to help ensure proper realignment upon reassembly.

   Caution: Make sure to fully vent the power gas pressure from the actuator cylinder before loosening the tie-rod nuts.
4. Remove the tie-rod nuts from the actuator cylinder top flange.
5. If the tie-rod nut seizes and the tie-rod unscrews, remove the entire tie rod.
6. Remove the actuator cylinder top flange and tubing wall by lifting it straight up.

   Caution: To prevent damage, do not strike the actuator cylinder tubing wall with any object while it is being removed.
7. If necessary, use solvent to remove any rust, dirt, or foreign material from the cylinder tubing wall and piston.

   Caution: Never use abrasive cleaning methods such as wire brushes or sandpaper.
8. Inspect the actuator cylinder tubing wall for scratches or excessive wear spots. If scratches or wear spots are present on the tubing wall, it may need to be replaced.
9. Install new actuator cylinder tube seals (O-rings) and piston seals (U-cups) as needed.

   Be careful not to damage replacement seals during installation.
10. Using a clean, lint-free cloth, apply a thin layer of STP brand lubricant to the cylinder tubing wall and piston seals.
11. Wipe excess STP brand lubricant from the cylinder wall and piston seals.
12. Reassemble the actuator cylinder and install the tie rods and tie-rod nuts.
13. Tighten the tie-rod nuts in a crossing pattern to the torque ratings specified in the following table.
14. Reassemble the instrumentation and tubing.

TABLE - Specified Actuator Cylinder Tie-Rod Torque				
Cylinder Bore (in.)	**Tie Rod Size (in.)**	**Tie Rod Torque**	**Piston Rod Seal Kit #**	**Piston Seal Kit #**
4	3/8-24	28 ft.-lb.	01-6836	01-6819
5	1/2-20	48 ft.-lb.	01-6836	01-6820
6	1/2-20	48 ft.-lb.	01-6837	01-6821
8	5/8-18	115 ft.-lb.	01-6837	01-6832
10	3/4-16	170 ft.-lb.	01-6838	01-6833
12	3/4-16	170 ft.-lb.	01-6839	01-6834
14	7/8-14	375 ft.-lb.	01-6840	01-6835

Replace the piston rod seals as follows:

Note: The cylinder from the actuator must be removed to access the rod seal cartridge. Because of the cartridge design, the replacement of the rod seals does not require disassembly of the cylinder.

1. Remove the power supply gas pressure and depressurize all instrumentation, including the actuator cylinder.
2. Remove the actuator cylinder (follow the disassembly procedures for actuator cylinder removal on pages 8 and 9).
3. Remove the rod extension (if equipped) and the clevis.
4. Remove the gland plate from the bottom of the actuator cylinder. Small bore (4 in., 5 in., and 6 in.) actuator cylinders are equipped with a mounting flange which must be removed.
5. Replace all of the piston rod seals, lubricate the assembly with STP* brand lubricant, and reassemble the gland plate, cylinder rod flange and the clevis.

Replace the tail rod seals as follows:

Note: The cylinder does not need to be removed from the actuator to complete this procedure.

1. Remove the power supply gas pressure and depressurize all instrumentation, including the actuator cylinder.

   Note: The actuator may be in any location for the tail rod seal replacement.
2. Remove the instrumentation tubing and instrumentation from the actuator cylinder.
3. Remove the actuator cylinder topworks box.
4. Remove the topworks box mounting flange to gain access to the tail rod seals.
5. Remove the tail rod seal cartridge assembly and replace all the tail rod seals with new seals from the repair kit. Use all of the seals provided in the kit (instructions provided in the kit illustrate the proper installation).
6. After replacing the tail rod seals, lubricate the assembly with STP brand lubricant and reassemble the gland plate.
4. Reinstall the topworks assembly, instrumentation and instrumentation tubing.

Inspecting and Correcting for Lost Motion in the Ball Valve Regulator

What is lost motion?

Becker Ball Valve Regulators from GE are manufactured to exacting tolerances to achieve precise, accurate control. Lost motion occurs when the actuator linkage does not have continuous communication with the ball element of the valve. Continuous cycling of the BVR while in control mode is a common symptom of BVR lost motion.

Lost motion can be defined as wear in the following areas:

- Actuator linkage connections
- The connection between the actuator and the valve stem
- The connection between the valve stem and the valve ball

What causes lost motion?

Lost motion is caused by:

- Excessive cycling of the BVR
- Normal wear after long service
- Improper disassembly/assembly

Inspect for lost motion as follows:

1. Supply full pressure to the loading side of the actuator cylinder compressing the spring
2. Reduce the power supply gas in increments of 2 psig or less.
3. Maintain a pressure differential across the valve to prevent the valve from moving.
4. Observe the position indicator on the actuator to note movement. If movement occurs with a very small drop in loading pressure (5 psig or less) and there is no movement with another similar small drop in output pressure, lost motion is present.
5. Measure the amount of linear movement on the linear valve position indicator scale.
6. If the amount of lost motion exceeds 0.25 inches, then excessive lost motion is present and corrective action is recommended (see below).

Correct for lost motion as follows:

1. Examine linkage, bearing, and valve stem connections for wear. Replace the affected parts to reduce lost motion.
2. Contact GE for assistance in determining the location and cause of lost motion.
3. Keep annual records indicating the amount of lost motion exhibited by a BVR. This data can be used to forecast the need for more in-depth maintenance.

"As Needed" Maintenance

Inspecting for Valve Seat Leaks

What is valve seat leakage?

Valve seat leakage is defined as the amount of gas that flows through a valve while it is in the "full closed" position. The American Petroleum Institute (API) has developed specific definitions for valve leakage. Becker control valves from GE exhibit the following leakage classes upon initial installation.

Control Valve Leakage Class			
Type 55	API 6D	Bubble Tight	Standard or Surge Control Service
Type B5, B4	API 6D	Bubble Tight	Standard or Surge Control Service
Type OF/MF	API 6D	Bubble Tight	Standard or Surge Control Service

What causes valve seat leakage?

Regulating valves may experience leakage after some time in service due to modulation and valve seat exposure to high velocity flows (erosion). The leakage rate of a BVR depends on several variables:

- Flow rates
- Pressure drop across control valve
- Length of service
- Frequency of service
- Quality of gas

How do I check for valve seat leakage?

Individual companies should have their own guidelines for properly checking valve leakage of the BVR. After years of service, the leakage rate may become excessive and the valve will require rebuilding or replacement. Determination of excessive leakage rate is based on your discretion. The following types of valve applications should not exhibit leakage since the valve seats are rarely exposed to erosive flow and should usually maintain API Class VI "bubble tight" shutoff:

- On-off valve applications
- Monitor regulators (overpressure protection)
- Relief valves (overpressure protection)
- Standby regulators

Correct valve seat leakage as follows:

Note: While policy varies by company, regulating or control valves do not generally require shutoff ability.

1. When valve seat leakage becomes excessive, valve seats and/or seals may need to be replaced.
2. In the following instances, the entire valve may need to be replaced:
   - Extreme wear of valve components
   - Unavailability of valve parts
   - When valve rebuild costs exceed valve replacement costs
3. Contact GE for information related to valve rebuilds, valve parts, or valve replacement. GE offers highly skilled personnel at our valve rebuild facility.
4. In the case where positive API Class VI "bubble tight" shutoff must be maintained, GE advises one of two options:
   - Automation of an upstream block valve
   - Incorporation of the upstream monitor regulator to provide shutoff

Actuator Cylinder Lubrication

When should actuator cylinders be lubricated?

Actuator cylinders should be lubricated after the discovery of improper BVR stroking (refer to the Checking for Proper Valve and Actuator Stroking on page 4).

What type of lubrication should I use?

One hundred percent STP* brand lubricant is recommended for lubrication of the valve operator's cylinder.

Apply cylinder lubrication as follows:

Note: The cylinder does not need to be removed from the actuator to complete this procedure.

1. Remove the power supply gas pressure and depressurize all instrumentation, including the actuator cylinder.
2. Remove tubing from both ports of the cylinder.
3. Make a vertical mark on the cylinder bottom flange and the tube to use to help properly realign this parts during reinstallation.
4. Loosen the tie-rod nuts from the top cylinder flange and remove them. If the tie rod loosens along with the nut, remove the entire tie rod.
5. Remove the top cylinder flange and cylinder sleeve by carefully lifting them straight up.
6. Remove all dirt and/or rust from the cylinder sleeve and piston (using solvent if necessary).
7. Using a clean, lint-free cloth, apply a thin layer of STP brand lubricant to the cylinder tubing wall and piston seals.
8. Wipe excess STP brand lubricant from the cylinder tubing wall and piston seals.
9. Reassemble and torque the tie rods in a cross pattern to the proper specifications.

Lubricating the Ball Valve

When should ball valves be lubricated?

Valve cleaner/lubricant should be applied only when erratic or difficult valve operation occurs. Check BVR stroking before lubricating the ball valves (refer to the Checking for Proper Ball Valve Regulator Stroking procedure on page 4).

What type of lubrication should I use?

It is important to use the correct valve cleaner/ lubricant. Improper valve cleaner/lubricant can worsen valve regulator performance and even damage the valve. GE recommends using Mobilith* AW2 (or equivalent) for lubrication when necessary. If lubrication does not return the valve to normal operation, a valve cleaner/lubricant may be necessary. GE recommends Sealweld* valve cleaner/lubricant (or equivalent).

Apply valve seat lubrication as follows:

1. If the valve is not equipped with valve seat lube features, proceed directly to step 1 of the next procedure to apply valve cleaner/lubricant to the valve body bleed fitting.
2. Isolate the control valve to be lubricated by closing upstream and downstream block valves.
3. Put the control valve to be lubricated in full closed position.
4. Apply lubricant to each valve seat lube fitting.
5. Stroke the valve from full open to full closed positions approximately 10 to 15 times. If normal valve operation returns, no further service is required.

Apply valve cleaner/lubricant to the valve body bleed fitting as follows:

Note: If applying lubrication to the valve seats does not result in proper valve operation, the ball valve should be lubricated directly through the valve body bleed fitting.

1. Isolate the control valve to be lubricated by closing upstream and downstream block valves.
2. Put the control valve in full open position.
3. Apply valve cleaner/lubricant to the body bleed fitting using the quantities as indicated:
   - For 2 in., 3 in., or 4 in. bore valves, apply two (2) tubes
   - For 6 in. and 8 in. bore valves, apply four (4) tubes
   - For 10 in. bore valves, apply six (6) tubes
   - For 12 in. bore valves, apply eight (8) tubes
   - For larger valves, contact GE factory for the proper lubrication amount

   Note: The valve bore is the first number of the regulator model number found on the stainless steel tag attached to the pneumatic actuator cylinder.
4. Apply half of the total quantity of valve cleaner/lubricant to the body bleed fitting of the valve. For valves with one fitting, this fitting is the body bleed port and should typically be used to lubricate 4-inch bore valves and smaller. For valves with three fittings that are installed above grade, the body bleed fitting is located in the bottom-center of the valve body. For valves with three (3) fittings that are installed below grade, the body bleed fitting is the middle fitting extension, which is terminated with a 0.50-inch ball valve.
5. Allow 15 minutes for the lubricant to take effect and then stroke the valve from full open to full closed position 10 to 15 times.
6. Apply the remaining half of the valve cleaner/lubricant to the body bleed fitting.
7. Allow 15 minutes for the cleaner/lubricant to take effect and then stroke the valve from full open to full closed position 10 to 15 times.
8. Return valve to service.

Maintaining Instrumentation (as needed)

For "as-needed" instrumentation maintenance instructions, refer to the technical manual supplied with the specific instrumentation application.

Above Grade Actuator Installation and Disassembly

Installing the Above Ground Actuator

Complete the following steps to install the above ground actuator:

Note: Drawing number 55-9024 (on page 17) shows the labeled parts related to this procedure.

1. Place the valve in full open position.
2. The actuator should be in fail-safe position with the spring relaxed.
3. Remove the existing actuator.
4. Remove the housing cover plate (G) from the actuator. Do not remove the outboard bearing (K) or torque arm (L).
5. Scrape and wire brush all corroded areas on the valve mounting flange (Q) and stem (O). Remove all burrs from stem and lubricate with cup grease.
6. Install the actuator on the valve mounting flange (Q). Apply and tighten the nuts (R) on the mounting studs (N).
7. Loosen both outboard bearing bolts (J) and then re-tighten them.
8. If the actuator fails in the closed position, apply pneumatic pressure (not exceeding 150 psig) to the traverse cylinder to full open position.
9. If the key (E) will not align with the keyway in the valve stem (O), loosen the connecting link jam nuts (B) and turn the connecting link stud (C) to shorten or lengthen the connecting link (A).

   Note: To reach the adjustment stud and maintain alignment with the valve stem keyway, maintain pressure on the cylinder top while adjusting the connecting link stud (B) on fail closed actuators.
10. To insert the key, remove the feedback bracket. After obtaining correct alignment, insert the key (E) and tighten the set screw (P). Reinstall the feedback bracket (S).
11. Lock both connecting link jam nuts (B).

    Caution: Keep hands and tools away from the torque arm while connecting the link and then stroking the actuator to the full open and full closed positions.
12. If the valve does not travel such that the bore of the ball valve is in perfect alignment with the inlet/outlet of the valve,adjust the actuator connecting link stud (A) (see note after step 9).
13. Loosen the connecting link jam nuts (B). Turn the connecting link stud (C) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. Lock both connecting link jam nuts (B).

    Note: It is imperative that the ball rotates properly to both the full closed and full open positions in order to provide complete shutoff capabilities.
14. Install the cover plate (G) by aligning the hole with the guide pin (D). Secure all of the nuts.

Note: The valve actuator is supplied with lubrication applied in the essential areas. For highly corrosive installations, GE recommends coating all rotating bearing areas with cup grease or similar grease to reduce the possibility of corrosion.

Install the surge control actuator as follows:

Note: Drawing number 55-9025 (on page 18) shows the labeled parts related to this procedure.

1. Place the valve in full closed position.
2. The actuator should be in the fail-safe position–fully open with the spring relaxed.
3. Remove the existing actuator.
4. Remove the housing cover plate (G) from the actuator. Do not remove the outboard bearing (K) or torque arm (L).
5. Scrape and wire brush all corroded areas on the valve mounting flange (Q) and stem (O). Remove all burrs from the stem and lubricate the stem with cup grease.
6. Install the actuator on the valve mounting flange (Q). Apply the nuts on the mounting studs (N).

7. Loosen all outboard bearing bolts (J) and then re-tighten the bolts.

   Caution: Make sure that the torque arm rotates freely on the valve stem without any interference.

9. Remove the feedback bracket (S).

10. Apply pneumatic pressure (not exceeding 150 psig) to the traverse cylinder to full closed position.

11. If the key (E) will not align the keyway in the valve stem (O), loosen the connecting link jam nuts (B) and turn the connecting link stud (C) to shorten or lengthen the connecting link (A).

    Note 1: To reach the adjustment stud and maintain alignment with the valve stem keyway, maintain pressure on the cylinder top while adjusting the connecting link stud (B).

    Note 2: Oversized key stock is provided so that the key supplied for surge control can be carefully sanded to achieve an extremely tight interface fit (requiring a hammer to drive home).

12. After obtaining correct alignment, insert the key (E) and tighten the set screw (P). Lock both connecting link jam nuts (B). Keeping all hands and tools clear, remove the cylinder pressure.

13. Reinstall the feedback bracket (S) when the actuator reaches full open.

    Caution: Keep hands and tools away from the torque arm and connecting link, while stroking the actuator to the full open and full closed positions.

14. If the valve does not travel such that the bore of the ball valve is in perfect alignment with the inlet/outlet of the valve, the actuator connecting link stud (A) must be adjusted (see Note 1).

15. Loosen the connecting link jam nuts (B). Adjust the connecting link stud (C) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. The ball must rotate properly to both the full closed and full open positions to provide complete shutoff capabilities.

16. Check to ensure that the washer in the position indicator window correlates to the open and closed marks when the valve is full open and full closed. If the washer does not line up, loosen the proportional feedback link jam nuts (T). Adjust the proportional feedback link stud (U) in either the clockwise or counter-clockwise direction to achieve proper alignment. Lock both proportional feedback link jam nuts (T).

17. Install the cover plate (G) by aligning the hole with the guide pin (D). Secure all of the nuts.

Note: The valve actuator is supplied with lubrication applied in the essential areas. For highly corrosive installations, GE recommends coating all rotating bearing areas with cup grease or similar grease to reduce the possibility of corrosion.

Disassembling the Above Ground Actuator (Cylinder Only)

Remove the actuator cylinder ONLY as follows:

Note: Refer to drawing number 55-9031 for "fail open" (page 19) and 55-9022 for "fail closed" (page 20). However, if the unit is equipped with gear operator, the proportional feedback assembly for the positioner is integral to the housing. In this case, refer to drawing number 55-9032 for "fail open" (page 21) and 55-9027 for "fail closed" (page 22).

1. Depressurize and remove instrumentation tubing lines.

2. The valve will be in failure position.

3. Remove the cover plate (9) from the actuator housing (2).

4. Remove the pin clamp (5) and torque arm pin (6).

For "fail closed" actuators (on units without a gear operator) complete these steps:

Note: Refer to drawing number 55-9022.

5. Remove the nuts (24) that hold the bottom cylinder flange to the spring housing (1).

6. Remove the cylinder (19) from the actuator assembly along with the cylinder rod flange (21), rod clevis (22), rod clevis pin (18), and connecting link (16).

For "fail closed" actuators (on units without a gear operator) complete these steps:

Note: Refer to drawing number 55-9031.

5. Remove the nuts (24) that hold the bottom cylinder flange to the spring housing (1).

6. Remove the cylinder (19) from the actuator assembly along with the cylinder rod flange (21), rod clevis (22), rod clevis pin (17), and connecting link (16).

For "fail closed" actuators (with a gear operator) complete these steps:

Note: Refer to drawing number 55-9027 and 55-9032.

5. Remove the nuts (29) that hold the spring cartridge to the housing (2). Remove the entire cylinder and spring cartridge assembly.

6. Loosen the jam nuts (26) to allow removal of the rod clevis (22), clevis pin (17), and connecting link (16). Remove the cylinder rod flange (21) to allow removal of the cylinder (19) by removing the nuts (30) that hold the cylinder bottom flange to the spring cartridge (1).

For units with bolt on proportional feedback complete these steps:

Remove the feedback unit first. Refer to the instruction manual for the HPP-SB positioner, then proceed according to the instructions for drawings 55-9022 and 55-9031.

Reinstalling the Above Ground Actuator (Cylinder Only)

Note: Refer to drawing number 55-9031 for "fail open" (page 19) and 55-9022 for "fail closed" (page 20). However, if the unit is equipped with a gear operator, the proportional feedback assembly for the positioner is integral to the housing. In this case, refer to drawing number 55-9032 for "fail open" (page 21) and 55-9027 for "fail closed" (page 22).

For units without a gear operator, reinstall the actuator cylinder ONLY as follows:

1. If the connecting link (16) has not been removed from the cylinder, proceed to step 5.

   Caution: Do not adjust the length of the connecting link.

For "fail closed" actuators (on units without a gear operator) complete these steps:

Note: Refer to drawing number 55-9031.

3. Reinstall the cylinder rod flange (21), rod clevis (22), rod clevis pin (17 and 18).

4. Match the original installed position of the rod clevis by counting the number of exposed threads on the cylinder piston rod to ensure agreement.

5. Reinstall the actuator cylinder (19) and bolts and nuts (24) that attach to the spring housing (1), and tighten the nuts.
6. Reinstall the torque arm pin (6) and pin clamp (5).
7. Reinstall the instrumentation tubing lines and pressurize.
8. Stroke the actuator to the full open and full closed positions.
9. If the valve does not travel such that the bore of the ball valve is in perfect alignment with the inlet/outlet of the valve, the actuator connecting link (16) must be adjusted.
10. Adjust the connecting link (16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. The ball must rotate properly to both the full closed and full open positions.

For "fail open" actuators (on units without a gear operator) complete these steps:

Note: Refer to drawing number 55-9022.

3. Reinstall the cylinder rod flange (21), rod clevis (22), rod clevis pin (17 and 18).
4. Match the original installed position of the rod clevis by counting the number of exposed threads on the cylinder piston rod to ensure agreement.
5. Reinstall the actuator cylinder (19) and bolts and nuts (23) that attach to the spring housing (1) and tighten nuts.
6. Reinstall the torque arm pin (6) and pin clamp (5).
7. Reinstall the instrumentation tubing lines and pressurize.
8. Stroke the actuator to the full open and full closed positions.
9. If the valve does not travel such that the bore of the ball valve is in perfect alignment with the inlet/outlet of the valve, the actuator connecting link (16) must be adjusted.
10. Adjust the connecting link (16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. The ball must rotate properly to both the full closed and full open position.

For units with a gear operator, reinstall the actuator cylinder ONLY as follows:

For "fail closed" actuators (on units with a gear operator) complete these steps:

Note: Refer to drawing number 55-9027.

Caution: Do not adjust the length of the connecting link.

1. Reinstall the jam nut (26) onto the piston rod and install the rod extension (27) locking the jam nut against it in the original position.
2. Install another jam nut (26) onto the stud extension (item number 28) and thread into the end of the rod extension (27).
3. Drop the entire assembly through the spring cartridge and secure with bolts and nuts (30).
4. Install the cylinder rod flange (21) onto the stud extension (28) and snug it against the spring cap. Lock it in place with a jam nut.
5. Install another jam nut (26), and reinstall rod clevis (22), clevis pin (18) and connecting link (16).
6. Reinstall the instrumentation tubing lines and pressurize.
7. Stroke the actuator to the full open and full closed positions.
8. If the valve does not travel such that the bore of the ball valve is in perfect alignment with the inlet/outlet of the valve, the actuator connecting link (16) must be adjusted.
9. Adjust the connecting link (16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. The ball must rotate properly to both the full closed and full open position.

For "fail open" actuators (on units with a gear operator) complete these steps:

Note: Refer to drawing number 55-9032.

Caution: Do not adjust the length of the connecting link.

1. Install the cylinder rod flange (21) onto the piston rod and reinstall the rod clevis (22), clevis pin (18) and connecting link (16).
2. Reinstall the instrumentation tubing lines and pressurize.
3. Stroke the actuator to the full open and full closed positions.
4. If the valve does not travel such that the bore of the ball valve is in perfect alignment with the inlet/outlet of the valve, the actuator connecting link (16) must be adjusted.
5. Adjust the connecting link (16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. The ball must rotate properly to both the full closed and full open position.

Disassembling the Above Ground Actuator (Complete Actuator)

Remove the complete actuator cylinder as follows:

Note: Refer to drawing number 55-9031 for "fail open" (page 19) and 55-9022 for "fail closed" (page 20). However, if the unit is equipped with gear operator, the proportional feedback assembly for the positioner is integral to the housing. In this case, refer to drawing number 55-9032 for "fail open" (page 21) and 55-9027 for "fail closed" (page 22).

1. Depressurize and remove the instrumentation tubing lines running away from the actuator assembly.
2. The valve will be in the failure position.
3. Remove the cover plate (9) from the housing.
4. Loosen the set screw (4) that holds the square key (7) in place.
5. Remove the nuts from the valve adapter plate studs.
6. Remove the complete actuator from the valve. Strap and support the actuator weight as the torque arm is walked off of the valve stem.

For units with bolt on proportional feedback complete these steps:

Remove the feedback unit first. Refer to the instruction manual for the HPP-SB positioner, then proceed according to the instructions for drawings 55-9022 and 55-9031.

Below Grade Actuator Disassembly & Installation

Disassembling the Below Grade Actuator (Cylinder Only)

For tail rod units, remove the actuator cylinder ONLY as follows:

These procedures are applicable to tail rod units. See the next set of procedures for single rod units.

Note: Refer to drawing number 55-9026 for "fail open" (page 24) and 55-9033 for "fail closed" (page 25).

For "fail open" actuators complete these steps:

Note: Refer to drawing number 55-9026.

1. Depressurize and remove the instrumentation tubing lines.
2. Remove access covers (14 and 21).
3. Remove one of the Tru-Arc rings (7) form the rod clevis pin (8).
4. Remove the rod clevis pin (8) by pushing it through the rod clevis (6).
5. Remove the nuts (24) that hold the spring cartridge to the housing (20).
6. Loosen the jam nuts (2) to allow for the removal of the rod clevis (22). Remove the cylinder rod flange (4) to allow for the removal of the cylinder (1) by removing the nuts (25) holding the cylinder bottom flange to spring cartridge (1).

Note: It is important to mark the position of the cylinder rod flange (4) and rod clevis (6) to the stud extension (5). The rod clevis (6) must be exactly in its original position when it is reassembled.

For "fail closed" actuators complete these steps:

Note: Refer to drawing number 55-9033.

1. Depressurize and remove the instrumentation tubing lines.
2. Remove the access covers (14 and 21).
3. Remove one of the Tru-Arc rings (7) from the rod clevis pin (8).
4. Remove the rod clevis pin (8) by pushing it through the rod clevis (6).
5. Remove the nuts and bolts that hold the cylinder flange (1) to the spring housing (23).
6. Remove the cylinder (1) from the actuator assembly along with the cylinder rod flange (4), rod extension (3), stud extension (5), and rod clevis (6).

For single rod units, remove the actuator cylinder ONLY as follows:

Note: Refer to drawing number 55-9030 for "fail open" (page 26) and 55-9028 for "fail closed" (page 27).

For "fail open" actuators complete these steps:

These procedures are applicable to single rod units. See the previous set of procedures for tail rod units.

Note: Refer to drawing number 55-9030.

1. Depressurize and remove the instrumentation tubing lines.
2. Remove the access covers (28 and 30).
3. Remove one of the Tru-Arc rings (16) from the rod clevis pin (15).
4. Remove the rod clevis pin (15) by pushing it through the rod clevis (18).
5. Remove nuts and bolts that hold the cylinder flange (23) to the spring housing (25).
6. Remove the cylinder (23) from the actuator assembly along with the cylinder rod flange (22), rod extension (24), rod clevis (18), rod clevis pin (16), and connecting link (14).

Note: It is important to mark the position of the cylinder rod flange (22) on the cylinder rod. The rod clevis (18) must be exactly in its original position when it is reassembled.

For "fail closed" actuators complete these steps:

Note: Refer to drawing number 55-9028.

1. Depressurize and remove the instrumentation tubing lines.
2. Remove the access covers (28 and 30).
3. Remove one of the Tru-Arc rings (16) from the rod clevis pin (15).
4. Remove the rod clevis pin (15) by pushing it through the rod clevis (18).
5. Remove the nuts and bolts that hold the spring cartridge to the housing (5). Remove the entire cylinder and spring cartridge assembly.
6. Loosen the jam nuts (20) to allow the removal of the rod clevis (18). Remove the cylinder rod flange (22) to allow the removal of the cylinder (19) by removing the nuts and bolts that hold cylinder bottom flange to the spring cartridge (25).

Reinstalling the Below Grade Actuator (Cylinder Only)

For tail rod units, reinstall the actuator cylinder ONLY as follows:

These procedures are applicable to tail rod units. See the next set of procedures for single rod units.

For "fail open" actuators complete these steps:

Note: Refer to drawing number 55-9026.

1. Match the original installed position of the rod extension (3) by counting the number of exposed threads on the cylinder piston rod to ensure agreement.
2. Tighten the cylinder rod extension (3) and stud extension (5) assembly onto the cylinder rod with the jam nut (2).
3. Drop the entire assembly through the spring housing (23) and install the cylinder (1) onto the spring cartridge (23)
4. Reinstall the cylinder rod flange (4) and tighten the jam nut (2).
5. Reinstall the rod clevis (6) onto the stud extension (5) and lock in place with the jam nut (2).
6. Set the cylinder and spring cartridge assembly onto the actuator housing (20).
7. Reinstall the rod clevis (8) by pushing it through the rod clevis (6).
8. Reinstall the Tru-Arc rings (7) to the rod clevis pin (8).

9. Tighten the nuts (24) to hold the spring cartridge and cylinder to the actuator housing.
10. Reinstall the access plate from the actuator housing (14 and 21).
11. Reinstall the instrumentation tubing lines and pressurize.
12. Stroke the actuator to the full open and full closed positions.

For "fail closed" actuators complete these steps:

Note: Refer to drawing number 55-9033.

1. Match the original installed position of the cylinder rod flange (4) by counting the number of exposed threads on the cylinder piston rod to ensure agreement.
2. Tighten the cylinder rod extension (3), stud extension (5), and rod clevis (6) assembly onto the cylinder rod.
3. Drop the entire assembly through the spring housing (23) and ensure that the rod clevis (6) lines up with the connecting link (9).
4. Reinstall the actuator cylinder (1) without tightening the nuts and bolts.
5. Reinstall the rod clevis pin (8) by pushing it through the rod clevis (6).
6. Reinstall the Tru-Arc rings (7) to the rod clevis pin (8).
7. Tighten the nuts and bolts of the actuator cylinder.
8. Reinstall the access plate from the actuator housing (14 and 21).
9. Reinstall the instrumentation tubing lines and pressurize.
10. Stroke the actuator to the full open and full closed positions.

For single rod units, reinstall the actuator cylinder ONLY as follows:

These procedures are applicable to single rod units. See the previous set of procedures for tail rod units.

For "fail open" actuators complete these steps:

Note: Refer to drawing number 55-9030.

1. Match the original installed position of the cylinder rod flange (22) by counting the number of exposed threads on the cylinder piston rod to ensure agreement.
2. Tighten the cylinder rod extension (24), stud extension (21), and rod clevis (18) assembly onto the cylinder rod.
3. Drop the entire assembly through the spring housing (25) and ensure that the rod clevis (18) lines up with the connecting link (14).
4. Reinstall the actuator cylinder (23) without tightening the nuts and bolts.
5. Reinstall the rod clevis pin (15) by pushing it through the rod clevis (18).
6. Reinstall the Tru-Arc rings (16) to the rod clevis pin (15).
7. Tighten the nuts and bolts of the actuator cylinder (32).
8. Reinstall the access plate from the actuator housing (28 and 30).
9. Reinstall the instrumentation tubing lines and pressurize.
10. Stroke the actuator to the full open and full closed positions.

For "fail closed" actuators complete these steps:

Note: Refer to drawing number 55-9028.

1. Match the original installed position of the rod extension (24) by counting the number of exposed threads on the cylinder piston rod to ensure agreement.
2. Tighten the cylinder rod extension (24) and stud extension (21) assembly onto the cylinder rod with the jam nut (20).
3. Drop the entire assembly through the spring housing (25) and install the cylinder (23) onto the spring cartridge.
4. Reinstall the cylinder rod flange (22) and tighten the jam nut (20).
5. Reinstall the rod clevis (18) onto the stud extension (21) and lock in place with the jam nut (20).
6. Set the cylinder and spring cartridge assembly onto the actuator housing (5).
7. Reinstall the rod clevis pin (15) by pushing it through the rod clevis (18).
8. Reinstall the Tru-Arc rings (16) to the rod clevis pin (15).
9. Tighten the nuts (31) to hold the spring cartridge and cylinder to the actuator housing.
10. Reinstall the access plate from the actuator housing (28 and 30).
11. Reinstall the instrumentation tubing lines and pressurize.
12. Stroke the actuator to the full open and full closed positions.

Disassembling the Below Grade Actuator (Complete Actuator)

Remove the complete actuator from the valve as follows:

Note: For tail rod cylinders, refer to drawing number 55-9026 for "fail open" (page 24) and 55-9033 for "fail closed" (page 25). For single rod cylinders, refer to drawing number 55-9030 for "fail open" (page 26) and 55-9028 for "fail closed" (page 27).

1. The valve may be in any position.
2. Excavate the below grade portion of the ball valve regulator.
3. Disconnect the valve lubrication lines and "knee brace" between the actuator and valve.
4. Remove the cover plate (10) from the actuator housing.

For tail rod cylinders complete these steps:

5. Loosen the set screw (19) that which holds the square key (16) in place.
6. Remove the nuts from the adapter plate studs.
7. Remove the complete actuator assembly from the valve.

For single rod cylinders complete these steps:

5. Remove the C.L. bracket (11) from the torque arm (13).
6. Loosen the set screw (6) that holds the square key (8) in place.
7. Remove the nuts from the adapter plate studs.
8. Remove the complete actuator assembly from the valve.

Reinstalling the Below Grade Actuator (Complete Actuator)

Reinstall the complete actuator on the valve as follows:

Note: For tail rod cylinders, refer to drawing number 55-9026 for "fail open" (page 24) and 55-9033 for "fail closed" (page 25). For single rod cylinders, refer to drawing number 55-9030 for "fail open" (page 26) and 55-9028 for "fail closed" (page 27).

1. Remove the cover plate (10) from the housing.
2. Slide the actuator onto the valve stem while supporting the actuator's weight.
3. Align all adapter plate studs withthe valve mounting plate holes, and tighten.
4. Loosen all outboard bearing bolts and re-tighten.
5. Connect the valve lubrication lines and "knee brace" between the actuator and the valve.

For tail rod cylinders complete these steps:

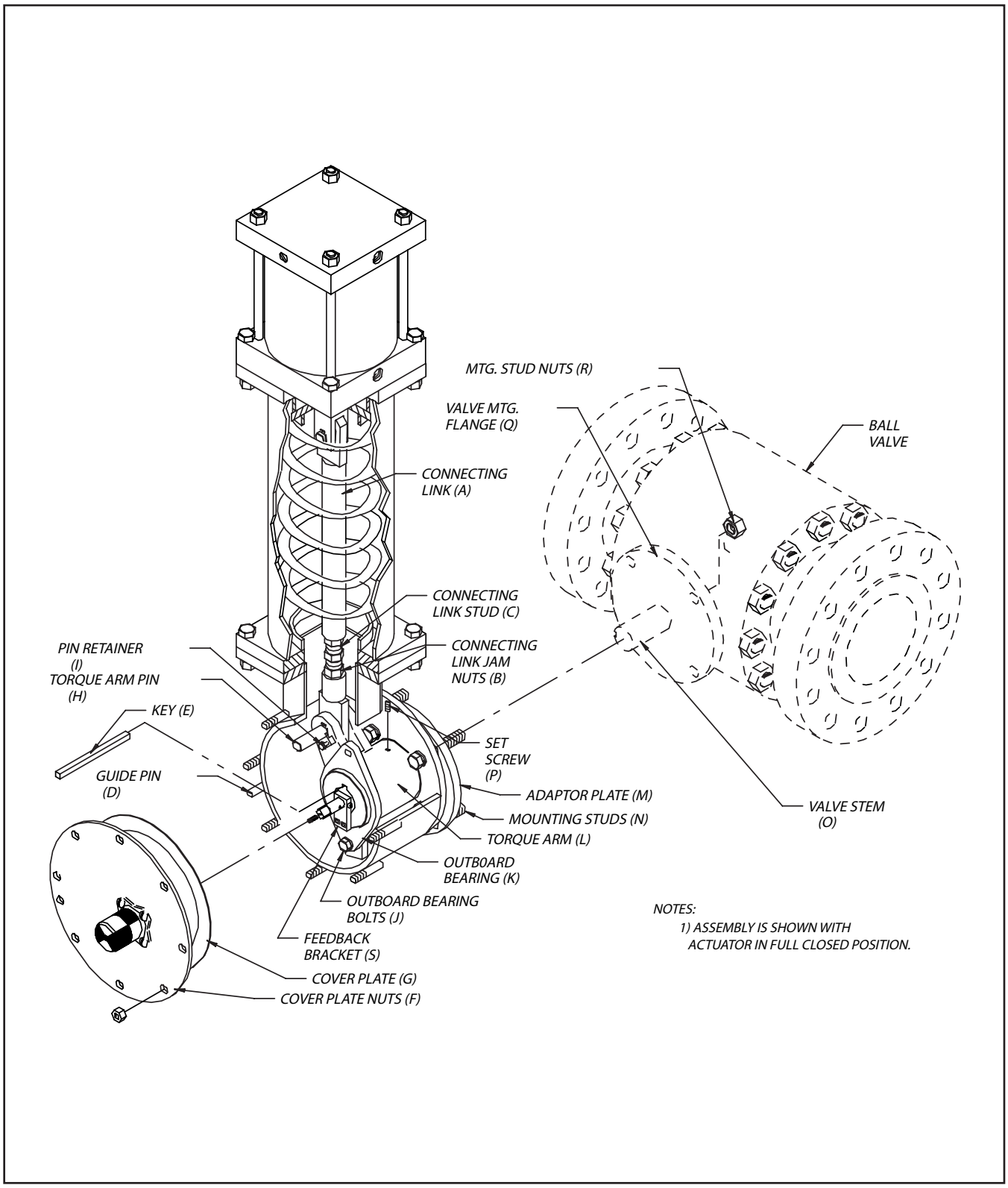
6. Reinstall the square key (16).
7. If the keyways do not align, readjust the position of the clevis. Follow the procedure described in the Reinstalling the Below Grade Actuator (Cylinder Only) section on page 14.
8. Reinstall set screw (19) that holds the square key in place.
9. Reinstall the instrumentation tubing lines and pressurize.
10. Stroke the actuator to the full open and full closed positions.

For single rod cylinders complete these steps:

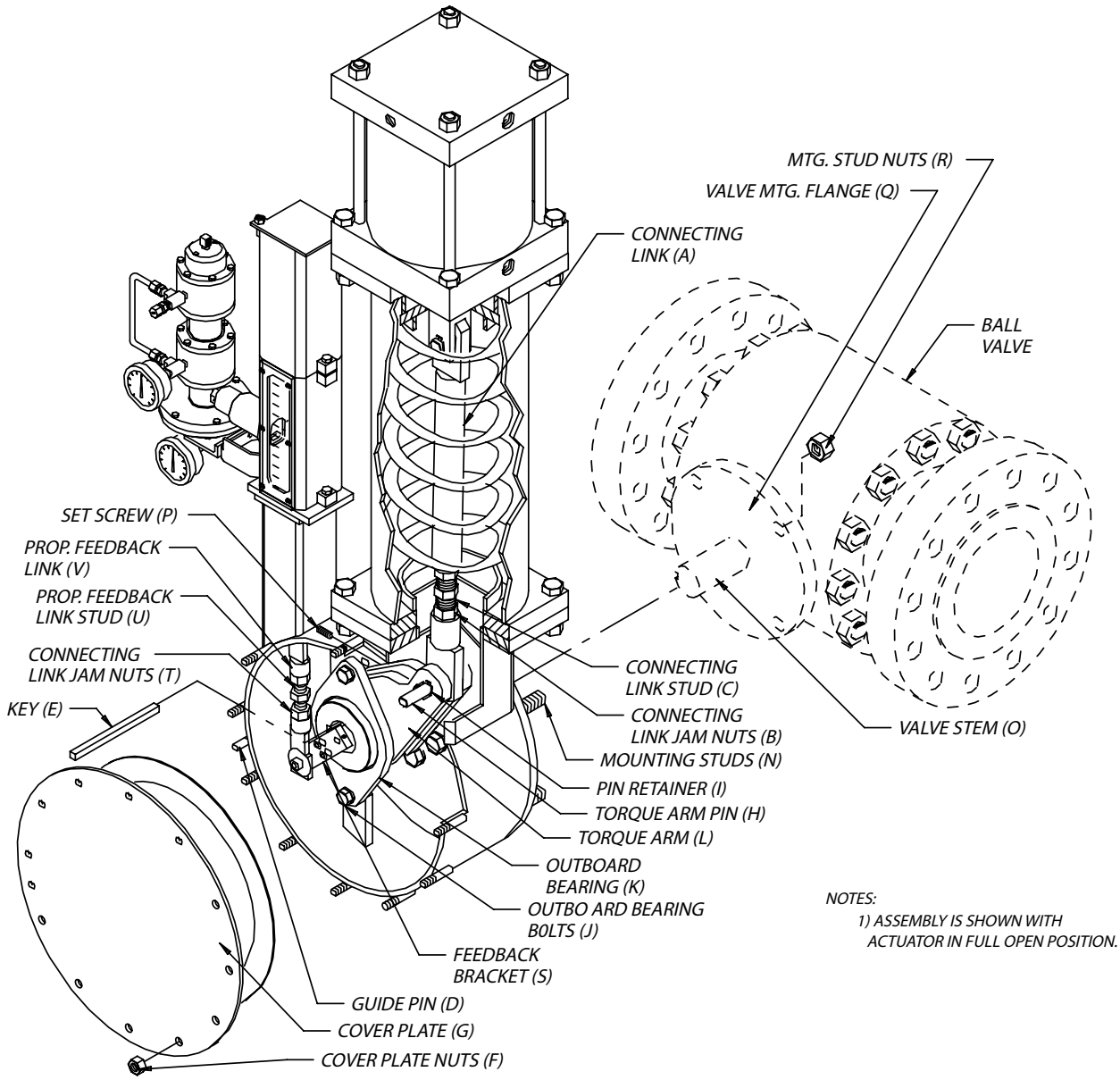
6. Reinstall the square key (8).
7. If the keyways do not align, readjust the position of the clevis. Follow the procedure described in the Reinstalling the Below Grade Actuator (Cylinder Only) section on page 14.
8. Reinstall the set screw (6) that holds the square key in place.
9. Reinstall the C.L. bracket (11) onto the torque arm (13).
10. Reinstall the instrumentation tubing lines and pressurize.
11. Stroke the actuator to the full open and full closed positions.

Part 6: Appendix

Drawings:

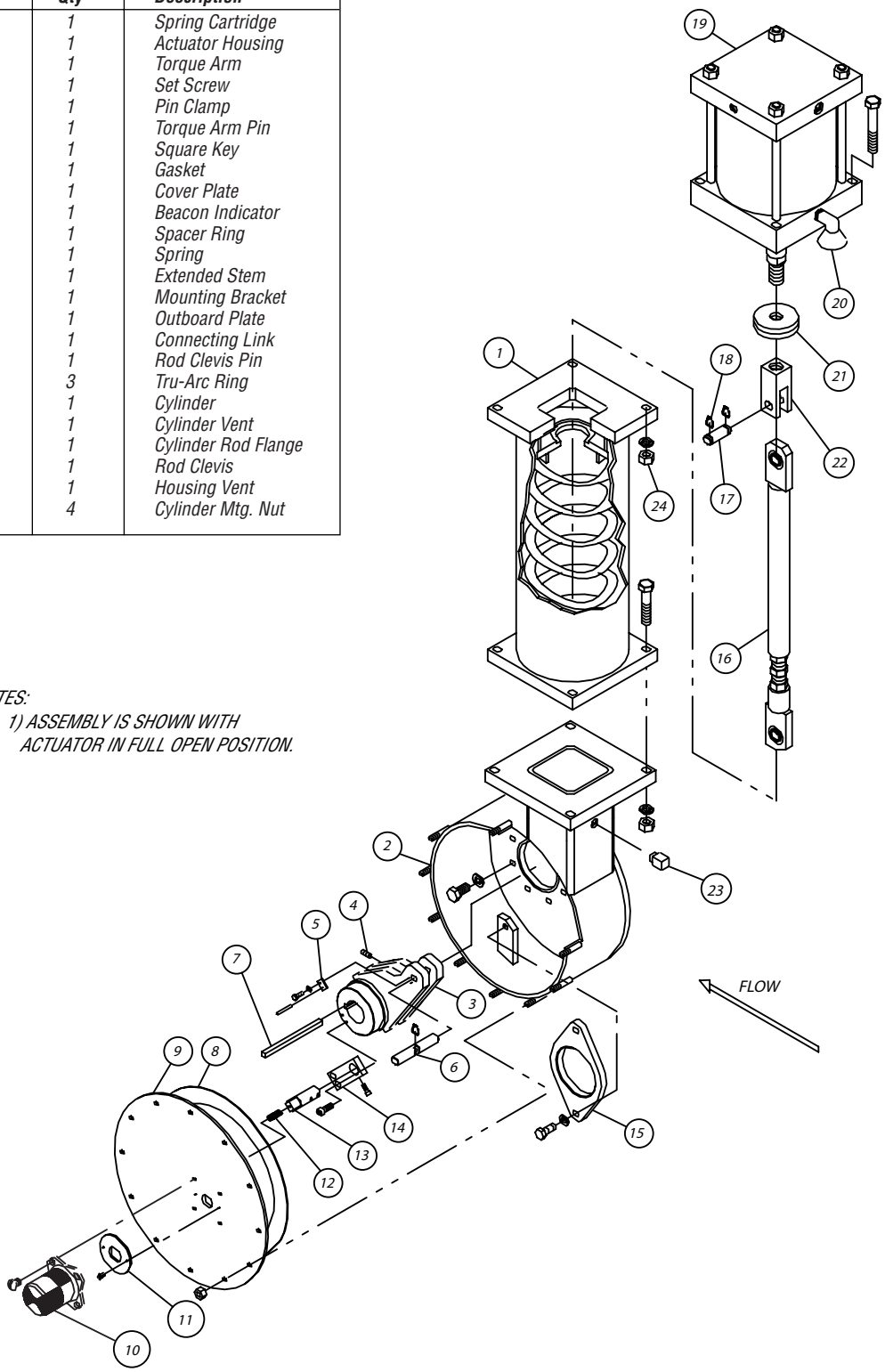


Drawing 55-9024: Single Return Actuator



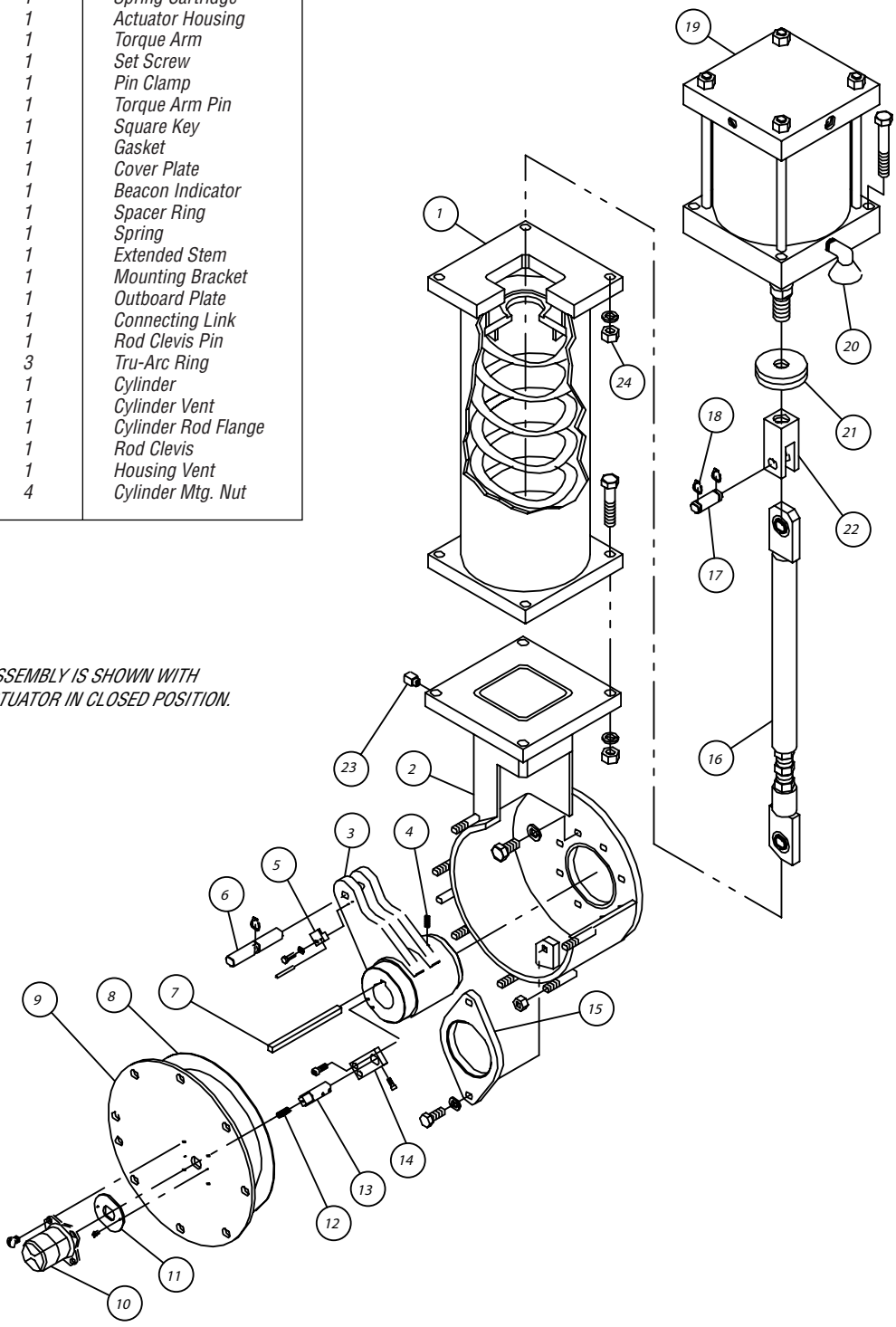
Drawing 55-9025: Surge Control Actuator

Item	Qty	Description
1.	1	Spring Cartridge
2.	1	Actuator Housing
3.	1	Torque Arm
4.	1	Set Screw
5.	1	Pin Clamp
6.	1	Torque Arm Pin
7.	1	Square Key
8.	1	Gasket
9.	1	Cover Plate
10.	1	Beacon Indicator
11.	1	Spacer Ring
12.	1	Spring
13.	1	Extended Stem
14.	1	Mounting Bracket
15.	1	Outboard Plate
16.	1	Connecting Link
17.	1	Rod Clevis Pin
18.	3	Tru-Arc Ring
19.	1	Cylinder
20.	1	Cylinder Vent
21.	1	Cylinder Rod Flange
22.	1	Rod Clevis
23.	1	Housing Vent
24.	4	Cylinder Mtg. Nut



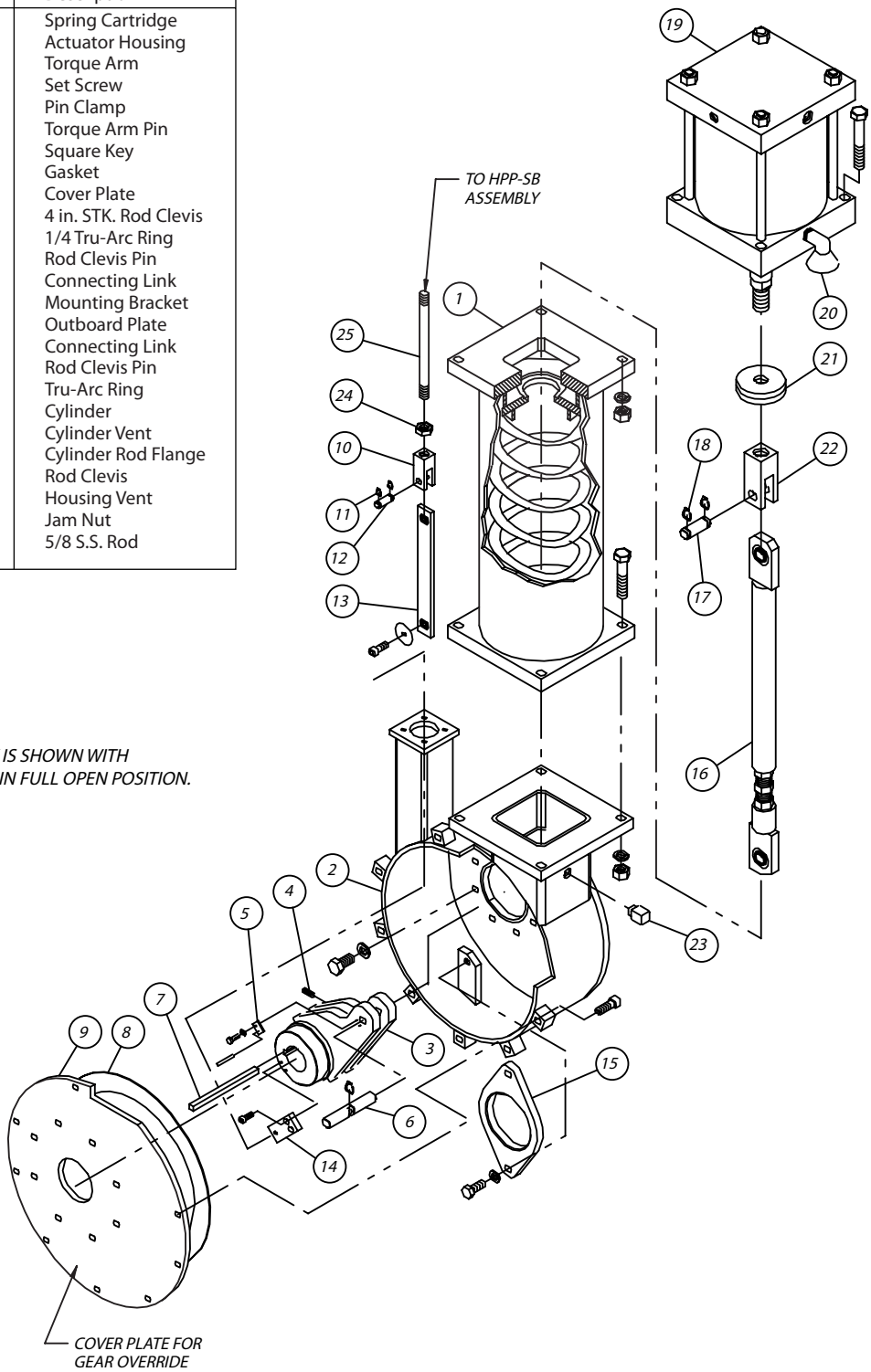
Drawing 55-9031: Above Grade Spring Return Actuator (Fail Open)

Item	Qty	Description
1.	1	Spring Cartridge
2.	1	Actuator Housing
3.	1	Torque Arm
4.	1	Set Screw
5.	1	Pin Clamp
6.	1	Torque Arm Pin
7.	1	Square Key
8.	1	Gasket
9.	1	Cover Plate
10.	1	Beacon Indicator
11.	1	Spacer Ring
12.	1	Spring
13.	1	Extended Stem
14.	1	Mounting Bracket
15.	1	Outboard Plate
16.	1	Connecting Link
17.	1	Rod Clevis Pin
18.	3	Tru-Arc Ring
19.	1	Cylinder
20.	1	Cylinder Vent
21.	1	Cylinder Rod Flange
22.	1	Rod Clevis
23.	1	Housing Vent
24.	4	Cylinder Mtg. Nut



Drawing 55-9022: Above Grade Spring Return Actuator (Fail Close)

Item	Qty	Description
1.	1	Spring Cartridge
2.	1	Actuator Housing
3.	1	Torque Arm
4.	1	Set Screw
5.	1	Pin Clamp
6.	1	Torque Arm Pin
7.	1	Square Key
8.	1	Gasket
9.	1	Cover Plate
10.	1	4 in. STK. Rod Clevis
11.	2	1/4 Tru-Arc Ring
12.	1	Rod Clevis Pin
13.	1	Connecting Link
14.	1	Mounting Bracket
15.	1	Outboard Plate
16.	1	Connecting Link
17.	1	Rod Clevis Pin
18.	3	Tru-Arc Ring
19.	1	Cylinder
20.	1	Cylinder Vent
21.	1	Cylinder Rod Flange
22.	1	Rod Clevis
23.	1	Housing Vent
24.	1	Jam Nut
25.	1	5/8 S.S. Rod



NOTES:

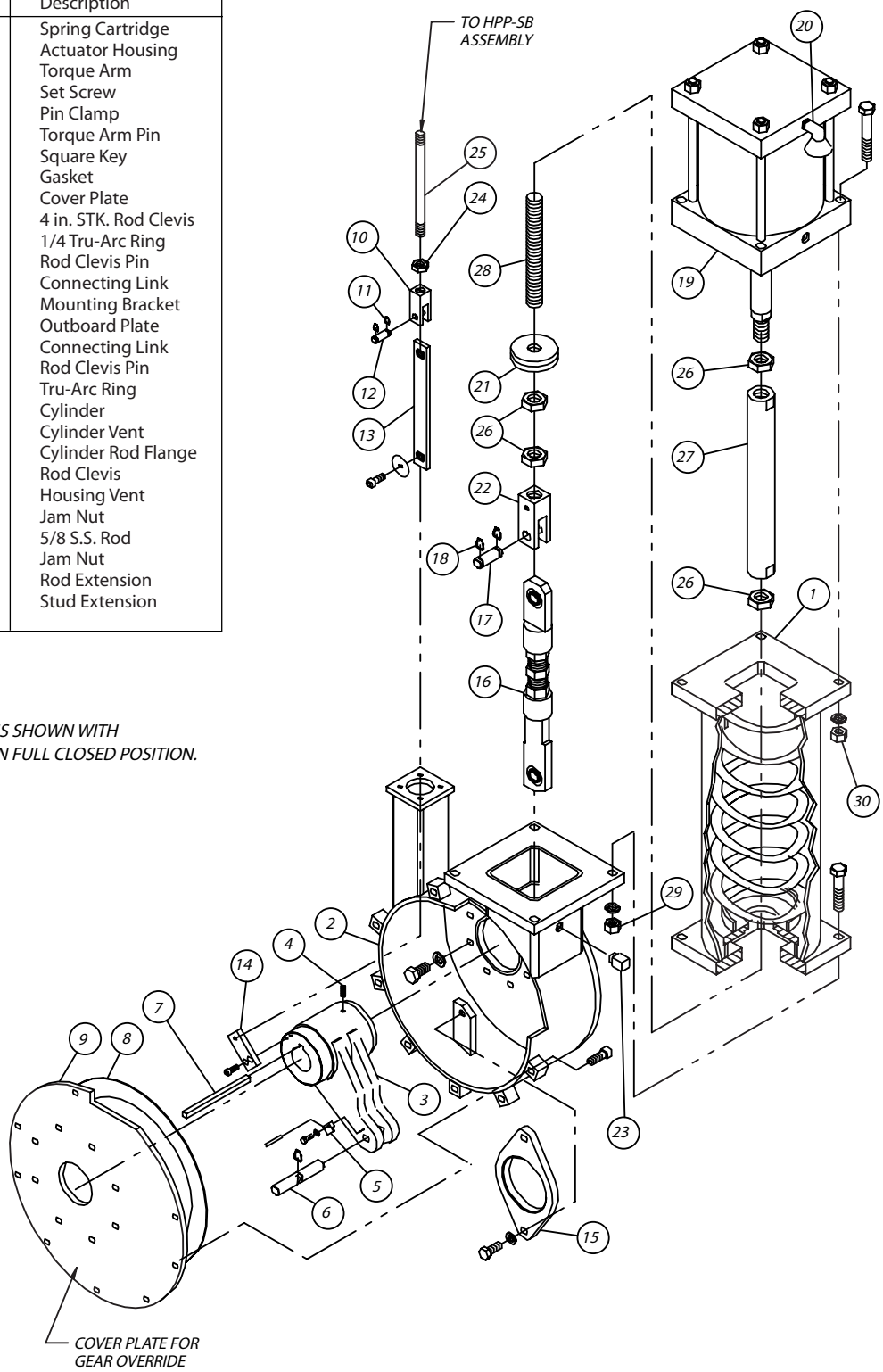
1) ASSEMBLY IS SHOWN WITH ACTUATOR IN FULL OPEN POSITION.

Drawing 55-9032: Spring Return Actuator with Gear Override (Spring to Open)

Item	Qty	Description
1.	1	Spring Cartridge
2.	1	Actuator Housing
3.	1	Torque Arm
4.	1	Set Screw
5.	1	Pin Clamp
6.	1	Torque Arm Pin
7.	1	Square Key
8.	1	Gasket
9.	1	Cover Plate
10.	1	4 in. STK. Rod Clevis
11.	2	1/4 Tru-Arc Ring
12.	1	Rod Clevis Pin
13.	1	Connecting Link
14.	1	Mounting Bracket
15.	1	Outboard Plate
16.	1	Connecting Link
17.	1	Rod Clevis Pin
18.	3	Tru-Arc Ring
19.	1	Cylinder
20.	1	Cylinder Vent
21.	1	Cylinder Rod Flange
22.	1	Rod Clevis
23.	1	Housing Vent
24.	1	Jam Nut
25.	1	5/8 S.S. Rod
26.	4	Jam Nut
27.	1	Rod Extension
28.	1	Stud Extension

NOTES:

1) ASSEMBLY IS SHOWN WITH ACTUATOR IN FULL CLOSED POSITION.

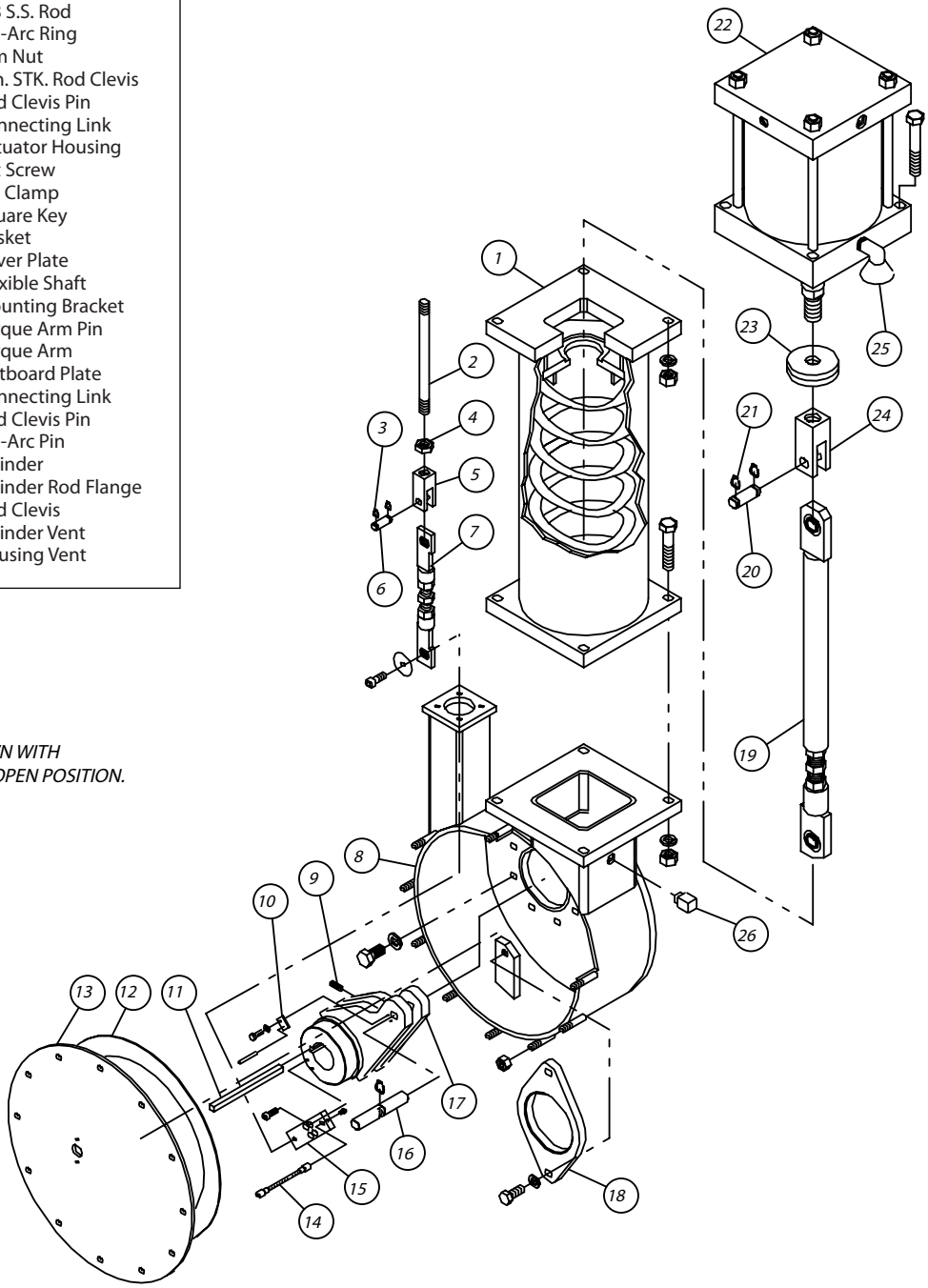


Drawing 55-9027: Spring Return Actuator with Gear Override (Spring to Close)

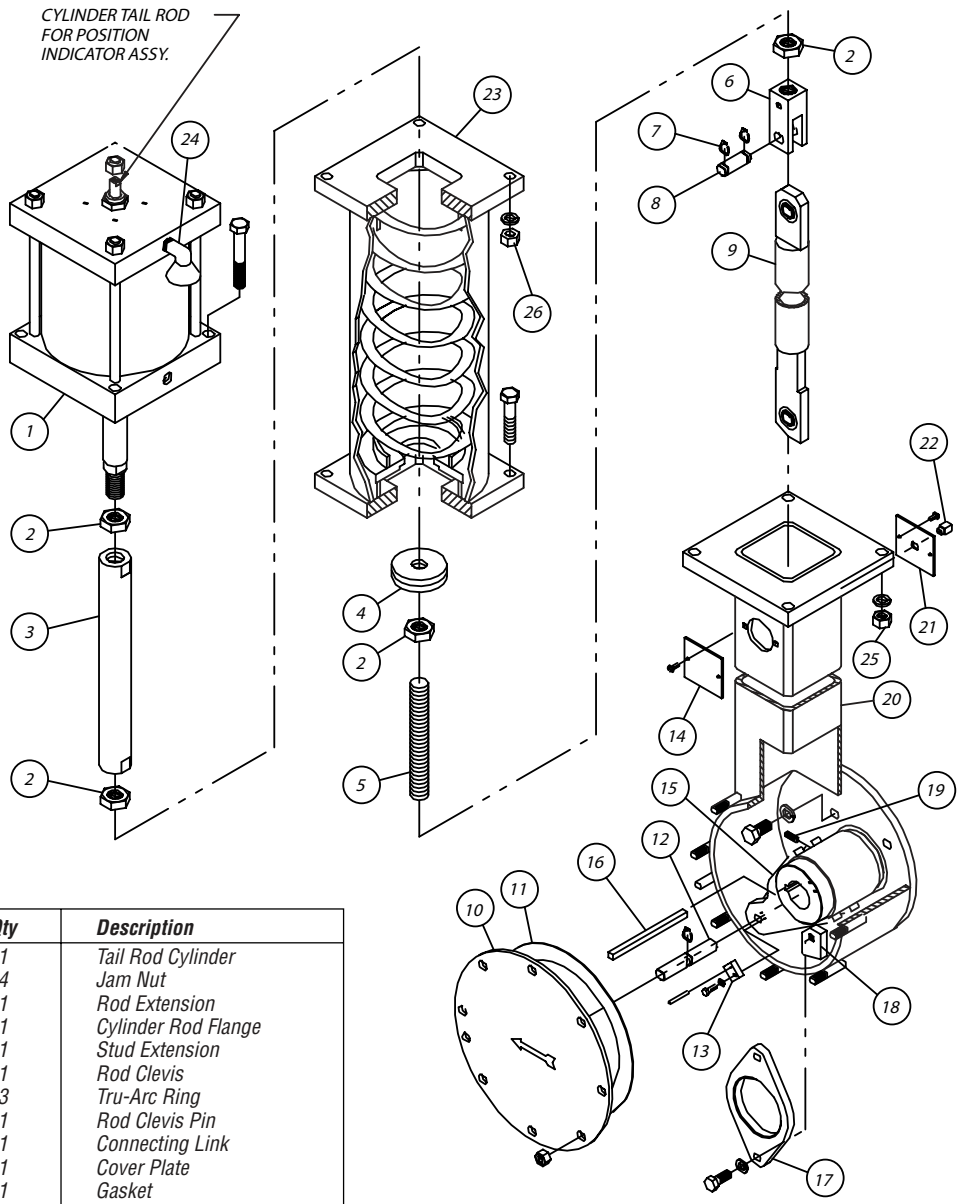
Item	Qty	Description
1.	1	Spring Cartridge
2.	1	5/8 S.S. Rod
3.	2	Tru-Arc Ring
4.	1	Jam Nut
5.	1	4 in. STK. Rod Clevis
6.	1	Rod Clevis Pin
7.	1	Connecting Link
8.	1	Actuator Housing
9.	1	Set Screw
10.	1	Pin Clamp
11.	2	Square Key
12.	1	Gasket
13.	1	Cover Plate
14.	1	Flexible Shaft
15.	1	Mounting Bracket
16.	1	Torque Arm Pin
17.	1	Torque Arm
18.	1	Outboard Plate
19.	1	Connecting Link
20.	1	Rod Clevis Pin
21.	3	Tru-Arc Pin
22.	1	Cylinder
23.	1	Cylinder Rod Flange
24.	1	Rod Clevis
25.	1	Cylinder Vent
26.	1	Housing Vent

NOTES:

1) ASSEMBLY IS SHOWN WITH ACTUATOR IN FULL OPEN POSITION.



Drawing 55-9020: Surge Control Actuator (Fail Open)

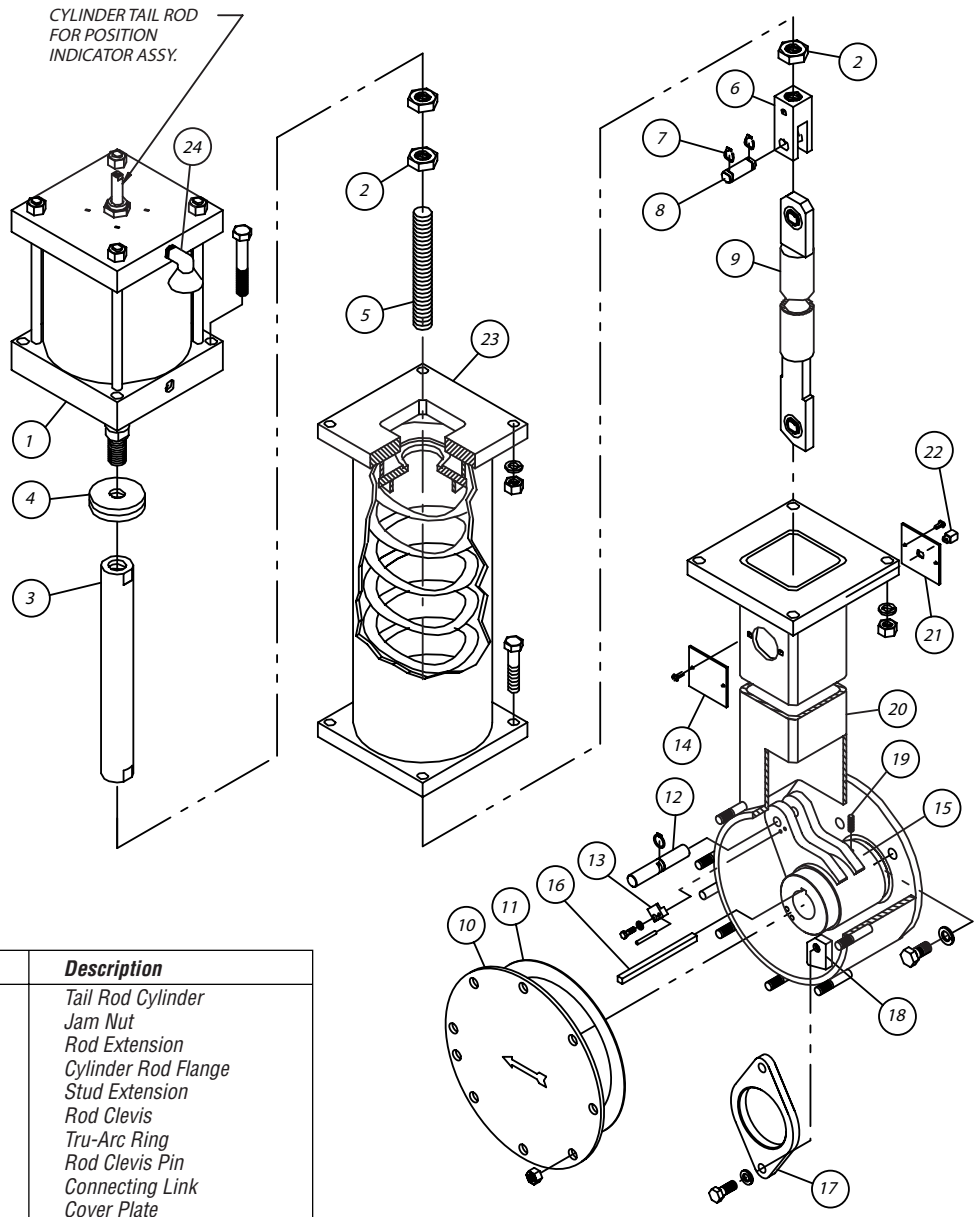


Item	Qty	Description
1.	1	Tail Rod Cylinder
2.	4	Jam Nut
3.	1	Rod Extension
4.	1	Cylinder Rod Flange
5.	1	Stud Extension
6.	1	Rod Clevis
7.	3	Tru-Arc Ring
8.	1	Rod Clevis Pin
9.	1	Connecting Link
10.	1	Cover Plate
11.	1	Gasket
12.	1	Torque Arm Pin
13.	1	Pin Clamp
14.	1	Access Cover
15.	1	Torque Arm
16.	1	Square Key
17.	1	Outboard Plate
18.	2	Ear
19.	1	Set Screw
20.	1	Housing Assy.
21.	1	Access Cover w/Hole
22.	1	Housing Vent
23.	1	Spring Cartridge
24.	1	Cylinder Vent
25.	4	Spring Cartridge Mtg. Nuts
26.	4	Cylinder Mtg. Nuts

NOTES:

1) ASSEMBLY IS SHOWN WITH ACTUATOR IN OPEN POSITION.

Drawing 55-9026: Below Grade Spring Return Actuator (Fail Open)



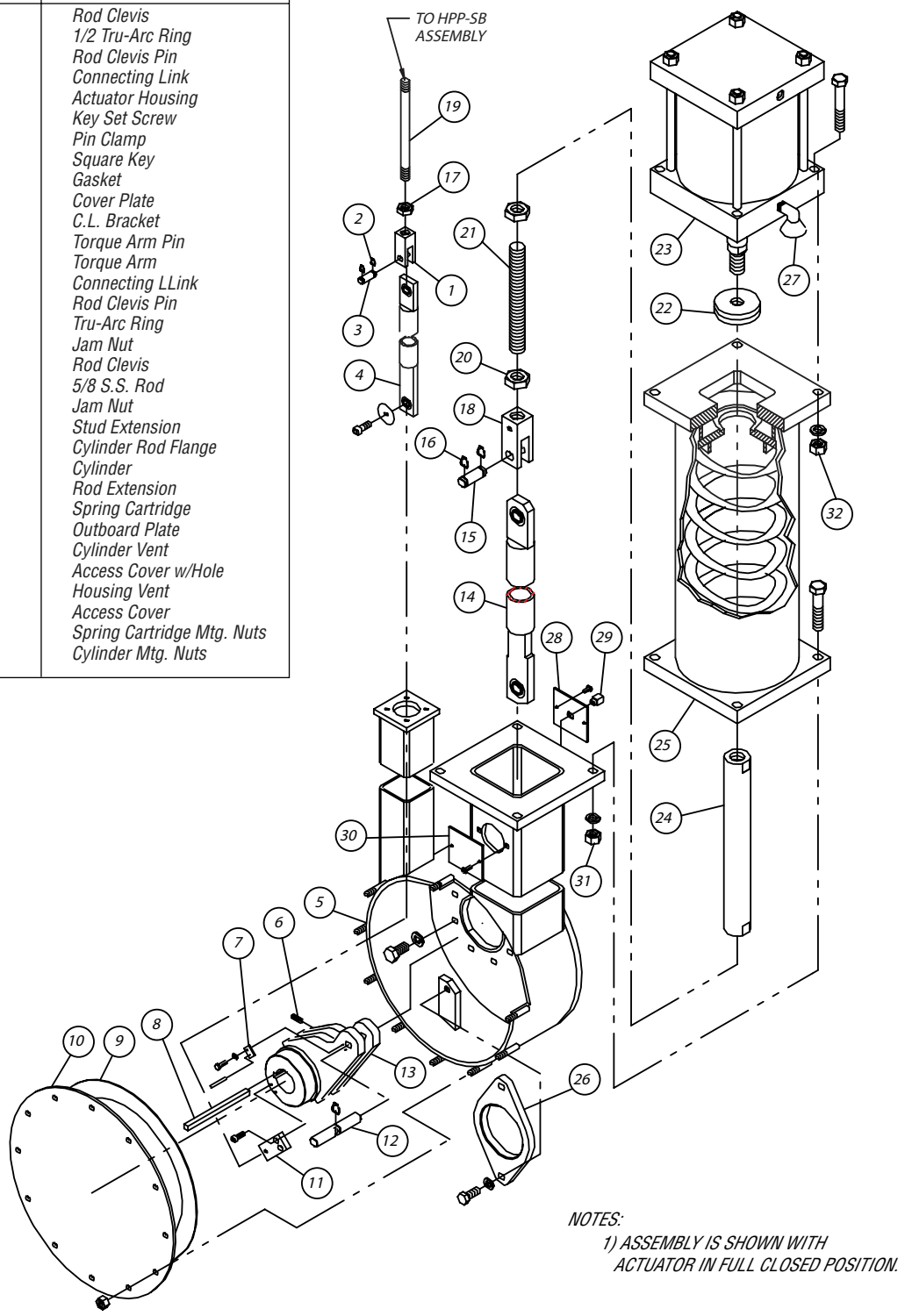
Item	Qty	Description
1.	1	Tail Rod Cylinder
2.	4	Jam Nut
3.	1	Rod Extension
4.	1	Cylinder Rod Flange
5.	1	Stud Extension
6.	1	Rod Clevis
7.	3	Tru-Arc Ring
8.	1	Rod Clevis Pin
9.	1	Connecting Link
10.	1	Cover Plate
11.	1	Gasket
12.	1	Torque Arm Pin
13.	1	Pin Clamp
14.	1	Access Cover
15.	1	Torque Arm
16.	1	Square Key
17.	1	Outboard Plate
18.	2	Ear
19.	1	Set Screw
20.	1	Housing Assy.
21.	1	Access Cover w/Hole
22.	1	Housing Vent
23.	1	Spring Cartridge
24.	1	Cylinder Vent

NOTES:

1) ASSEMBLY IS SHOWN WITH ACTUATOR IN CLOSED POSITION.

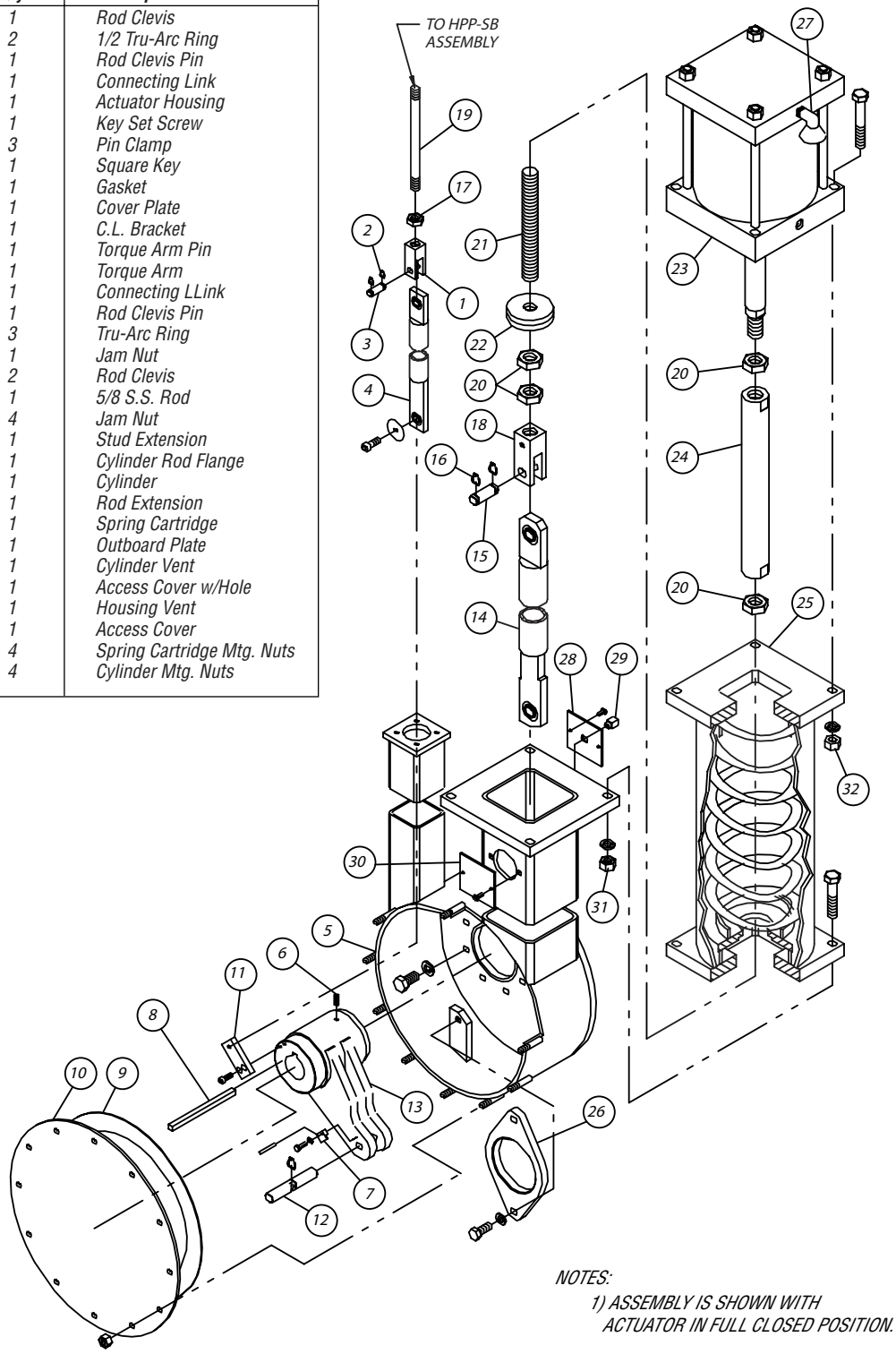
Drawing 55-9033: Below Grade Spring Return Actuator (Fail Closed)

Item	Qty	Description
1.	1	Rod Clevis
2.	2	1/2 Tru-Arc Ring
3.	1	Rod Clevis Pin
4.	1	Connecting Link
5.	1	Actuator Housing
6.	1	Key Set Screw
7.	3	Pin Clamp
8.	1	Square Key
9.	1	Gasket
10.	1	Cover Plate
11.	1	C.L. Bracket
12.	1	Torque Arm Pin
13.	1	Torque Arm
14.	1	Connecting LLink
15.	1	Rod Clevis Pin
16.	3	Tru-Arc Ring
17.	1	Jam Nut
18.	1	Rod Clevis
19.	1	5/8 S.S. Rod
20.	4	Jam Nut
21.	1	Stud Extension
22.	1	Cylinder Rod Flange
23.	1	Cylinder
24.	1	Rod Extension
25.	1	Spring Cartridge
26.	1	Outboard Plate
27.	1	Cylinder Vent
28.	1	Access Cover w/Hole
29.	1	Housing Vent
30.	1	Access Cover
31.	4	Spring Cartridge Mtg. Nuts
32.	4	Cylinder Mtg. Nuts



Drawing 55-9030: Below Grade Spring Return Actuator with Proportional Feedback (Fail Open)

Item	Qty	Description
1.	1	Rod Clevis
2.	2	1/2 Tru-Arc Ring
3.	1	Rod Clevis Pin
4.	1	Connecting Link
5.	1	Actuator Housing
6.	1	Key Set Screw
7.	3	Pin Clamp
8.	1	Square Key
9.	1	Gasket
10.	1	Cover Plate
11.	1	C.L. Bracket
12.	1	Torque Arm Pin
13.	1	Torque Arm
14.	1	Connecting LLink
15.	1	Rod Clevis Pin
16.	3	Tru-Arc Ring
17.	1	Jam Nut
18.	2	Rod Clevis
19.	1	5/8 S.S. Rod
20.	4	Jam Nut
21.	1	Stud Extension
22.	1	Cylinder Rod Flange
23.	1	Cylinder
24.	1	Rod Extension
25.	1	Spring Cartridge
26.	1	Outboard Plate
27.	1	Cylinder Vent
28.	1	Access Cover w/Hole
29.	1	Housing Vent
30.	1	Access Cover
31.	4	Spring Cartridge Mtg. Nuts
32.	4	Cylinder Mtg. Nuts



Drawing 55-9028: Below Grade Spring Return with Proportional Feedback (Fail Closed)

Drawing 01-6779: Single Rod Cylinder (8 in. - 14 in. Bore)

Item	Qty	Description	Material
1.	4	Hex Nut	Steel
2.	1	Top Head	Steel
3.	1	Piston	Nodular Iron
4.	2	Piston Seal	Buna-N U-Cup
5.	1	Bottom Head	Steel
6.	4	Gland Screw	Alloy Steel
7.	1	Rod Seal	Polyurethane U-Cup
8.	1	Piston Rod	Hard Chrome Plated Steel
9.	1	Piston Rod Bearing	Duralon Bearing in a Steel Shell
10.	1	Gland Plate	Steel
11.	1	Tubing	Precision Honed Steel
12.	2	Tube Seal	Buna-N O-Ring
13.	4	Tie Rod	High Strength Steel
14.	1	Piston Rod Static Seal	Buna-N O-Ring

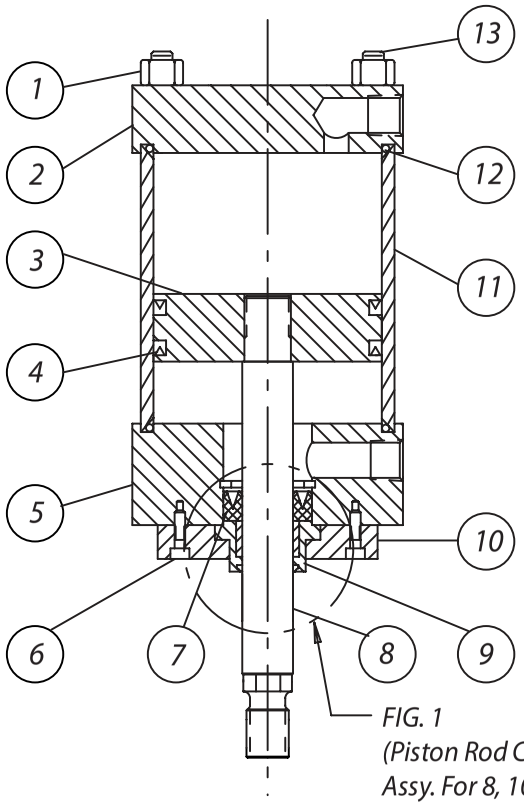


FIG. 1
(Piston Rod Cart. Assy. For 8, 10, 14" Bore Only)

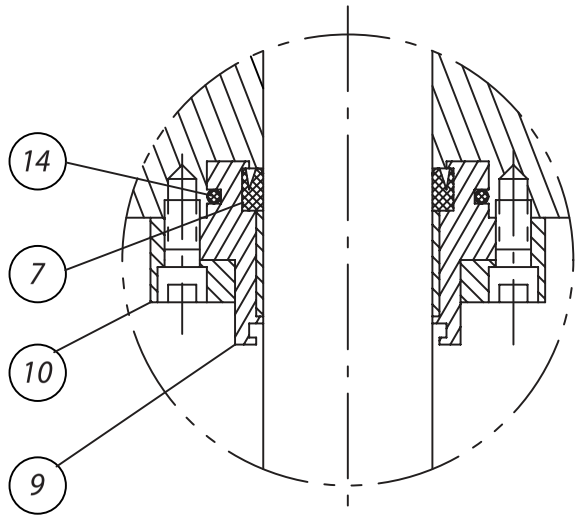


FIG. 1
(This Piston Rod Cart. Assy for 12" Bore Only)

Item	Qty	Description	Material	Item	Qty	Description	Material
1.	4	Hex Nut	Steel	11.	1	Tubing	Precision Honed Steel
2.	1	Top Head	Steel	12.	2	Tube Seal	Buna-N O-Ring
3.	1	Piston	Nodular Iron	13.	4	Tie Rod	High Strength Steel
4.	2	Piston Seal	Buna-N U-Cup	15.	1	Tail Rod Seal	Buna-N U-Cup
5.	1	Bottom Head	Steel	16.	1	Tail Rod Static Seal	Buna-N O-Ring
7.	1	Rod Seal	Polyurethane U-Cup	17.	1	Tail Rod Bearing	Duralon Bearing in a Steel Shell
8.	1	Piston Rod	Hard Chrome Plated Steel				
9.	1	Piston Rod Bearing Shell	Duralon Bearing in a Steel	18.	1	5/8" Dia. Tail Rod	Hard Chrome Plated Steel
10.	1	Gland Plate	Steel				

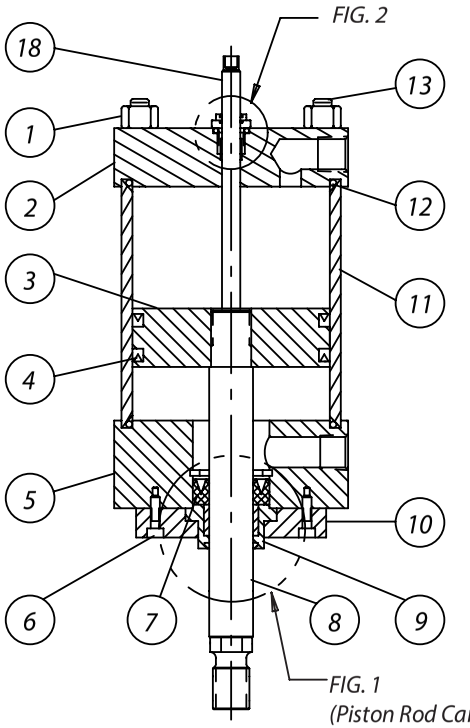


FIG. 1
(Piston Rod Cart.
Assy. for 8, 10, 14" Bore)

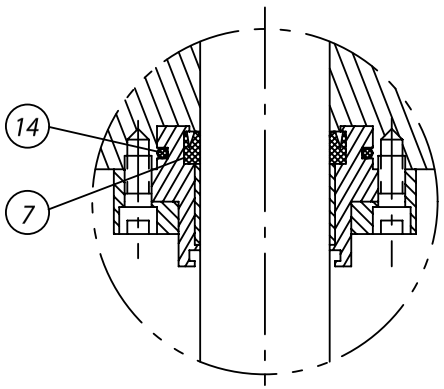


FIG. 1
(This Piston Rod Cart.
Assy. for 12" Bore Only)

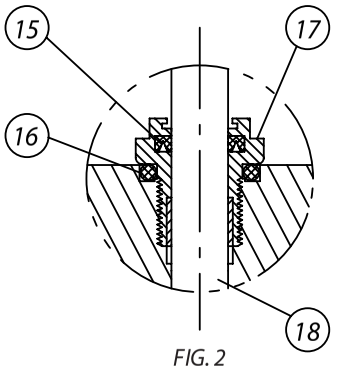


FIG. 2

Drawing 01-6780: Tail Rod Cylinder (8 in. - 14 in. Bore)

Item	Qty	Description	Material
1.	4	Hex Nut	Steel
2.	1	Top Head	Steel
3.	1	Piston	Nodular Iron
4.	2	Piston Seal	Buna-N U-Cup
5.	1	Bottom Head	Steel
7.	1	Rod Seal	Polyurethane U-Cup
8.	1	Piston Rod	Hard Chrome Plated Steel
9.	1	Piston Rod Bearing	Duralon Bearing in a Steel Shell
10.	1	Mounting Flange	Steel
11.	1	Tubing	Precision Honed Steel
12.	2	Tube Seal	Buna-N O-Ring
13.	4	Tie Rod	High Strength Steel

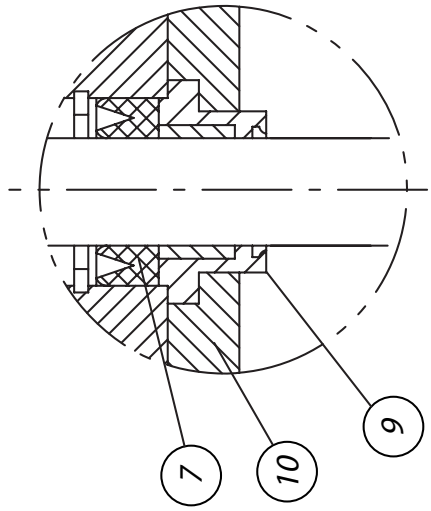


FIG. 1

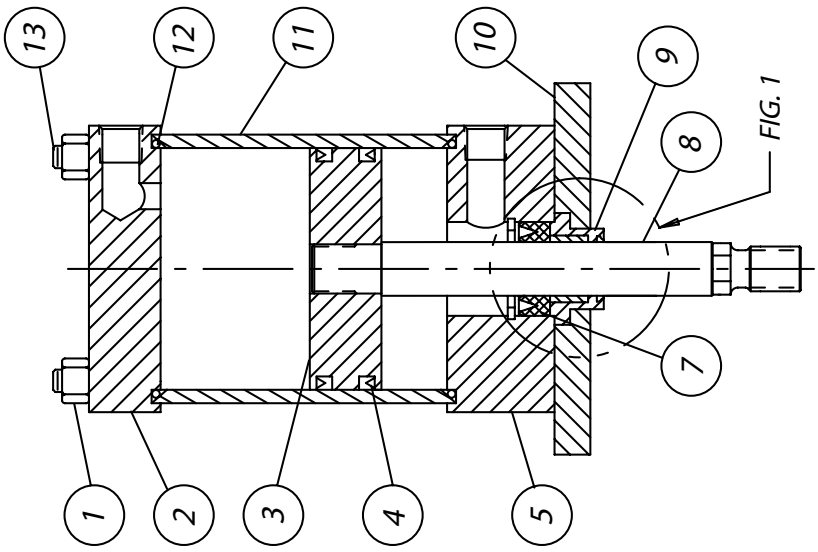
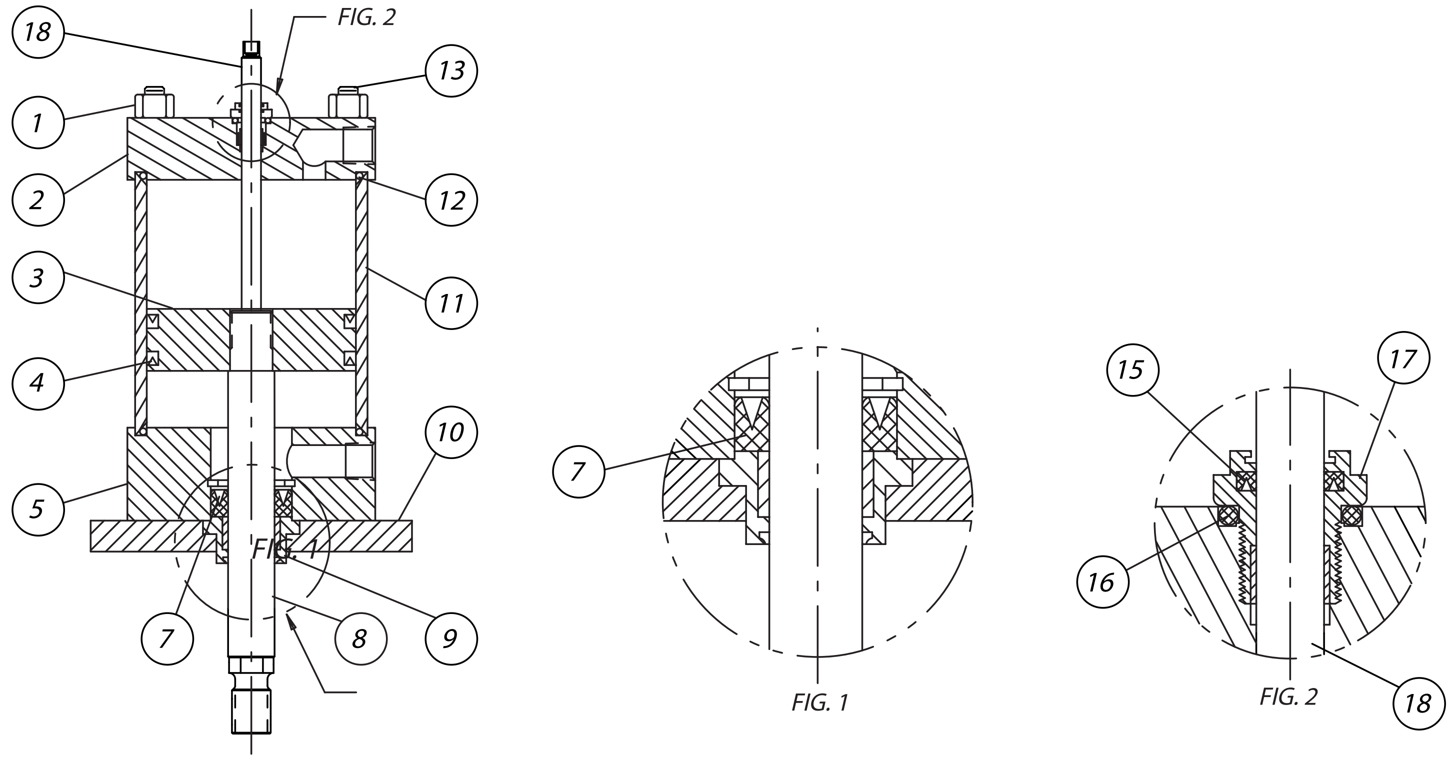


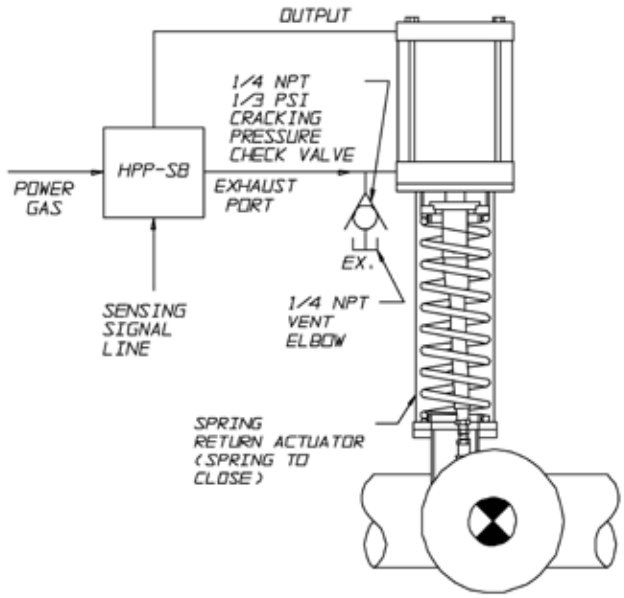
FIG. 1

Drawing 01-6851: Single Rod Cylinder (4 in. - 6 in. Bore)

Item	Qty	Description	Material	Item	Qty	Description	Material
1.	4	Hex Nut	Steel	11.	1	Tubing	Precision Honed Steel
2.	1	Top Head	Steel	12.	2	Tube Seal	Buna-N O-Ring
3.	1	Piston	Nodular Iron	13.	4	Tie Rod	High Strength Steel
4.	2	Piston Seal	Buna-N U-Cup	15.	1	Tail Rod Seal	Buna-N U-Cup
5.	1	Bottom Head	Steel	16.	1	Tail Rod Static Seal	Buna-N O-Ring
7.	1	Rod Seal	Polyurethane U-Cup	17.	1	Tail Rod Bearing Steel Shell	Duralon Bearing in a
8.	1	Piston Rod	Hard Chrome Plated Steel				
9.	1	Piston Rod Bearing Shell	Duralon Bearing in a Steel	18.	1	5/8" Dia. Tail Rod	Hard Chrome Plated Steel
10.	1	Gland Plate	Steel				



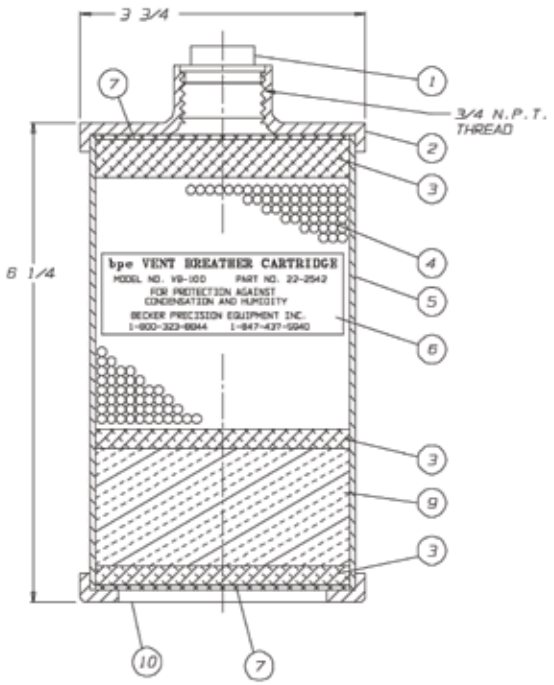
Drawing 01-6852: Tail Rod Cylinder (4 in. - 6 in. Bore)



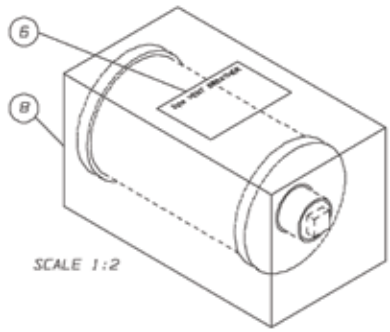
Notes:

1. Check valve maintains a 1/2 psi positive pressure inside of the cylinder during steady state. This protects cylinder against moisture.
2. During startups, pressure increases in the cylinder up to 3 psig. This generates a a boost and greatly reduces the unloading time.
3. When additional accessories are used (MCV, Versa valves, etc.) all parts must be connected through the check valve.

Drawing Jan97-1: Spring Return Regulator Buffer System



Item	Qty	Part No.	Description
1.	1	22-2307	Plastic Plug
2.	1	22-2302	Canister Top
3.	4	22-2510	Fiberglass Retainer
4.	.75 lb.	21-0100	Silica Gel (1/2 lb.)
5.	1	22-2309	Canister Top
6.	2		Identification Label
7.	2	22-3007	Screen
8.	1	22-2306	Shipping Carton
9.	2 ft.	22-2543	S.S. Wool
10.	1	22-2308	Canister Bottom



Drawing 21-2542: Vent Breather

Ball Valve Regulator (Single-Acting) Maintenance Checklists

Note: Refer to the Ball Valve Regulator Maintenance and Inspection section of the Becker Ball Valve Regulator (Single Acting, Spring Return) Maintenance and Operation Manual for details about completing the following checklists.

(Includes ball control valve and actuator)

1. _____ **Ball Valve Regulator Stroking Operation**
   Page 5
2. _____ **Inspecting the Actuator Housing Vent**
   Page 5
3. _____ **Inspecting for Valve Stem Seal Leaks**
   Page 5
4. _____ **Inspecting for Cylinder Piston Rod Seal Leaks**
   Page 5
5. _____ **Inspecting the Control Instrumentation**
   Refer to the technical manual included with each specific instrumentation application for further instruction.

5 Year Maintenance Checklist
(Includes ball control valve and actuator)

1. _____ Performing Ball Valve Regulator (Single-Acting) Recommended Annual Maintenance
Refer to Annual Maintenance above.

2. _____ Checking Tube Seals (O-Rings)
Page 6

3. _____ Checking Piston Seals (U-Cups)
Page 6

4. _____ Checking Tail Rod Seals
Page 7

5. _____ Inspecting for Lost Motion
Page 8

6. _____ Inspecting the Control Instrumentation
Refer to the technical manual included with each specific instrumentation application for further instruction.

"As Needed" Maintenance Checklist
(Includes ball control valve and actuator)

1. _____ Inspecting for Valve Seat Leaks
Page 9

2. _____ Lubricating the Actuator Cylinder
Page 9

3. _____ Lubricating the Ball Valve
Page 9

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