BECKER
PRECISION EQUIPMENT INC.

Maintenance and Operation Manual
for
Becker Ball Valve Regulator
(Single-Acting, Spring Return Series)

Introduction:

The **Becker** Ball Valve Regulator (BVR) is a high capacity regulator designed specifically for natural gas regulation. The **Becker** BVR is built to exacting specifications in order to offer 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 the assistance of **Becker Precision Equipment** factory personnel). All **Becker** BVR's 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 those qualified through training or experience should install, operate, or maintain **Becker** BVR's.

The **Becker** Spring Return Ball Valve Regulator is comprised of three (3) major components:

1. Control Valve (Ball Valve Type)
2. Throttling Valve Actuator with welded spring cartridge
3. 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 Control Instrumentation supplied with your Ball Valve Regulator.

Technical Assistance:

Should you have any questions, you may contact your local **Becker Precision** sales representative or **Becker Precision** technical assistance at:

Becker Precision Equipment, Inc.
Attn.: Technical Assistance
950 Pratt Boulevard
Elk Grove Village, IL 60007 USA

Toll-Free: (800) 323-8844
Tel: (847) 437-5940
Fax: (847) 437-2549
e-mail: Becker@bpe950.com
Web site: www.bpe950.com

In order to 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)***
- **Becker Invoice Number *(see upper right corner of first page of instruction manual*)**

Becker Web Site:

To receive the most recent version of these instructions, visit the becker web site and click on the **Manuals** button. In order to view and print these documents, you will need to download the Adobe Acrobat Reader®. Follow the instructions provided on the web page. For further assistance using the web page, contact us toll free.

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Part 1: Single-Acting, Spring Return Valve Actuators

Technical Specifications

Actuator Type	• Pneumatic Crank Arm Design (quarter turn) with Spring Return
Rotation (Output)	• Fixed 90E (standard) • 85E through 95E 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	• 2200 inch lbs. To 120,000 inch lbs. (for Fail Open actuators) • 1500 inch lbs. To 60,000 inch lbs. (for Fail Open actuators)
Operating Temperature Range	• -20EF to +160EF (standard)
Power Gas Minimum	• 100 psig (standard) • 75 psig minimum (contact Becker)
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 insures non-pressurized side of piston stays clean and dry
Power Gas Moisture Requirements	• < 7 Lb. Per 1.0 mmscf If excessive moisture or hydrocarbon content is present, a Filter Dryer may be necessary. For adequate filtration and elimination of moisture, a Becker Model FD-1500 Filter-Dryer should be installed. Refer to Becker FD-1500 literature to determine if a Model FD-1500 Filter-Drier is necessary. For adequate filtration and elimination of liquid hydrocarbon, a Becker Model FACD-1500 Filter-Deodorizer should be installed.
Power Gas Heat Requirements	If ambient temperatures may fall below the specified temperature range, it is recommended that the Ball Valve Regulator be installed in a heated enclosure. Any heating devices utilized must be rated as "explosion-proof for a hazardous environment." Becker Precision Equipment recommends the use of catalytic heaters when heat is required. The catalytic heater utilizes natural gas fuel and provides a safe, flameless heat.

Materials of Construction

Housing/Linkage	• Carbon Steel
Spring cartridge	• Carbon Steel • Welded construction
Spring	• 6150H • 316 SS (available for low temp.)
Torque Arm Bearings	• Duralon J (fiberglass weave with Teflon J coating) in steel shell
Linkage Bearings	• 316SS spherical bearings
Cylinder Tube°	• Chrome-plated steel
Pneumatic Cylinder Tube Seals	• Buna-N O-Rings
Cylinder Piston	• Nodular iron
Pneumatic Cylinder Piston Seals	• Buna-N U-Cups
Cylinder Piston Rod	• Chrome-plated hardened steel
Pneumatic Cylinder Piston Rod Bearing	• Duralon J (fiberglass weave with Teflon J coating) in steel shell
Pneumatic Cylinder Piston Rod Seal	• Polyurethane U-Cup
Cylinder Tailrod*	• Chrome-plated hardened steel
Pneumatic Cylinder Tailrod Bearing*	• Duralon J (fiberglass weave with Teflon J coating) in steel shell
Pneumatic Cylinder Tailrod Seal*	• Buna-N U-Cups
Pneumatic Cylinder Tailrod Static Seal*	• Buna-N O-Ring
Actuator Paint/Coating	• Above Grade Portion std. coating: -prime coat epoxy (6-10 mil) -finish coat polyurethane. • Below Grade Portion std. coating: -Tar Set J -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	• $^3/_8$" Seamless Tubing 316 SSH
Instrumentation Tubing Fittings	• Double Ferrule design 316 SS (standard)

Notes:

1. *Applicable only to actuators equipped with tailrod cylinder.
2. HLarger actuators and quick stroking actuators typically require ½" Seamless Tubing 316 SS.
3. °Cylinders are supplied with pneumatic cushions when stroking time is three (3) seconds or less.

PART 2: Becker 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 individual valve manufacturer's manuals. • Options available for valve construction and trim materials- contact Becker Precision Equipment factory personnel.
WKM Valves	• Refer to DynaSeal**7** 370E-4 Ball Valve Installation, Operation and Maintenance Manual.
Grove Valves	• Grove B-5 & B-4D Ball Valve Installation & Maintenance Manual (Bulletin No. B-IRM 5/95) • Grove Ball Valves (Bulletin No. 209 11/94)
TK Valves	• Refer to TK Instruction Manual
Final Control Elements T-Ball **J**	• Refer to Final Control Elements T-Ball **J** Control Valve literature and Grove Valve literature
Valve Face to Face Dimensions	• Per ANSI B16.10
Available Size Ranges	• 2" through 16" Standard ANSI sizes
Available ANSI Ratings	• 150 ANSI through 2500 ANSI
Available End Connections	• RFFE standard • Weld end • RTJ (ring-joint)

Notes on Becker Approved Control Valves:

- Becker Precision Equipment has many years of experience in the design of Ball Valve Regulators. While Becker heavily utilizes preferred standard control valves, a differing application or customer preference may dictate the need for an alternate valve. Becker Throttling Actuators can be matched with almost any valve for various Ball Valve Regulator applications. Consult Becker factory personnel for specific applications.

Control Valve Specifications:

WKM 370E-4	• Manufactured to API Spec. 6D
Grove Control B-5, B-4D	• Manufactured to API Spec 6D
TK Valve	• Manufactured to API Spec. 6D
Final Control Elements T-Ball **J**	• Manufactured to ANSI B16.34

Leakage Rate Specifications

Control Valve Leakage Class:

WKM 370E-4	• API 6D "Bubble Tight"
Grove Control B-5	• API 6D "Bubble Tight"
TK Valve	• API 6D "Bubble Tight"
Final Control Elements T-Ball **J**	• ANSI Class IV "0.01% of Valve capacity" for standard service • ANSI Class V for surge control service

Notes on Control Valve Leakage:
Regulating valves, or control valves, do not generally require shut-off 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 guaranteed to maintain "bubble tight" shutoff (API Class VI) upon initial installation. Regulators equipped with the Final Control Elements T-Ball **J** exhibit API Class IV shutoff upon initial installation. 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 the customer's discretion.

The leakage rate of a Ball Valve Regulator depends upon several variables:

- 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 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

In the case where positive API Class VI "bubble tight" shutoff must be maintained, Becker advises one of two possibilities:

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

PART 3:
Ball Valve Regulator Maintenance and Inspection

It is important to inspect and maintain Becker Precision Equipment Ball Valve Regulators on a regular basis. In the following section, instructions are provided for ***Annual***, ***5 year***, and *"**As-needed**"* maintenance and inspection of the BVR. Although Becker 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. In order to prevent further damage to the BVR and the surrounding environment, the following maintenance and inspection procedures are recommended:

Annual Maintenance and Inspection

Ball Valve Regulator Stroking Operation

What is considered proper valve & actuator stroking?

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

- 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 mid-stroke.
- Consistent stroking speed.
- No abnormal noises (scraping, chattering, or metallic sounds).

Procedure 1: Checking for Proper Valve and Actuator Stroking.

How do I check for 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), stroke the BVR from one end of travel to the other.
3. If the BVR is not equipped with a Manual Control Valve (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, corrective action is probably necessary (see below).

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.

How do I correct any problems associated with improper valve and actuator stroking?

If improper stroking of the valve or actuator is exhibited, then:

- First check the lubrication of the ball valve (refer to **Ball Valve Lubrication [Procedures 9 and 9.a]** on page 12).
- If lubrication of the ball valve does not fix improper stroking, check the lubrication of the actuator cylinder (refer to **Applying Cylinder Lubrication [Procedure 8]** on page 11).

Actuator Housing Vent Inspection

An annual inspection of Actuator Housing is recommended 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.

Procedure 2:
Checking Actuator Housing for Venting Gas.

How do I determine if Actuator Housing is venting gas?

1. Make sure Actuator Cover Plate is installed and securely sealed with Gasket.
2. Make sure all Actuator Access Covers and plates are installed and sealed.
3. Remove Vent Elbow. (All 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 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 (starting with Valve Stem Seal leakage inspection).

Procedure 2.a:
Valve Stem Seal Leakage Inspection.

How do I inspect for Valve Stem Seal 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 continue to the next step.
2. Shut off the power (supply) gas.
3. Depressurize actuator
4. Valve Stem Seal leakage allows gas to escape from the pressurized valve body into the BVR Actuator Housing which is normally maintained at atmospheric pressure.
5. Valve Stem Seal leakage will be apparent when gas escapes from the BVR Actuator Housing while power gas is shut off.
6. Minimal degrees of Valve Stem Seal leakage can be visually detected by placing a soap bubble on the vent of the Actuator Access Cover.
7. Greater degrees of Valve Stem Seal leakage may be detected by an audible flow of gas coming from the Actuator Access Cover. If Valve Stem Seal leakage is detected, replace the Valve Stem Seal (refer to **Procedure 3: Valve Stem Seal Replacement** on this page).

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 **Procedure 5.a: Replacing Piston Rod Seals** on page 10).

Procedure 2.b:
Cylinder Piston Rod Seal Leakage Inspection.

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

How do I Inspect for Cylinder Piston Rod Seal leakage?

(Including Piston Rod Static Seal)

1. Valve must be in full open or closed position.
2. Leave 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 Piston Rod Seals (refer to **Procedure 5.a: Replacing Piston Rod Seals** on page 10).

Valve Stem Leakage

What is valve stem leakage?

Ball valves utilized by **Becker Precision Equipment** 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.

What causes valve stem leakage?

Valve stem leakage can be caused by the following:

- 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.

Valve Stem Seal Inspection

For instructions on Valve Stem Seal inspection, refer to **Procedure 2.a: Valve Stem Seal Leakage Inspection** on this page.

Procedure 3:
Valve Stem Seal Replacement.

How can Valve Stem leakage be corrected?

1. Valve Stem leakage necessitates replacement of the Valve Stem Sealing components. (Consult valve manuals or **Becker Precision** factory staff for replacement parts).
2. The COMPLETE BVR actuator must be removed in order to access the Valve Stem Seals.
3. Valve Stem Seal kits are available from **Becker Precision Equipment**.
4. Consult the valve manufacturer's specific instruction manual for stem seal replacement procedures.
5. **DO NOT** apply sealant or attempt to lubricate the stem seal without contacting Becker Precision Equipment for proper instruction.
6. The BVR should be inspected for lost motion in order to minimize the possibility of premature Valve Stem Seal wear (refer to **Procedure 6: Inspecting for Lost Motion** on page 10).

Control Instrumentation Inspection (Annual) – see applicable manual

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

5 Year Maintenance and Inspection

Actuator Cylinder Seal Leakage Inspection

(Refer to **Drawings 01-6779, 01-6780, 01-6851, and 01-6852,** on pages 19-22).

What is Actuator Cylinder Seal leakage?

Becker Precision Equipment utilizes the highest quality pneumatic cylinders in order to ensure long-life and optimum performance. 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 occur causing degradation in the performance of the Ball Valve Regulator. Actuator Cylinder Seal leakage is typically attributed to wear over a very long period of time. However, Actuator Cylinder Seals can wear prematurely due to excessive cycling (caused by Ball Valve Regulator 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?

Becker recommends the inspection of all Cylinder Seals every 5 years. Begin by removing the Pneumatic buffer system or desiccant canister.

Procedure 4:
Checking Tube Seals (O-Rings).

1. Pressurize the normally pressurized side of the cylinder with at least 100 psig power supply gas.
2. Apply a leak-check solution around the perimeter of the cylinder tubing wall. Any leakage should be easily visible.
3. Tube Seals should be replaced if ANY leakage is exhibited (refer to **Procedure 5: Replacing Tube Seals or Piston Seals** on page 9).

Procedure 4.a:
Checking Piston Seals (U-Cups).

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 table below), replace the seal (refer to **Procedure 5: Replacing Tube**

Seals or Piston Seals on page 9).

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 put back in service immediately. New seals can then 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 table below).
7. Apply 100 psig power gas supply 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 Definition
> +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

Checking Piston Rod Seals.

For instructions on Piston Rod Seal inspection, refer to **Procedure 2.b: Cylinder Piston Rod Seal Leakage Inspection** on page 7.

Procedure 4.b: Checking Tail Rod Seals.

(Includes Tail Rod Static Seal)

1. Pressurize the cylinder top with at least 100 psig power supply gas.
2. Remove Lexan Position Indicator Scale from Actuator Cylinder Topworks Box in order to gain access to Actuator Cylinder Tail Rod Seals.
3. Apply light grade oil around the Tail Rod Cylinder Seal area.
4. Any leakage should be easily visible.
5. Tail Rod Cylinder Seals should be replaced if excessive leakage is exhibited (refer to **Procedure 5.b: Replacing Tail Rod Seals** on page 10).

Procedure 4.c: Pneumatic Buffer System or Vent Breather

(Refer to **Drawings 21-2542** and **Jan97-1** on page 38).

What is the pneumatic buffer system or vent breather?

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 non-pressurized cylinder port and out through the check valve. The check valve "traps" 1/3 psig of gas pressure in the cylinder to insure that it remains clean, dry, and free of contaminants from the surrounding air (see drawing #Jan97-1). The vent breather insures 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).

1. For the pneumatic buffer system – check for leaks around the check valve and up to the cylinder port to insure the system is working.
2. For the vent breather – Replace the unit at the first signs of moisture inside the canister. For a working regulator, it is recommended to replace the cartridge annually. The replacement part number is **22-2542**.

Correcting Actuator Cylinder Seal Leakage

Procedure 5:
Replacing Tube Seals (O-Rings) or Piston Seals (U-Cups).

(This procedure DOES NOT require 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 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 ensure proper realignment upon reassembly.
4. CAUTION: BE SURE THAT POWER GAS PRESSURE HAS BEEN FULLY VENTED FROM THE ACTUATOR CYLINDER PRIOR TO LOOSENING TIE-ROD NUTS.
5. Remove Tie-Rod Nuts from the Actuator Cylinder Top Flange.
6. If Tie-Rod Nut seizes and Tie-Rod unscrews, remove entire Tie-Rod.
7. Remove Actuator Cylinder Top Flange and Tubing Wall by lifting straight up.
8. TO PREVENT DAMAGE: DO NOT STRIKE ACTUATOR CYLINDER TUBING WALL WITH ANY OBJECT WHEN REMOVING.
9. Remove any rust, dirt, or foreign material from the Cylinder Tubing Wall and Piston using solvent if needed. DO NOT USE ABRASIVE CLEANING METHODS SUCH AS WIRE BRUSHES OR SANDPAPER.
10. Inspect 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.
11. Install new Actuator Cylinder Tube Seals (O-Rings) and/or Piston Seals (U-Cups) as needed.
12. Be careful not to damage replacement seals during installation.
13. Using a clean, lint-free cloth, apply a thin layer of STP**7** brand lubricant to the Cylinder Tubing Wall and the Piston Seals.
14. Wipe excess STP**7** brand lubricant from the Cylinder Wall and the Piston Seals.
15. Reassemble actuator cylinder and install Tie-Rods and Tie-Rod Nuts.
16. Tighten Tie-Rod Nuts in a crossing pattern, tightening to specified torque ratings (listed below).
17. Reassemble instrumentation and tubing.

TABLE- Specified Actuator Cylinder Tie-Rod Torque

Cylinder Bore	Tie Rod Size	Tie Rod Torque	Piston Rod Seal Kit #	Piston Seal Kit #
4	**d** -24	28 ft.- lb.	01-6836	01-6819
5	½ - 20	48 ft.- lb.	01-6836	01-6820
6	½ - 20	48 ft.- lb.	01-6837	01-6821
8	**e** - 18	115 ft.- lb.	01-6837	01-6822
10	¾ - 16	170 ft.- lb.	01-6838	01-6833
12	¾ -16	170 ft.- lb.	01-6839	01-6834
14	**f** - 14	375 ft.- lb.	01-6840	01-6835

Procedure 5.a:
Replacing Piston Rod Seals.

(This procedure necessitates removal of the cylinder from actuator to access the rod seal cartridge. Replacement of the rod seals, however, does not require disassembly of the cylinder due to this cartridge design)

1. Remove the power supply gas pressure and depressurize all instrumentation, including the actuator cylinder.
2. Remove actuator cylinder - follow disassembly procedures for actuator cylinder removal (**refer to pages 13 & 14**).
3. Remove the rod extension (if equipped) and Clevis.
4. Remove the Gland Plate from the bottom of the actuator cylinder. Small bore (4", 5", & 6") actuator cylinders are equipped with a Mounting Flange which must be removed.
5. After replacement of all Piston Rod Seals, lubricate assembly with STP**7** brand lubricant and reassemble the Gland Plate, Cylinder Rod Flange, and the Clevis.

Procedure 5.b:
Replacing Tail Rod Seals.

(This procedure DOES NOT require removal of cylinder from actuator).

1. Remove the power supply gas pressure and depressurize all instrumentation, including the actuator cylinder.
2. Actuator may be in any location for Tail Rod Seal replacement.
3. Remove instrumentation tubing and instrumentation from the actuator cylinder.
4. Remove Actuator Cylinder Topworks Box.
5. Remove Topworks Box Mounting Flange to gain access to the Tail Rod Seals.
6. Remove the Tail Rod Seal Cartridge Assembly and replace all Tail Rod Seals with new seals

from repair kit. Use all seals provided in the kit (instructions provided in the kit illustrate the proper installation).
7. After replacement of all Tail Rod Seals, lubricate assembly with STP**7** brand lubricant and reassemble the Gland Plate.
8. Reinstall Topworks Assembly, instrumentation and instrumentation tubing.

Ball Valve Regulator Lost Motion Inspection

What is Lost Motion?
Becker Precision Ball Valve Regulators are manufactured to exacting tolerances in order 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.

Procedure 6:
Inspecting for Lost Motion.

How do I inspect for Lost Motion?
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. It is advisable to 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), however, 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 ¼", then excessive Lost Motion is present and corrective action is recommended (see below).

Procedure 6.a:
Correcting Lost Motion.

How can Lost Motion be corrected?
1. Examining linkage, bearing, and valve stem connections for wear and replacing the affected parts eliminates lost Motion.
2. Contact **Becker Precision Equipment** factory personnel for assistance in determining the location and cause of the Lost Motion.
3. Records of the amount of Lost Motion exhibited by a BVR should be kept annually in order to forecast the need for more in-depth maintenance.

Maintain As Needed

Valve Seat Leakage Check

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 exhibit the following leakage classes upon initial installation (see chart below):

Control Valve Leakage Class:

WKM 370E-4	API 6D	Bubble Tight	Standard or Surge Control Service
Grove Control B-5	API 6D	Bubble Tight	Standard or Surge Control Service
TK Valve	API 6D	Bubble Tight	Standard or Surge Control Service
Final Control Elements T-Ball ™	ANSI Class IV	0.01% of Valve Capacity	Standard Service
Final Control Elements T-Ball ™	ANSI Class V	As defined per ANSI	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 Ball Valve Regulator depends upon 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 Ball

Valve Regulator. 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 the discretion of the customer. 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

Procedure 7:
Correcting Valve Seat Leakage.

How do I correct Valve Seat leakage?

1. It is important to remember that regulating valves, or control valves, generally do not require shutoff ability. This policy is specific to every operating company.
2. When valve seat leakage becomes excessive, valve seats and/or seals may need to be replaced.
3. 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.
4. Consult **Becker Precision** factory personnel for information regarding valve rebuild, valve parts, or valve replacement.
5. **Becker** maintains a highly skilled and qualified valve rebuild facility.
6. In the case where positive API Class VI "bubble tight" shutoff must be maintained, **Becker** 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 Ball Valve Regulator stroking (refer to **Procedure 1: Checking for Proper Valve and Actuator Stroking** on page 6).

What type of lubrication should I use?

100% **STP** ® brand lubricant is recommended for lubrication of the valve operator's cylinder.

Procedure 8:
Applying Cylinder Lubrication.

(This procedure DOES NOT require removal of cylinder from actuator).

How do I apply lubrication to the cylinder?

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 for line-up when reinstalling.
4. Loosen Tie Rod Nuts from the Top Cylinder Flange and remove them (if Tie Rod loosens along with the nut, remove the entire Tie Rod).
5. Remove Top Cylinder Flange and Cylinder Sleeve by carefully lifting 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 Wall and Piston Seals.
9. Reassemble and Torque Tie Rods in cross pattern to proper specification.

Ball Valve lubrication

When should ball valves be lubricated?

Valve cleaner/lubricant should be applied only when erratic or difficult valve operation is exhibited. Ball Valve Regulator stroking should be checked before ball valves are lubricated (refer to **Procedure 1: Checking for Proper Valve and Actuator Stroking** on page 6).

What type of lubrication should I use?

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

Procedure 9:
Applying Lubrication to Valve Seats.

How do I apply lubrication to Valve Seats?

1. If the valve is not equipped with Valve Seat lube features, proceed directly to step 6.
2. Isolate control valve to be lubricated by closing upstream and downstream block valves.
3. Put control valve to be lubricated in full closed position.
4. Apply lubricant to each Valve Seat lube fitting.
5. Stroke valve from full open to full closed positions approximately 10 to 15 times. If normal valve operation returns, no further service is required.

Procedure 9.a:
Applying Valve Cleaner/Lubricant to Valve Body Bleed Fitting.

If applying lubrication to Valve Seats does not provide proper valve operation, it is necessary to lubricate the ball valve directly through the Valve Body Bleed Fitting.

How do I apply valve cleaner/lubricant to Valve Body Bleed Fitting?

6. Isolate control valve to be lubricated by closing upstream and downstream block valves.
7. Put control valve to be lubricated in full open position.
8. Valve cleaner/lubricant should be applied to the body bleed fitting per the following quantities:
   - For 2", 3", or 4" bore valves, apply two (2) tubes.
   - For 6" and 8" bore valves, apply four (4) tubes.
   - For 10" bore valves, apply six (6) tubes.
   - For 12" bore valves, apply eight (8) tubes.

For larger valves, contact **Becker** for proper lubrication amount.

*Note: Valve bore is the first number of the **Becker** regulator model number located on the stainless steel tag attached to the pneumatic actuator cylinder.*

9. Apply ½ of total quantity of valve cleaner/lubricant to body bleed fitting of valve. For valves with one fitting, this fitting is the body bleed port and should be used for lubrication typically 4" 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 ½" ball valve.
10. Allow 15 minutes for lubricant to take effect and then stroke from full open to full closed position 10 to 15 times.
11. Apply remaining ½ of valve cleaner/lubricant to body bleed fitting.
12. Allow fifteen minutes for cleaner/lubricant to take effect and then stroke valve from full open to full closed position 10 to 15 times.
13. Return valve to service.

Instrumentation Maintenance (as needed)

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

PART 4:
Above Grade Actuator Installation and Disassembly.

Procedure 10:
Above Grade Actuator Installation.

(Refer to **Drawing No. 55-9024** on page 23).

1. Place valve in full open position
2. Actuator is in fail-safe position (spring relaxed).
3. Remove existing actuator.
4. Remove Housing Cover plate (G) from actuator. DO NOT REMOVE Outboard Bearing (K) or Torque Arm (L).
5. Scrape and wire brush all corroded areas on Valve Mounting Flange (Q) and Stem (O). Be sure to remove all burrs from Stem and lubricate with cup grease.
6. Install actuator on Valve Mounting Flange (Q). Apply and tighten nuts (R) on Mounting Studs (N).
7. Loosen both Outboard Bearing Bolts (J) and then re-tighten.
8. If actuator fails in the closed position, apply pneumatic pressure (not exceeding 150 PSIG) to traverse cylinder to full open position.
9. If Key (E) will not align with keyway in Valve Stem (O), Loosen connecting link jam nuts (B) and turn Connecting Link Stud (C) to shorten or lengthen Connecting Link (A).

   NOTE: Pressure must be maintained on cylinder top while adjusting the Connecting Link Stud (B) on fail closed actuators in order to be able to reach the adjustment stud and maintain alignment with valve stem keyway.

10. In order to insert the key, the feedback bracket (S) must be removed. When perfect alignment is obtained, insert Key (E) and tighten Set Screw (P). Reinstall the feedback bracket (S).
11. Lock both connecting Link Jam Nuts (B).
12. **Keeping hands and tools away** from the torque arm and connecting link, stroke the actuator to the FULL OPEN and FULL CLOSED positions.
13. 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.
14. **See Note after Step 9**. 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). It is imperative that the ball rotates properly to both the FULL CLOSED and FULL OPEN positions in order to provide complete shutoff capabilities.
15. Install Coverplate (G) by aligning hole with Guide Pin (D). Secure all nuts.

Note: Valve actuator is supplied with lubrication in essential areas. In highly corrosive installations, it is advisable to coat all rotating bearing areas with cup grease or similar grease to reduce possibility of corrosion.

Procedure 10.a:
Surge Control Actuator Installation.

(Refer to **Drawing No. 55-9025** on page 24).

1. Place valve in full closed position.
2. Actuator is in fail-safe position (full open - spring relaxed).
3. Remove existing actuator.
4. Remove Housing Cover plate (G) from actuator. DO NOT REMOVE Outboard Bearing (K) or Torque Arm (L).
5. Scrape and wire brush all corroded areas on Valve Mounting Flange (Q) and Stem (O). Be sure to remove all burrs from Stem. Lubricate Stem with cup grease.
6. Install actuator on Valve Mounting Flange (Q). Apply and tighten nuts on Mounting Studs (N).
7. Loosen all Outboard Bearing Bolts (J) and then re-tighten.
8. **IMPORTANT:** Insure that torque arm will rotate freely on valve stem at this point without any interference
9. Remove the feedback bracket (S).
10. Apply pneumatic pressure (not exceeding 150 PSIG) to traverse cylinder to full closed position.
11. If Key (E) will not align with keyway in Valve Stem (O), loosen connecting link jam nuts (B) and turn Connecting Link Stud (C) to shorten or lengthen Connecting Link (A).

    NOTE 1: Pressure must be maintained on cylinder top while adjusting the Connecting Link Stud (B) in order to be able to reach the adjustment stud and maintain alignment with valve stem keyway.

    NOTE 2: The Key supplied for surge control needs to achieve an extremely tight fit. Oversized key stock will be provided. This key must be carefully

sanded to achieve this tight interference fit (requiring a hammer to drive home).

12. When perfect alignment is obtained, insert Key (E) and tighten 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.
14. Keeping hands and tools away from the torque arm and connecting link, stroke the actuator to the FULL OPEN and FULL CLOSED positions.
15. 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.
16. **See Note 1**. 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. It is imperative that the ball rotates properly to both the FULL CLOSED and FULL OPEN positions in order to provide complete shutoff capabilities.
17. Check to insure 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).
18. Install Coverplate (G) by aligning hole with Guide Pin (D). Secure all nuts.

Note: Valve actuator is supplied with lubrication in essential areas. In highly corrosive installations, it is advisable to coat all rotating bearing areas with cup grease or similar grease to reduce possibility of corrosion.

Procedure 10.b: Above Grade Actuator Disassembly (Cylinder Only).

To remove actuator cylinder ONLY:
(Refer to **Drawing No. 55-9031 for fail open** on page 25**, 55-9022 for fail closed** on page 26. If unit is equipped with Gear operator, the **Proportional Feedback** assembly for the positioner is integral to the housing, refer to **Drawing No. 55-9032** for **fail open** on page 27, **55-9027** for **fail closed** on page 28. Bolt on proportional feedback assemblies for actuators without gear overrides are illustrated on pages 29 and 30

1. Depressurize and remove instrumentation tubing lines.
2. Valve will be in failure position.
3. Remove Cover Plate (Item No. 9) from Actuator Housing (Item No. 2).
4. Remove the Pin Clamp (Item No. 5) and Torque Arm Pin (Item No. 6).

Drawings 55-9022 and 55-9031
For Fail Closed Actuators…
5. Remove nuts (Item No. 24) holding bottom Cylinder Flange to the Spring Housing (Item No. 1).
6. Cylinder (Item No. 19) can now be removed from the actuator assembly along with the cylinder rod flange (Item No. 21), Rod Clevis (Item No. 22), Rod Clevis Pin (Item No. 17), and Connecting Link (Item No. 16)

For Fail Open Actuators…
5. Remove nuts (Item No. 24) holding bottom Cylinder Flange to the Spring Housing (Item No. 1).
6. Cylinder (Item No. 19) can now be removed from the actuator assembly along with the Cylinder Rod Flange (Item No. 21), Rod Clevis (Item No. 22), Rod Clevis Pin (Item No. 17), and Connecting Link (Item No. 16)

Drawings 55-9027 and 55-9032
For Fail Closed Actuators…
5. Remove nuts (Item No. 29) holding the Spring Cartridge to the housing (Item No. 2). Remove the entire cylinder and spring cartridge assembly.
6. Loosen Jam Nuts (Item No. 26) allowing removal of the Rod Clevis (Item No. 22), Clevis Pin (Item No. 17), and connecting link (Item No. 16). Now remove the cylinder rod flange (Item No. 21), allowing removal of the cylinder (Item No. 19) by removing the nuts (Item No. 30) holding the cylinder bottom flange to spring cartridge (Item No. 1).

For units with bolt on proportional feedback…
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.

Procedure 10.c: Above Grade Actuator Reinstallation (Cylinder Only):

To reinstall the actuator cylinder ONLY:
(Refer to **Drawing No. 55-9031 for fail open** on page 25**, 55-9022 for fail closed** on page 26. If unit is equipped with Gear operator, the **Proportional Feedback** assembly for the positioner is integral to the housing, refer to **Drawing No. 55-9032** for **fail open** on page 27, **55-9027** for **fail closed** on page 28.

Drawings 55-9022 and 55-9031

1. If the Connecting Link (Item No. 16) has not been removed from the cylinder, proceed to step 5.
2. DO NOT ADJUST THE LENGTH OF THE CONNECTING LINK.

For Fail Closed Actuators…

3. Reinstall the cylinder rod flange (Item No. 21), Rod Clevis (Item No. 22), Rod Clevis Pin (Item No. 17 and 18).
4. Be sure to match the original installed position of the Rod Clevis. It is recommended to count the number of exposed threads on the Cylinder Piston Rod to achieve agreement.
5. Reinstall the Actuator Cylinder (Item No. 19) and bolts and nuts (Item No. 24) that attach to the Spring Housing (Item No. 1) and tighten nuts.
6. Reinstall the Torque Arm Pin (Item No. 6) and Pin Clamp (Item No. 5).
7. Reinstall 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 (Item No. 16) must be adjusted.
10. Adjust the Connecting Link (Item No. 16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. *It is imperative the ball rotate properly to both the FULL CLOSED the FULL OPEN position.*

For Fail Open Actuators…

1. Reinstall the cylinder rod flange (Item No. 21), Rod Clevis (Item No. 22), Rod Clevis Pin (Item No. 17 and 18).
2. Be sure to match the original installed position of the Rod Clevis. It is recommended to count the number of exposed threads on the Cylinder Piston Rod to achieve agreement.
3. Reinstall the Actuator Cylinder (Item No. 19) and bolts and nuts (Item No. 23) that attach to the Spring Housing (Item No. 1) and tighten nuts.
4. Reinstall the Torque Arm Pin (Item No. 6) and Pin Clamp (Item No. 5).
5. Reinstall instrumentation tubing lines and pressurize.
6. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.
7. 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 (Item No. 16) must be adjusted.
8. Adjust the Connecting Link (Item No. 16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. *It is imperative the ball rotate properly to both the FULL CLOSED the FULL OPEN position*

Drawings 55-9027 and 55-9032

Fail Closed Actuators…

1. DO NOT ADJUST THE LENGTH OF THE CONNECTING LINK.
2. Reinstall the Jam nut (Item No. 26) onto the piston rod and install the rod extension (Item No. 27) locking the jam nut against it in the original position.
3. Install another jam nut (Item No. 26) onto the stud extension (Item No. 28) and thread into the end of the rod extension (Item No. 27).
4. Drop entire assembly through spring cartridge and secure with bolts and nuts (Item No. 30)
5. Install cylinder rod flange (Item No. 21) onto the stud extension (Item No. 28) and snug against the spring cap. Lock in place with jam nut.
6. Install another Jam nut (Item No. 26), and reinstall rod clevis (Item No. 22), clevis pin (Item No. 18) and connecting link (Item No. 16).
7. Reinstall 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 (Item No. 16) must be adjusted.
10. Adjust the Connecting Link (Item No. 16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. *It is imperative the ball rotate properly to both the FULL CLOSED the FULL OPEN position.*

For Fail Open Actuators…

1. DO NOT ADJUST THE LENGTH OF THE CONNECTING LINK.
2. Install cylinder rod flange (Item No. 21) onto the piston rod and reinstall rod clevis (Item No. 22), clevis pin (Item No. 18) and connecting link (Item No. 16).
3. Reinstall instrumentation tubing lines and pressurize.
4. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.
5. 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 (Item No. 16) must be adjusted.
6. Adjust the Connecting Link (Item No. 16) in either the clockwise or counter-clockwise direction to achieve proper alignment of the valve ball. *It is imperative the ball rotate properly to both the FULL CLOSED the FULL OPEN position.*

Procedure 10.d: Above Grade Actuator Disassembly (Complete Actuator).

To remove COMPLETE actuator from the valve:

(Refer to **Drawing No. 55-9031 for fail open** on page 25**, 55-9022 for fail closed** on page 26. If unit is equipped with Gear operator, the **Proportional Feedback** assembly for the positioner is integral to the housing, refer to **Drawing No. 55-9032** for **fail open** on page 27, **55-9027** for **fail closed** on page 28.

Drawings 55-9022, 55-9031, 55-9027, and 55-9032

1. Depressurize and remove instrumentation tubing lines running away from actuator assembly.
2. Valve will be in failure position.
3. Remove Cover Plate (Item No. 9) from housing.
4. Loosen Set Screw (Item No. 4) which holds Square Key (Item No. 7) in place.
5. Remove Nuts from Valve Adapter Plate Studs.
6. COMPLETE actuator may now be removed from valve. Strap and support actuator weight as the torque arm is walked off of the valve stem

For units with bolt on proportional feedback…
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.

PART 5: Below Grade Actuator Disassembly & Installation

Procedure 11:
Below Grade Actuator Disassembly (Cylinder Only).
For Tail Rod cylinders

To remove actuator cylinder ONLY:
(Refer to **Drawing No. 55-9026 for fail open** on page 30**, 55-9033 for fail closed** on page 31.

For Fail Open Actuators…

1. Depressurize and remove instrumentation tubing lines.
2. Remove access covers (Items No. 14 and 21).
3. Remove one of the Tru-Arc Rings (Item No. 7) from the Rod Clevis Pin (Item No. 8).
4. Remove the Rod Clevis Pin (Item No. 8) by pushing it through the Rod Clevis (Item No. 6).
5. Remove nuts (Item No. 24) holding the Spring Cartridge to the housing (Item No. 20). Remove the entire cylinder and spring cartridge assembly.
6. Loosen Jam Nuts (Item No. 2) allowing removal of the Rod Clevis (Item No. 22). Now remove the cylinder rod flange (Item No. 4), allowing removal of the cylinder (Item No. 1) by removing the nuts (Item No. 25) holding the cylinder bottom flange to spring cartridge (Item No. 1).

It is important to mark the position of the Cylinder Rod Flange (Item No. 4) and Rod Clevis (Item No. 6) on the Stud Extension (Item No. 5). The Rod Clevis (Item No. 6) must be exactly at its original position when reassembled.

For Fail Closed Actuators…

1. Depressurize and remove instrumentation tubing lines.
2. Remove access covers (Items No. 14 and 21).
3. Remove one of the Tru-Arc Rings (Item No. 7) from the Rod Clevis Pin (Item No. 8).
4. Remove the Rod Clevis Pin (Item No. 8) by pushing it through the Rod Clevis (Item No. 6).
5. Remove bolts/nuts holding Cylinder Flange (Item No. 1) to the Spring Housing (Item No. 23).
6. Cylinder (Item No. 1) can now be removed from the actuator assembly along with the Cylinder Rod Flange (Item No. 4), Rod Extension (Item No. 3), Stud Extension (Item No. 5), and Rod Clevis (Item No. 6).

For Single Rod cylinders

To remove actuator cylinder ONLY:
(Refer to **Drawing No. 55-9030 for fail open** on page 32**, 55-9028 for fail closed** on page 33.

For Fail Open Actuators…

1. Depressurize and remove instrumentation tubing lines.
2. Remove access covers (Items No. 28 and 30)
3. Remove one of the Tru-Arc Rings (Item No. 16) from the Rod Clevis Pin (Item No. 15).
4. Remove the Rod Clevis Pin (Item No. 15) by pushing it through the Rod Clevis (Item No. 18).
5. Remove bolts/nuts holding Cylinder Flange (Item No. 23) to the Spring Housing (Item No. 25).
6. Cylinder (Item No. 23) can now be removed from the actuator assembly along with the Cylinder Rod Flange (Item No. 22), Rod Extension (Item No. 24), Rod Clevis (Item No. 18), Rod Clevis Pin (Item No. 16), and Connecting Link (Item No. 14).

It is important to mark the position of the Cylinder Rod Flange (Item No. 22) on the Cylinder Rod. The Rod Clevis (Item No. 18) must be exactly at its original position when reassembled.

For Fail Closed Actuators…

7. Depressurize and remove instrumentation tubing lines.
8. Remove access covers (Items No. 28 and 30)
9. Remove one of the Tru-Arc Rings (Item No. 16) from the Rod Clevis Pin (Item No. 15).
10. Remove the Rod Clevis Pin (Item No. 15) by pushing it through the Rod Clevis (Item No. 18).
11. Remove bolts/nuts holding the Spring Cartridge to the housing (Item No. 5). Remove the entire cylinder and spring cartridge assembly.
12. Loosen Jam Nuts (Item No. 20) allowing removal of the Rod Clevis (Item No. 18). Now remove the cylinder rod flange (Item No. 22), allowing removal of the cylinder (Item No. 19) by removing the bolts/nuts holding the cylinder bottom flange to spring cartridge (Item No. 25).

Procedure 11.a:
Below Grade Actuator Reinstallation (Cylinder Only).
For Tail Rod cylinders

To remove actuator cylinder ONLY:
(Refer to **Drawing No. 55-9026 for fail open** on page 30**, 55-9033 for fail closed** on page 31.

For Fail Open Actuators…

1. Be sure to match the original installed position of the Rod Extension (Item No. 3). It is recommended to count the number of exposed threads on the Cylinder Piston Rod to achieve agreement.
2. Tighten the Cylinder rod extension (Item No. 3), Stud Extension (Item No. 5), assembly onto the cylinder rod with the jam nut (Item No 2).
3. Drop the entire assembly through the spring housing (Item No. 23) and install the cylinder (Item No. 1) onto the spring cartridge (Item No. 23)
4. Reinstall the Cylinder Rod Flange (Item No. 4) and tighten the jam nut (Item No. 2).
5. Reinstall the Rod Clevis (Item no. 6) onto the Stud Extension (Item No. 5) and lock in place with the Jam nut (Item No. 2).
6. Set the Cylinder and Spring Cartridge assembly onto the Actuator Housing (Item No. 20).
7. Reinstall the Rod Clevis Pin (Item No. 8) by pushing it through the Rod Clevis (Item No. 6).
8. Reinstall the Tru-Arc Rings (Item No. 7) to the Rod Clevis Pin (Item No. 8).
9. Tighten nuts (Item No. 24) to hold Spring Cartridge and Cylinder to Actuator Housing.
10. Reinstall Access Plate from Actuator Housing (Items No. 14 and 21).
11. Reinstall instrumentation tubing lines and pressurize.

Stroke the actuator to the FULL OPEN and FULL CLOSED positions.

For Fail Closed Actuators…

1. Be sure to match the original installed position of the Cylinder Rod Flange (Item No. 4). It is recommended to count the number of exposed threads on the Cylinder Piston Rod to achieve agreement.
2. Tighten the Cylinder rod extension (Item No. 3), Stud Extension (Item No. 5), and Rod Clevis (Item No. 6) assembly onto the cylinder rod.
3. Drop the entire assembly through the spring housing (Item No. 23) and ensure that the rod clevis (Item No. 6) lines up with the connecting link (Item No. 9).
4. Reinstall the Actuator Cylinder (Item No. 1) without tightening bolts/nuts.
5. Reinstall the Rod Clevis Pin (Item No. 8) by pushing it through the Rod Clevis (Item No. 6).
6. Reinstall the Tru-Arc Rings (Item No. 7) to the Rod Clevis Pin (Item No. 8).
7. Tighten the Actuator Cylinder bolts/nuts.
8. Reinstall Access Plate from Actuator Housing (Items No. 14 and 21).
9. Reinstall instrumentation tubing lines and pressurize.
10. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.

For Single Rod cylinders

To reinstall the actuator cylinder ONLY:
(Refer to **Drawing No. 55-9028 for fail closed** on page 33**, 55-9030 for fail open** on page 32.

For Fail Open Actuators…

1. Be sure to match the original installed position of the Cylinder Rod Flange (Item No. 22). It is recommended to count the number of exposed threads on the Cylinder Piston Rod to achieve agreement.
2. Tighten the Cylinder rod extension (Item No. 24), Stud Extension (Item No. 21), and Rod Clevis (Item No. 18) assembly onto the cylinder rod.
3. Drop the entire assembly through the spring housing (Item No. 25) and ensure that the rod clevis (Item No. 18) lines up with the connecting link (Item No. 14).
4. Reinstall the Actuator Cylinder (Item No. 23) without tightening bolts/nuts.
5. Reinstall the Rod Clevis Pin (Item No. 15) by pushing it through the Rod Clevis (Item No. 18).
6. Reinstall the Tru-Arc Rings (Item No. 16) to the Rod Clevis Pin (Item No. 15).
7. Tighten the Actuator Cylinder bolts/nuts (Item No. 32).
8. Reinstall Access Plate from Actuator Housing (Items No. 28 and 30).
9. Reinstall instrumentation tubing lines and pressurize.
10. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.

For Fail Closed Actuators…

1. Be sure to match the original installed position of the Rod Extension (Item No. 24). It is recommended to count the number of exposed threads on the Cylinder Piston Rod to achieve agreement.
2. Tighten the Cylinder rod extension (Item No. 24), Stud Extension (Item No. 21), assembly onto the cylinder rod with the jam nut (Item No 20).

3. Drop the entire assembly through the spring housing (Item No. 25) and install the cylinder (Item No. 23) onto the spring cartridge.
4. Reinstall the Cylinder Rod Flange (Item No. 22) and tighten the jam nut (Item No. 20).
5. Reinstall the Rod Clevis (Item No. 18) onto the Stud Extension (Item No. 21) and lock in place with the Jam nut (Item No. 20).
6. Set the Cylinder and Spring Cartridge assembly onto the Actuator Housing (Item No. 5).
7. Reinstall the Rod Clevis Pin (Item No. 15) by pushing it through the Rod Clevis (Item No. 18).
8. Reinstall the Tru-Arc Rings (Item No. 16) to the Rod Clevis Pin (Item No. 15).
9. Tighten nuts (Item No. 31) to hold Spring Cartridge and Cylinder to Actuator Housing.
10. Reinstall Access Plate from Actuator Housing (Items No. 28 and 30).
11. Reinstall instrumentation tubing lines and pressurize.
12. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.

Procedure 11.b:
Below Grade Actuator Disassembly (Complete Actuator).

To remove COMPLETE actuator from the valve:
(Refer to **Drawing No. 55-9026 for fail open** on page 30**, 55-9033 for fail closed** on page 31.
For single rod cylinders, refer to **Drawing No. 55-9030 for fail open** on page 32**, 55-9028 for fail closed** on page 33.

1. Valve may be in any position.
2. Excavate below grade portion of the Ball Valve Regulator.
3. Disconnect valve lubrication lines and “knee brace” between actuator and valve.
4. Remove Cover Plate (Item No. 10) from Actuator Housing.

For Tail Rod cylinders

5. Loosen the Set Screw (Item No. 19) which holds the Square Key (Item No. 16) in place.
6. Remove Nuts from Adapter Plate Studs.
7. Remove COMPLETE actuator assembly from valve.

For Single Rod cylinders

1. Remove C.L. Bracket (Item No. 11) from the Torque Arm (Item no. 13)
2. Loosen the Set Screw (Item No. 6) which holds the Square Key (Item No. 8) in place.
3. Remove Nuts from Adapter Plate Studs.
4. Remove COMPLETE actuator assembly from valve.

Procedure 11.c:
Below Grade Actuator Reinstallation (Complete Actuator).

To reinstall the COMPLETE actuator on the valve:
(Refer to **Drawing No. 55-9026 for fail open** on page 30**, 55-9033 for fail closed** on page 31. For single rod cylinders, refer to **Drawing No. 55-9030 for fail open** on page 32**, 55-9028 for fail closed** on page 33.

1. Remove Cover Plate (Item No. 10) from housing.
2. Slide actuator onto valve stem while supporting the actuator’s weight.
3. Align all adapter plate studs with valve mounting plate holes and tighten.
4. Loosen all Outboard Bearing Bolts and re-tighten.
5. Connect valve lubrication lines and “knee brace” between actuator and valve

For Tail Rod cylinders

6. Reinstall Square Key (Item No. 16).
7. If keyways do not align, the position of the Clevis must be readjusted – follow procedures in Section 11.a.
8. Reinstall Set Screw (Item No. 19) which holds Square Key in place.
9. Reinstall instrumentation tubing lines and pressurize.
10. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.

For Single Rod cylinders

6. Reinstall Square Key (Item No. 8).
7. If keyways do not align, the position of the Clevis must be readjusted – procedures in Section 11.a
8. Reinstall Set Screw (Item No. 6) which holds Square Key in place.
9. Reinstall C.L. Bracket (Item No. 11) onto the Torque Arm (Item no. 13)
10. Reinstall instrumentation tubing lines and pressurize.
11. Stroke the actuator to the FULL OPEN and FULL CLOSED positions.

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