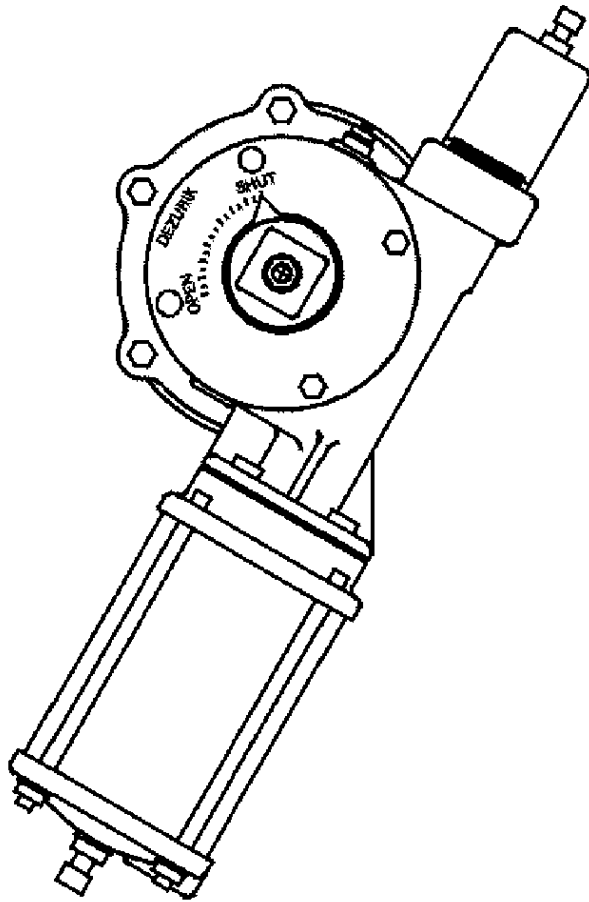


DEZURIK CYLINDER OPERATED G-SERIES ACTUATOR USED ON PFW & PTW TAPERED PLUG VALVES



Instruction D10191
July 2016

Instructions

These instructions provide information about G-Series Cylinder Actuators. They are for use by personnel who are responsible for installation, operation and maintenance of G-Series Cylinder Actuators.

Safety Messages

All safety messages in the instructions are flagged with an exclamation symbol and the word Caution, Warning or Danger. These messages indicate procedures that must be followed exactly to avoid equipment damage, personal injury or death. Safety label(s) on the product indicate hazards that can cause equipment damage, personal injury or death. If a safety label becomes difficult to see or read, or if a label has been removed, please contact DeZURIK for replacement label(s).



WARNING!

Personnel involved in the installation or maintenance of valves should be constantly alert to potential emission of pipeline material and take appropriate safety precautions. Always wear suitable protection when dealing with hazardous pipeline materials. Handle valves, which have been removed from service with the assumption of pipeline material within the valve.

Inspection

Your G-Series Cylinder Actuator has been packaged to provide protection during shipment; however, it can be damaged in transport. Carefully inspect the unit for damage upon arrival and file a claim with the carrier if damage is apparent.

Parts

Recommended spare parts are listed on the assembly drawing. These parts should be stocked to minimize downtime.

Order parts from your local DeZURIK sales representative, or directly from DeZURIK. When ordering parts, please include the 7-digit part number and 4-digit revision number (example: **9999999R000**) located on the data plate attached to the valve assembly. Also include the part name, the assembly drawing number, the balloon number and the quantity stated on the assembly drawing.

DeZURIK Service

DeZURIK service personnel are available to install, maintain and repair all DeZURIK products. DeZURIK also offers customized training programs and consultation services.

For more information, contact your local DeZURIK sales representative or visit our website at www.dezurik.com.

Table of Contents

Description - - - - -	4
Air Supply - - - - -	4
Lubrication - - - - -	4
Actuator Identification - - - - -	4
Position Stops - - - - -	5
Adjusting Position Stops - - - - -	5
Seat/Plug Clearance Adjustment - - - - -	5
Removing Actuator - - - - -	6
Installing Actuator - - - - -	7
Removing Cylinder - - - - -	8
Installing Cylinder - - - - -	8
Disassembling Actuator - - - - -	9
Reassembling Actuator - - - - -	10
Changing Mounting Positions - - - - -	12
<i>Mounting Actuator in 60° Increments</i> - - - - -	12
<i>Mounting Actuator in 30° Increments</i> - - - - -	12
Troubleshooting - - - - -	14

Description

The G-Series Cylinder Actuator is a totally enclosed, quarter turn, pneumatic operated actuator. A 2" (50mm) square nut on top of the actuator is provided for manual operation.

Note: Tapered Plug valves equipped with cylinder actuators do not provide dead-tight shutoff.

Air Supply

The supply pressure to the cylinder should be between 50 and 100 psi (344 and 689 kPa).

Lubrication

The G-Series Cylinder Actuator has been lubricated at the factory and requires no routine lubrication. If the actuator is disassembled, lubricate the rack, rack guide, gear sector and bearings using one of these lubricants:

- Keystone Zeniplex-1 (**recommended**)
- Amoco Amolith Grease #1-EP (alternate)
- Amsoil GHD (alternate)
- Mobil Mobilux EP 1 (alternate)
- Petro-Canada Vultrex MPG EP 1 (alternate)
- Shell Alvania EP 1 (alternate)
- Texaco Multifak EP 1 (alternate)

If the cylinder is disassembled, it must be lubricated as described in the cylinder instructions.

Actuator Identification

The G-Series Cylinder Actuator is available in two sizes: G6 and G12. See Figure 1 for actuator identification.

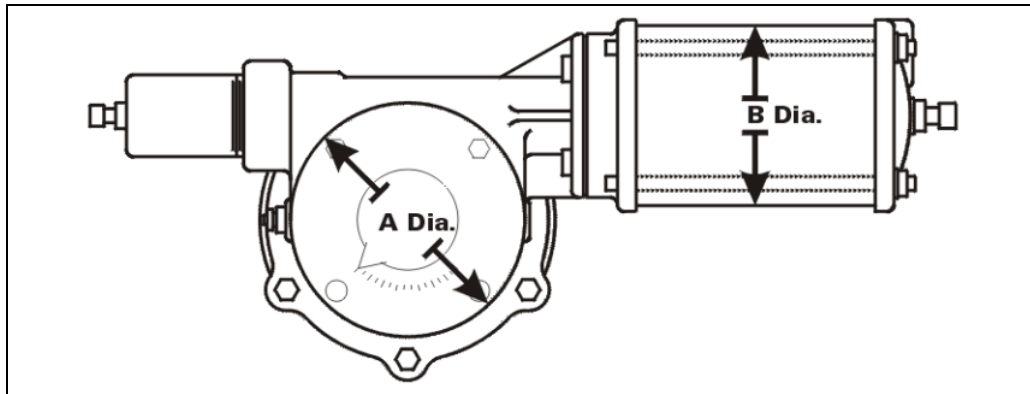


Figure 1 - Actuator Identification

To determine the actuator size, measure the diameter of the cover - see Figure 1 and Table A. To determine the cylinder size, measure the diameter of the cylinder - see Figure 1 and Table B.

Table A: Actuator Identification

Actuator	Ø "A"	
	IN	MM
G6	8	205
G12	15	390

Table B: Cylinder Identification

Cylinder	Ø "B"	
	IN	MM
C4	4.5	115
C6	6.5	165
C8	8.5	215
C10	10.5	265

Position Stops

Valves equipped with cylinder operated G-Series actuators have stops to limit valve travel in both the clockwise and counterclockwise directions. These stops have been adjusted at the factory to coincide with the Combination Number on the purchase order and do not require adjustment unless the Combination Number is changed, or if the actuator has been disassembled. See the *STOP ADJUSTMENTS* section of this instruction for details on adjusting the stops.

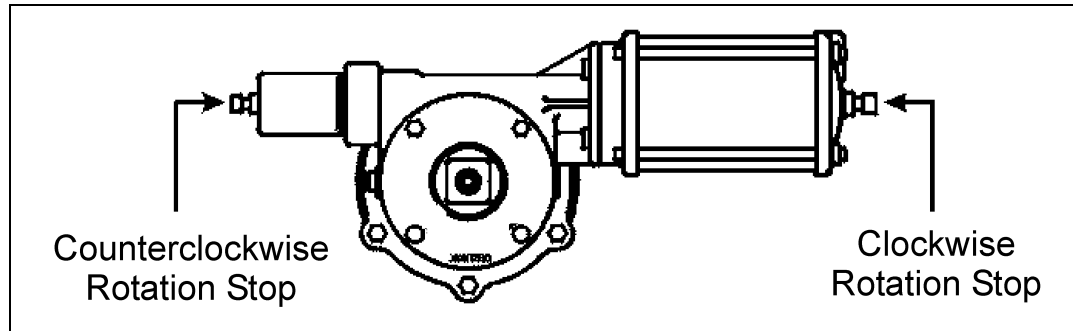


Figure 2 – Position Stops

The position stops are factory set and do not require adjustment unless the actuator has been disassembled or actuator orientation has been changed.

Adjusting Position Stops

Clockwise rotation of the plug is stopped when the piston rod contacts the set screw in the cylinder cap.

Counterclockwise rotation of the plug is stopped when the end of the rack rod contacts the set screw in the end of the extension cap.

To adjust the stops, follow these steps:

1. Actuate the valve to determine the need for stop adjustment.



WARNING!

Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. If adjustment is required, loosen the lock nut on the stop to be adjusted and turn the stop in or out as required. Tighten the lock nut.
3. Actuate the valve to check the stop adjustment and repeat Steps 2 and 3 until the desired stop setting is achieved.

Seat/Plug Clearance Adjustment

See the *ADJUSTMENTS* section of the *Valve Instruction* for details on adjusting seat/plug clearance.

Removing Actuator

When tapered plug valves are mounted in a vertical pipeline, or mounted in a horizontal pipeline with the plug stem horizontal, gravity can cause the plug to swing to a lower position in the valve body when the actuator is removed. To avoid this problem, place the plug in the lowest position before removing the actuator.

1. Discontinue flow, relieve pipeline pressure and close valve.



WARNING!

Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. Disconnect and lock out the pneumatic power to prevent accidental operation of the actuator.
3. Scribe corresponding lines on the valve and actuator to help align them during installation.
4. Remove the lock nut from the top of the wrenching square.
5. Remove the four socket head screws and wrenching square.
6. Note the position of the pointer, then remove the two socket head screws and slide the pointer off the actuator.
7. Remove the plug adjusting nut from the stud and slide the bearing washer off the stud.
8. Note the stampings on the top of the valve plug stem. These stampings correspond with the plug face as shown in Figure 3. It is important that the plug position be noted to ensure it is in the correct position during actuator installation.

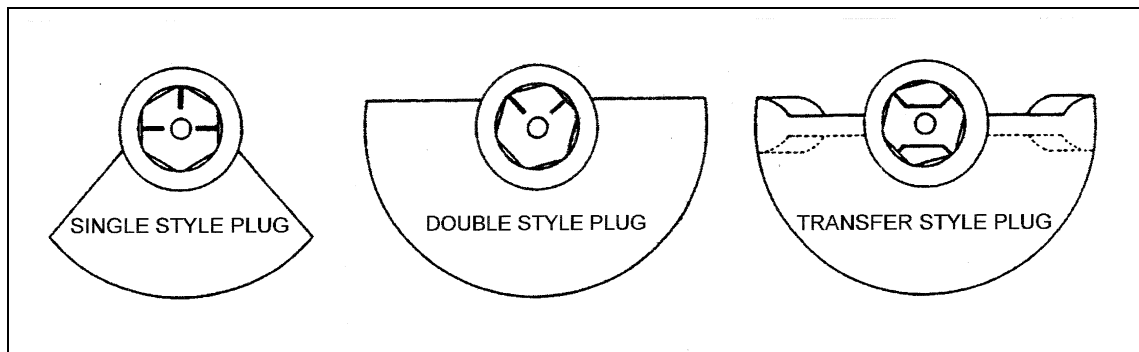


Figure 3 – Plug Stem Stampings



WARNING!

This valve is a pressure vessel. Removing the bonnet bolts before relieving pipeline pressure can result in personal injury or equipment damage. Always relieve pipeline pressure before removing the actuator.

9. Remove the screws fastening the adapter to the adaptor plate (2" - 4" valves) or to the valve bonnet (5" - 16" valves).
10. Lift the actuator and adapter off the valve.

Installing Actuator

1. Place the valve plug in the position noted when the actuator was removed.
Note: Normally this will be so the plug is in the lowest position in the valve body.
2. Line up the scribe marks on the valve and actuator made during actuator removal, then set the actuator on the valve so that the valve shaft slides into the actuator gear sector.
3. Fasten the actuator adapter to the valve.
4. Slide the bearing washer down the plug stud.
5. Screw the plug adjusting nut down the plug stud until it touches the bearing washer.
6. Turn the plug adjusting nut clockwise until there is .010" clearance between the plug face and the body seat. (If the valve is used with paper stock, the clearance should be .030").
Note: The holes in the bearing washer must line up with the tapped holes in the top of the gear sector.
7. Slide the pointer down the plug stud so that it rests on top of the bearing washer; the pointer should point to the correct valve position. Fasten the pointer to the gear sector with the two shorter socket head screws.
8. Slide the wrenching square down the plug stud so that it rests on top of the pointer. Fasten the wrenching square to the gear sector with the four remaining socket head screws.
9. Screw the lock nut down the stud until it contacts the wrenching square and tighten to lock the assembly into place.
10. Connect the supply pressure tubing to the cylinder.
11. Check the stop settings and readjust if necessary. The correct adjustment procedure is described in the STOP ADJUSTMENT Section of this instruction.
12. If the actuator is a powered actuator, reconnect power to the actuator.
13. Pipeline flow may now be restored.

Removing Cylinder

This procedure can be performed with the actuator installed on the valve or removed.

1. Discontinue flow and relieve pipeline pressure.
2. Apply air pressure to the port in the cylinder cap (the end farthest from the actuator housing) until the valve has moved to the end of its stroke.



WARNING!

Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

3. Disconnect and lock out the pneumatic power to prevent accidental operation of the actuator.
4. Disconnect the tubing from both cylinder ports.
5. Remove the extension cap from the actuator housing opposite the cylinder.
6. After the extension cap is removed, remove the nuts and spring washers from the end of the rack rod.
7. Remove the four screws fastening the cylinder assembly to the housing, and carefully remove the cylinder assembly by sliding it away from the actuator until the rack rod clears the actuator housing.
8. See *Cylinder* instructions for details on rebuilding the cylinder.

Installing Cylinder

1. Scrape the old gasket material from the actuator housing and cylinder head, and then place a new gasket on the cylinder head.
2. Install the cylinder/rack rod assembly by sliding the rack rod through the rack; then fasten the cylinder to the housing.

Note: If the rack rod is not attached to the cylinder, clean the threads of both the rack rod and the cylinder shaft, then apply Loctite to the cylinder shaft threads, and screw the rack rod onto the cylinder shaft until tight.

3. Slide the spacer, spring washers and nuts onto the rack rod. See Figure 4 for stacking arrangement of spring washers.

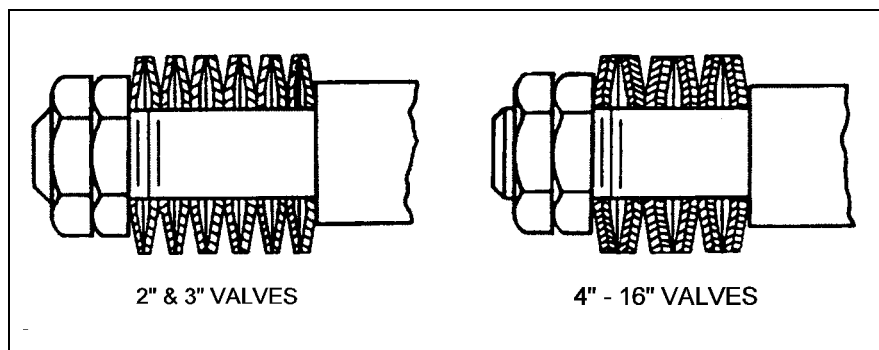


Figure 4 – Plug Stem Stampings

Installing Cylinder *(Continued)*

4. Screw one nut onto the rack rod. Screw the nut down until the spring washers are completely compressed, then back the nut off until the washers return to their normal shape.
5. Screw the other nut onto the rack rod and tighten the two nuts against each other.
6. Replace the extension cap onto the actuator housing.
7. Reconnect power to the actuator.
8. Adjust the position stops as described in the "Position Stop" section.
9. Pipeline flow may now be restored.

Disassembling Actuator

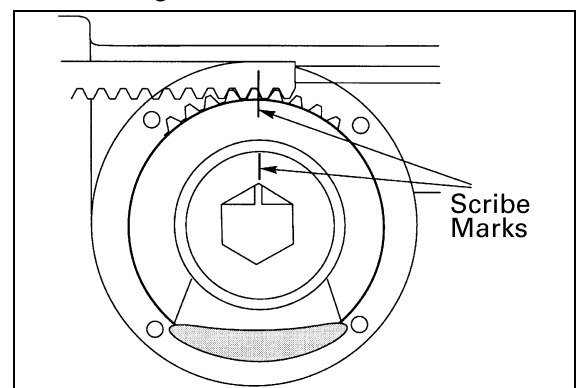
When tapered plug valves are mounted in a vertical pipeline, or mounted in a horizontal pipeline with the plug stem horizontal, gravity can cause the plug to swing to a lower position in the valve body when the actuator is removed. To avoid this problem, place the plug in the lowest position before removing the actuator.

1. Discontinue flow and relieve pipeline pressure.

**WARNING!**

**Accidental operation of power actuator can cause personal injury or equipment damage.
Disconnect and lock out power to actuator before servicing.**

2. Apply air pressure to the port in the cylinder cap (the end farthest from the actuator housing) until the valve has moved to the end of its stroke.
3. Turn off the supply pressure to the cylinder, then disconnect the tubing from both cylinder ports
4. Disconnect and lock out the pneumatic, hydraulic, or electrical power to prevent accidental operation of the actuator.
5. Scribe corresponding lines on the valve and actuator to help align them during installation.
6. Remove the lock nut from the top of the wrenching square.
7. Remove the four socket head screws and wrenching square.
8. Note the position of the pointer, then remove the two socket head screws and slide the pointer off the actuator.
9. Remove the plug adjusting nut from the stud and slide the bearing washer off the stud.
10. Scribe corresponding lines on the actuator cover and housing, then remove the cover screws and cover from the top of the actuator.
11. Mark the teeth of the rack and gear as shown in Figure 5 and lift the gear sector out of the actuator.
12. Remove the rack from the housing.

**Figure 5 – Scribe Marks**

Disassembling Actuator *(Continued)*

13. Remove the screws or nuts fastening the cylinder assembly to the housing and carefully remove the cylinder assembly by sliding it away from the actuator until the rack rod clears the actuator housing.
14. Remove the rack from the housing.
15. Remove the rack bearing (if noticeable wear to bearing) by prying it from the actuator housing.
16. Scribe corresponding lines on the valve and adapter to be used for alignment during actuator reassembly.

**WARNING!**

This valve is a pressure vessel. Removing the bonnet bolts before relieving pipeline pressure can result in personal injury or equipment damage. Always relieve pipeline pressure before removing the actuator.

17. Remove the screws fastening the adapter to the adaptor plate (2" - 4" valves) or to the valve bonnet (5" - 16" valves).
18. Lift the rest of the actuator and the adapter off the valve.
19. Remove the screws fastening the adapter to the actuator housing, and separate the two parts.

Reassembling Actuator

Install new bearings and seals in the adapter and cover if necessary. See Figure 6 for proper placement.

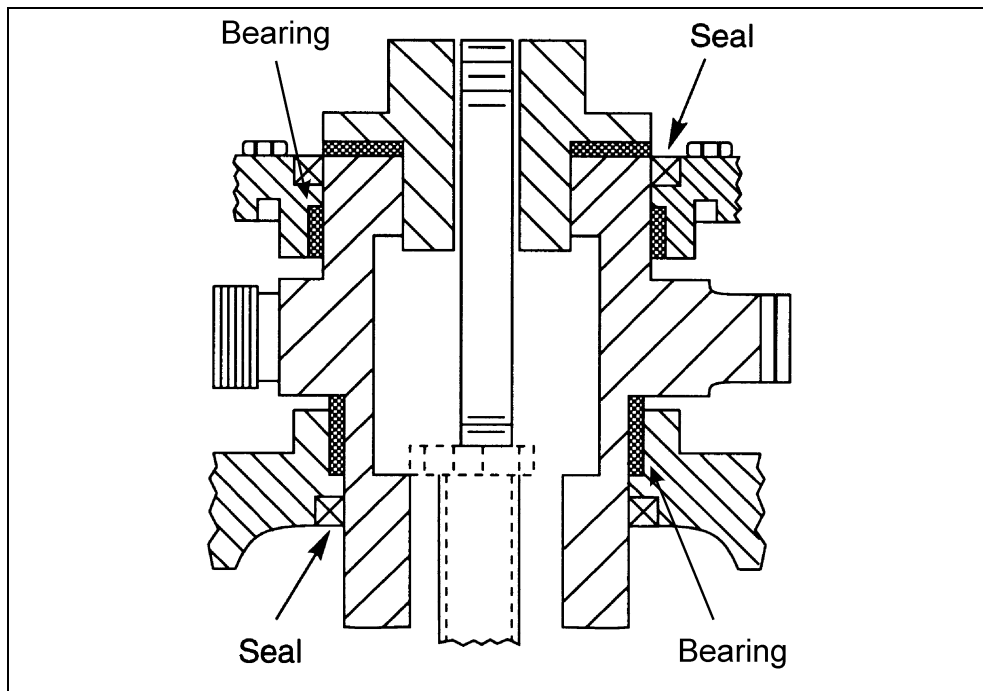


Figure 6 – Location of Actuator Seals and Bearings

Reassembling Actuator *(Continued)*

1. Scrape old gasket material from the actuator housing and the adapter, install a new gasket, and then fasten the adapter to the actuator housing with the screws.
2. Line up the scribe marks on the valve and adapter made during actuator removal, then set the adapter and housing on the valve.
3. Fasten the adapter to the valve.
4. Insert the rack bearing on the pin in the actuator housing (if replacing worn bearing).
5. Apply a liberal amount of lubricant to the rack teeth and the back of the rack, which will contact the rack bearing, and then install the rack in the housing.
6. Apply a liberal amount of lubricant to the gear sector teeth and journals, then place the gear sector in the housing and carefully align the teeth with the rack as marked during disassembly.

NOTE: It may be necessary to loosen the adapter mounting screws and move the housing a small amount to align the gears. Be sure to retighten the mounting screws after aligning the gears.

7. Scrape the old gasket material from the actuator housing and cylinder head, and then place a new gasket on the cylinder head.
8. Install the cylinder/rack rod assembly by sliding the rack rod through the rack then fasten the cylinder to the housing.
NOTE: If the rack rod is not attached to the cylinder, clean the threads of both the rack rod and the cylinder shaft, then apply Loctite to the cylinder shaft threads and screw the rack rod onto the cylinder shaft.
9. Slide the spacer, spring washers and nuts onto the rack rod. See Figure 4 for spring washer arrangement.
10. Screw one nut onto the rack rod until the spring washers are completely compressed, and then loosen the nut just until the washers return to normal shape.
11. Screw the other nut onto the rack rod and tighten the two nuts against each other.
12. Set a new cover gasket on the housing, then install and fasten the top cover on the housing; make sure the scribe marks line up.
13. Slide the bearing washer down the plug stud.
14. Screw the plug adjusting nut down the plug stud until it touches the bearing washer.
15. Turn the plug adjusting nut clockwise until there is .010" clearance between the plug face and the body seat. (If the valve is used with paper stock, the clearance should be .030".
Note: The holes in the bearing washer must line up with the tapped holes in the top of the gear sector.
16. Slide the pointer down the plug stud so that it rests on top of the bearing washer; the pointer should point to the correct valve position. Fasten the pointer to the gear sector with the two shorter socket head screws.
17. Slide the wrenching square down the plug stud so that it rests on top of the pointer. Fasten the wrenching square to the gear sector with the four remaining socket head screws.
18. Screw the lock nut down the stud until it contacts the wrenching square and tighten to lock the assembly into place.

Reassembling Actuator *(Continued)*

19. Replace the extension cap.
20. Check the stop settings and readjust if necessary. The correct adjustment procedure is described in the STOP ADJUSTMENT Section of this instruction.
21. Pipeline flow may now be restored.

Changing Mounting Positions

The actuator can be mounted in 30° increments around the valve shaft. 30° position changes require changing the timing between the gear sector and the rack; 60° position changes do not require changing the timing.

When tapered plug valves are mounted in a vertical pipeline, or mounted in a horizontal pipeline with the plug stem horizontal, gravity can cause the plug to swing to a lower position in the valve body when the actuator is removed. To avoid this problem, place the plug in the lowest position before removing the actuator.

Mounting Actuator in 60° Increments

1. Remove the actuator from the valve. See “*Removing Actuator*” section.



WARNING!

Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. Disconnect and lock out the pneumatic power to prevent accidental operation of the actuator.
3. Rotate the actuator into position.
4. Install the actuator on the valve. See “*Installing Actuator*”.

Mounting Actuator in 30° Increments

1. Discontinue flow and relieve pipeline pressure.



WARNING!

Accidental operation of power actuator can cause personal injury or equipment damage. Disconnect and lock out power to actuator before servicing.

2. Disconnect and lock out the pneumatic power to prevent accidental operation of the actuator.
3. Remove the lock nut from the top of the wrenching square.
4. Remove the four socket head screws and wrenching square.
5. Note the position of the pointer, then remove the two socket head screws and slide the pointer off the actuator.
6. Remove the plug adjusting nut from the stud and slide the bearing washer off the stud.
7. Note the stampings on the top of the valve plug stem. These stampings correspond with the plug face as shown in Figure 3. It is important that the plug position be noted to ensure it is in the correct position during actuator installation.

Changing Mounting Positions *(Continued)*

8. Scribe corresponding lines on the actuator cover and housing, then remove the cover screws and cover from the top of the actuator.
9. Mark which teeth of the rack and gear are engaged and lift the gear sector out of the actuator.

**WARNING!**

This valve is a pressure vessel. Removing the bonnet bolts before relieving pipeline pressure can result in personal injury or equipment damage. Always relieve pipeline pressure before removing the actuator.

10. Remove the screws fastening the adapter to the adaptor plate (**2" - 4" valves**) or to the valve bonnet (**5" - 16" valves**).
 11. Take out the four screws fastening the actuator housing to the adapter.
 12. Rotate the adapter on the valve, and the actuator on the adapter until the holes line up and the actuator is in the desired position. Replace all of the screws.
 13. Find the tooth that was marked on the gear sector and count over clockwise four teeth on the size 6 actuator, and five teeth on the size 12 actuator. This is the tooth that will engage with the marked tooth on the rack. Install the gear sector using the new tooth engagement, and be sure the gear sector fits on the plug stem properly.
 14. Set a new cover gasket on the housing, then install and fasten the top cover on the housing; make sure the scribe marks line up.
 15. Slide the bearing washer down the plug stud.
 16. Screw the plug adjusting nut down the plug stud until it touches the bearing washer.
 17. Turn the plug adjusting nut clockwise until there is .010" clearance between the plug face and the body seat. (If the valve is used with paper stock, the clearance should be .030".
- Note:** The holes in the bearing washer must line up with the tapped holes in the top of the gear sector.
18. Slide the pointer down the plug stud so that it rests on top of the bearing washer; the pointer should point to the correct valve position. Fasten the pointer to the gear sector with the two shorter socket head screws.
 19. Slide the wrenching square down the plug stud so that it rests on top of the pointer. Fasten the wrenching square to the gear sector with the four remaining socket head screws.
 20. Screw the lock nut down the stud until it contacts the wrenching square and tighten to lock the assembly into place.
 21. Connect the supply pressure tubing to the cylinder.
 22. Check the stop settings and readjust if necessary. The correct adjustment procedure is described in the *STOP ADJUSTMENT* section of this instruction.
 23. Reconnect power to the actuator.
 24. Pipeline flow may now be restored.

Troubleshooting

Condition	Possible Cause	Corrective Action
Actuator will not fully operate valve	Cylinder pressure is low	Increase cylinder pressure. Do not exceed 100 psi (69 kPa).
	Piston seal in cylinder is leaking	Replace piston seal(s). See Cylinder instructions.
	Pipeline obstruction in valve is preventing closure	Remove obstruction
Actuator rotates wrong direction	Air connections to cylinder are incorrect	Reverse air connections to cylinder

Limited Warranty

DeZURIK, Inc. ("Seller") manufactured products, auxiliaries and parts for a period of twenty-four (24) months from date of shipment from Seller's factory, are warranted to the original purchaser only against defective workmanship and material, but only if properly stored, installed, operated, and serviced in accordance with Seller's recommendations and instructions.

For items proven to be defective within the warranty period, your exclusive remedy under this limited warranty is repair or replacement of the defective item, at Seller's option, FCA Incoterms 2020 Seller's facility with removal, transportation, and installation at your cost.

Products or parts manufactured by others but furnished by Seller are not covered by this limited warranty. Seller will provide repair or replacement for other's products or parts only to the extent provided in and honored by the original manufacturer's warranty to Seller, in each case subject to the limitations contained in the original manufacturer's warranty.

No claim for transportation, labor, or special or consequential damages or any other loss, cost or damage is being provided in this limited warranty. You shall be solely responsible for determining suitability for use and in no event shall Seller be liable in this respect.

This limited warranty does not warrant that any Seller product or part is resistant to corrosion, erosion, abrasion or other sources of failure, nor does Seller warrant a minimum length of service.

Your failure to give written notice to us of any alleged defect under this warranty within twenty (20) days of its discovery, or attempts by someone other than Seller or its authorized representatives to remedy the alleged defects therein, or failure to return product or parts for repair or replacement as herein provided, or failure to store, install, or operate said products and parts according to the recommendations and instructions furnished by Seller shall be a waiver by you of all rights under this limited warranty.

This limited warranty is voided by any misuse, modification, abuse or alteration of Seller's product, accident, fire, flood or other Act of God, or your failure to pay entire contract price when due.

The foregoing limited warranty shall be null and void if, after shipment from our factory, the item is modified in any way or a component of another manufacturer, such as but not limited to, an actuator is attached to the item by anyone other than a Seller factory authorized service personnel.

All orders accepted shall be deemed accepted subject to this limited warranty, which shall be exclusive of any other or previous Warranty, and this shall be the only effective guarantee or warranty binding on Seller, despite anything to the contrary contained in the purchase order or represented by any agent or employee of Seller in writing or otherwise, notwithstanding, including but not limited to implied warranties.

THE FOREGOING REPAIR AND REPLACEMENT LIMITED WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS AND LIABILITIES, INCLUDING ALL WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR OF MERCHANTABILITY OR OTHERWISE, EXPRESSED OR IMPLIED IN FACT OR BY LAW, AND STATE SELLER'S ENTIRE AND EXCLUSIVE LIABILITY AND YOUR EXCLUSIVE REMEDY FOR ANY CLAIM IN CONNECTION WITH THE SALE AND FURNISHING OF SERVICES, GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATIONS.

Disclaimer

Metric fasteners should not be used with ASME Class 150/300 bolt holes and flange bolt patterns. If you use metric fasteners with ASME Class 150/300 bolt holes and flange bolt patterns, it may lead to product failure, injury, and loss of life. DeZURIK Inc. disclaims all liability associated with the use of metric fasteners with ASME Class 150/300 bolt holes and flange patterns, including but not limited to personal injury, loss of life, loss of product, production time, equipment, property damage, lost profits, consequential damages of any kind and environment damage and/or cleanup. Use of metric fasteners with ASME Class 150/300 bolt holes and flange bolt patterns is a misuse that voids all warranties and contractual assurances. If you use metric fasteners with ASME Class 150/300 bolt holes and flange bolt patterns, you do so at your sole risk and any liability associated with such use shall not be the responsibility of DeZURIK, Inc. In addition to the foregoing, DeZURIK's Manufacturer's Conditions apply.

Limitation of Liability

IN NO EVENT SHALL SELLER BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES WHATSOEVER, AND SELLER'S LIABILITY, UNDER NO CIRCUMSTANCES, WILL EXCEED THE CONTRACT PRICE FOR THE GOODS AND/OR SERVICES FOR WHICH LIABILITY IS CLAIMED. ANY ACTION FOR BREACH OF CONTRACT BY YOU, OTHER THAN RIGHTS RESPECTING OUR LIMITED WARRANTY DESCRIBED ABOVE, MUST BE COMMENCED WITHIN 12 MONTHS AFTER THE DATE OF SALE.

Sales and Service

For information about our worldwide locations, approvals, certifications and local representative:

Web site: www.dezurik.com E-Mail: info@dezurik.com



250 Riverside Ave. N., Sartell, MN 56377 • Phone: 320-259-2000 • Fax: 320-259-2227

DeZURIK, Inc. reserves the right to incorporate our latest design and material changes without notice or obligation. Design features, materials of construction and dimensional data, as described in this manual, are provided for your information only and should not be relied upon unless confirmed in writing by DeZURIK, Inc. Certified drawings are available upon request.