

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR MODELS

G40XX-S

LOCKED PISTON ROD

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

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SECTION 1 - INTRODUCTION

1.1 GENERAL

- 1.1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis models G4012-S, G4014-S and G4016-S Locked Piston Rod Double Acting Series pneumatic actuators.
- 1.1.2 Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.
- 1.1.3 The maximum recommended service interval for this actuator is five years. Storage time is counted as part of the service interval.

1.2 SERVICE SUPPORT ITEMS

- 1.2.1 Bettis Service/Seal Kit.
- 1.2.2 G4 Rod Extension Retainer Nut tool part number 117370.
- 1.2.3 Commercial leak testing solution.
- 1.2.4 Non-hardening thread sealant.

1.3 BETTIS REFERENCE MATERIALS

- 1.3.1 Assembly Drawing part number 118736.

1.4 DEFINITIONS

WARNING: If not observed, user incurs a high risk of severe damage to actuator and/or fatal injury to personnel.

CAUTION: If not observed, user may incur damage to actuator and/or injury to personnel.

NOTE: Advisory and information comments provided to assist maintenance personnel to carry out maintenance procedures.

1.5 GENERAL INFORMATION

- 1.5.1 This procedure is applicable with the understanding that all electrical power and pneumatic pressure has been removed from the actuator. Also, it is understood that the actuator has been removed from the valve as well as all piping and accessories that are mounted on the actuator have been removed.
- 1.5.2 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.

- 1.5.3 Numbers in parentheses, () indicate the bubble number (reference number) used on the Bettis Assembly Drawing and Actuator Parts List.
- 1.5.4 This procedure is written using the stop screw side of the housing (1-10) as a reference and this side will be considered the front side of the actuator. The housing cover (1-20) will be the top of the actuator.
- 1.5.5 The actuator weight, without accessories or valve mount hardware, is 467 pounds/211.8 KGS.
- 1.5.6 To ensure correct re-assembly; that is, with pneumatic cylinder on same end of housing as was, mark or tag right (or left) and mark mating surfaces.
- 1.5.7 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp corners rounded off.
- 1.5.8 Use a non-hardening thread sealant on all pipe threads.

CAUTION: Apply the thread sealant per the manufacture's instructions.

- 1.5.9 Disassembly of actuator should be done in a clean area on a work bench.

1.6 LUBRICATION REQUIREMENTS - Use Bettis ESL-5 lubricant. ESL-5 lubricant is contained in the Bettis Service/Seal Kit. Lubricants, other than Bettis ESL-5 should not be used without prior written approval of Bettis Product Engineering.

1.7 SAFETY Products supplied by Bettis, in its "as shipped" condition, are intrinsically safe if the instructions contained within this Service Instruction are strictly adhered to and executed by well trained, equipped, prepared and competent personnel.

WARNING: For the protection of personnel working on Bettis actuators, this procedure should be reviewed and implemented for safe disassembly and reassembly. Close attention should be noted to the WARNINGS, CAUTIONS and NOTES contained in this procedure.

WARNING: This procedure should not supersede or replace any customers plant safety or work procedures. If a conflict arises between this procedure and the customers procedures the differences should be resolved in writing between an authorized customers representative and a authorized Bettis representative.

1.8 TOOLS

- 1.8.1 Tools: All tools are American Standard inch. Large adjustable wrench, two (2) large screwdrivers, Allen wrench set, set of open/box-end wrenches, rubber or leather mallet, torque wrench (up to 5,000 in. lbs.), breaker bar, 1/4" drift punch and a 1/2" drive socket set. For recommended tool and wrench sizes refer to Section 4 Table 4.1.

SECTION 2 - ACTUATOR DISASSEMBLY

2.1 GENERAL DISASSEMBLY

- 2.1.1 If not already removed disconnect all operating pressure from actuator power cylinders.
- 2.1.2 Mark stop screws (1-180) left and right. The setting of stop screws (1-180) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screws will be removed later in this procedure.
- 2.1.3 Unscrew and remove two vent check assemblies (13) from housing (1-10).
- 2.1.4 Mark and record location of the ports on outer end cap (3-80) and inner end cap (3-10).

2.2 PNEUMATIC CYLINDER MODULE DISASSEMBLY

- 2.2.1 Remove two socket cap screws (3-130), with lockwasher (3-140), from outer end cap (3-80).
- 2.2.2 Remove two tie bar hex nuts (3-90) from outboard side of outer end cap (3-80).
- 2.2.3 The fit between cylinder (3-70) and outer end cap (3-80) is very tight. Break end cap free by tapping with a breaker bar on lip provided on the end cap. Remove outer end cap (3-80) from cylinder (3-70).

CAUTION: Do not damage o-ring groove when removing end cap.

- 2.2.4 NOTE: When removing cylinder (3-70) off of piston (3-30), tilt the cylinder 15° to 30° degrees with respect to actuator centerline. Remove cylinder (3-70) from inner end cap (3-10).

CAUTION: Do not use pipe wrench to remove tie bars.

- 2.2.5 NOTE: Flats on outboard end of tie bars (3-20) are provided for wrench placement. Unscrew and remove tie bars (3-20) from inner end cap (3-10) and piston (3-30).
- 2.2.6 Refer to assembly drawing page 2 of 2 Detail "D". Remove four socket cap screws (3-140) with lockwashers (3-130) inboard side of piston (3-30).
- 2.2.7 Refer to assembly drawing page 2 of 2 Detail "D". Remove lock plate (3-200) from inboard side of piston (3-30).
- 2.2.8 Refer to assembly drawing page 2 of 2 Detail "D". Remove two split rings (3-50) and one retainer ring (3-60) from outboard side of piston (3-30).

NOTE: Piston (3-30) acts as the retainer for inboard split rings (3-50). When removing the piston be careful to not lose split rings (3-50).

- 2.2.9 Remove piston (3-30) and inboard split rings (3-50) from piston rod (3-40).
- 2.2.10 Remove o-ring seal (4-70) from piston rod (3-40).

- 2.2.11 Remove six hex cap screws (3-100) with lockwashers (3-110) from housing (1-10).
- 2.2.12 Remove inner end cap (3-10) off of piston rod (3-40).
- 2.2.13 Unscrew and remove piston rod (3-40) from extension rod assembly (1-50).

2.3 DRIVE MODULE DISASSEMBLY

NOTE: For steps 2.3.1 through 2.3.8 refer to assembly drawing page 2 of 2 Section A-A.

- 2.3.1 Before removing position indicator (1-220), record or mark it's position. Remove position indicator (1-220).
- 2.3.2 Unscrew and remove hex cap screws (1-160) with lockwashers (1-170) from yoke cover (1-150).
- 2.3.3 Remove yoke cover (1-150) from housing cover (1-20).
- 2.3.4 Mark and record the orientation of the position indicator assembly (1-140) in relation to the top of yoke (1-70).
- 2.3.5 Remove position indicator assembly (1-140) from top of yoke (1-70).
- 2.3.6 Remove hex cap screws (1-110), with lockwashers (1-170), from housing cover (1-20).

NOTE: Groove pins (1-130) will remain in housing cover (1-20) when housing cover is removed from housing (1-10). Groove pins (1-130) should not be removed from housing cover (1-20) unless they are damaged and require new replacements.

- 2.3.7 Remove housing cover (1-20) from housing (1-10).
- 2.3.8 Remove guide bar (1-90) from housing (1-10).
- 2.3.9 Rotate the arms of yoke (1-70) to the center position of housing (1-10).
- 2.3.10 Remove yoke (1-70) with yoke pin (1-80), guide block (1-30), and extension rod assembly (1-50), by lifting yoke up and out of the housing (1-10).
- 2.3.11 Remove yoke pin (1-80) by inserting 3/8"-16 UNC screw into top of yoke pin and pull straight up and out.
- 2.3.12 Remove guide block (1-30) with extension rod assembly (1-50) from between the arms of yoke (1-70).
- 2.3.13 Remove two yoke/guide block bushings (2-30).
- 2.3.14 Refer to assembly drawing page 2 of 2 Detail "B". Use Bettis tool part number 117369 and remove retention retainer nut assemblies (1-60) from guide block (1-30).
- 2.3.15 Remove rod extension assembly (1-50) from guide block (1-30).

NOTE: One spherical washer will be removed from guide block (1-30) when extension rod assembly is removed.

- 2.3.16 Remove the remaining spherical washer (1-40) from guide block (1-30).
- 2.3.17 Remove hex cap screws (5-20), with spring lockwashers (5-30), from blind end cap (5-10).
- 2.3.18 Remove blind end cap (5-10) from end of housing (1-10).
- 2.3.19 Remove two stop screw nuts (1-190) from front of housing (1-10).
- 2.3.20 Remove two stop screws (1-180) from front of housing (1-10).
- 2.3.21 The following items do not need to be removed from their assembled locations unless replacing with new items: One spring pin (1-100), two yoke pin thrust bearings (2-10), two guide bar bearings (2-20), two yoke pin bearings (2-25), two yoke bearings (2-40), and one pipe plug (3-120).

SECTION 3 - ACTUATOR REASSEMBLY

3.1 GENERAL RE-ASSEMBLY

CAUTION: Only new seals, that are still within the seals expectant shelf life, should be install back into actuator being refurbished.

- 3.1.1 Remove and discard all old seals and gaskets.
- 3.1.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
- 3.1.3 All parts should be thoroughly inspected for excessive wear, stress cracking, galling and pitting. Attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding or rotating motion. Sealing surfaces of the cylinder, tie bars and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

CAUTION: Actuator parts that reflect any of the above listed characteristics should be replaced with new parts.

- 3.1.4 Before installation coat all moving parts with a complete film of lubricant. Coat all seals with a complete film of lubricant, before installing into seal grooves. NOTE: The parts and seals used in the actuator will be assembled using lubricant as identified in section 1 step 1.6.
- 3.1.5 T-seal set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.
 - 3.1.5.1 Install the T-seal into the seal grooves.
 - 3.1.5.2 Install a back-up ring on each side of the T-seal.

3.1.5.3 When installing the back-up rings, do not align the skive-cuts.

3.1.5.4 If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor sharp instrument.

3.2 GUIDE BLOCK PRE-ASSEMBLY

NOTE: Refer to assembly drawing page 2 of 2 Detail "B" for section drawing of guide block.

3.2.1 If guide bar bearing (2-20) is being replaced install new bearing into guide block (1-30).

NOTE: The guide bar bearing (2-20) must be pressed into guide block guide bar bore with the seam located $\pm 5^\circ$ degrees of the top or bottom centerline as shown in section A-A.

3.2.2 Lubricate guide block (1-30), two spherical washers (1-40), and one extension rod assembly (1-50).

3.2.3 Install one spherical washer (1-40) into the side of guide block (1-30). NOTE: The spherical side of washer (1-40) will be facing to the outside of guide block (1-30).

3.2.4 Install second spherical washer (1-40) over threaded end of extension rod assembly (1-50).
NOTE: The spherical side of the washer will go on the extension rod assembly facing the head of the extension rod assembly.

3.2.5 Install extension rod assembly (1-50) into guide block (1-30) and up against the first spherical washer (1-40).

3.2.6 Install extension retainer nut assembly (1-60) over extension rod assembly (1-50) and screw into guide block (1-30).

3.2.7 Tighten extension retainer nut assembly (1-60) until extension rod assembly (1-50) can not move. Back off the extension retainer nut assembly (1-60) just enough to allow for extension rod assembly (1-50) to move freely.

3.3 DRIVE MODULE REASSEMBLY

3.3.1 If the two yoke bearings (2-40) are being replaced install new bearing into housing cover (1-20) and housing (1-10).

NOTE: The yoke bearing (2-40) must be pressed into housing (1-10) and housing cover (1-20). Install the yoke bearings with the bearing seam located $45^\circ \pm 5^\circ$ degrees from the yoke arm slot when yoke (1-70) is rotated to its full clockwise position.

3.3.2 If the two yoke bearings (2-40) are being replaced install new bearing into housing cover (1-20) and housing (1-10).

3.3.3 Lubricate two yoke/guide block bushings (2-30) and install onto top and bottom sides of guide block (1-30).

NOTE: The guide block (1-30) should be already pre-assembled with extension rod assembly and associated parts assembled in the guide block.

3.3.4 Install guide block (1-30), with yoke pin thrust bearings (2-10), between arms of yoke (1-70).

3.3.5 Install one o-ring seal (2-50) into inner diameter seal groove in the bottom of housing (1-10).

3.3.6 Coat the bearing surfaces of yoke (1-70) with lubricant and install into housing (1-10).

3.3.7 Align hole in guide block (1-30) with the matching holes in the two yoke/guide block bushings (2-30) and the slots in the arms of yoke (1-70).

NOTE: The yoke pin can be held in place by installing a screw into the .375-16UNC tapped hole in the upper end of yoke pin (1-80).

3.3.8 Install yoke pin (1-80) by inserting into the upper yoke arm, upper yoke/guide block bushing, guide block, lower yoke/guide block bushing, lower yoke arm and resting on lower yoke pin thrust bearing (2-10).

3.3.9 Install guide bar (1-90) into either side of housing (1-10) by inserting through the housing, through guide block and then insert the guide bar into the other side of housing (1-10).

3.3.10 Install position indicator assembly (1-140) onto the top of yoke (1-70) and over spring pin (1-100). NOTE: Refer to step 2.3.4 for correct installation position.

3.3.11 Install thrust bearing (2-110) over the shaft of position indicator assembly (1-140) and down against the flat plate of position indicator assembly (1-140).

3.3.12 Install o-ring seal (2-100) over the shaft of position indicator assembly (1-140) and down against thrust bearing (2-110).

3.3.11 Install o-ring (2-50) into housing cover (1-20).

3.3.12 Install o-ring seal (2-60) into housing cover (1-20).

3.3.13 Install housing cover (1-20), being careful not to damage o-ring seals (2-50) and (2-60).

3.3.14 Place lockwashers (1-170) onto hex cap screws (1-110).

3.3.15 Install hex cap screws (1-110) with lockwashers (1-170). NOTE: Leave hex cap screws (1-110) finger tight - do not tighten.

3.3.16 NOTE: Do this step only if groove pins (1-130) have been pulled or if the pins are being replaced. Drive groove pins (1-130) through housing cover (1-20) and into housing (1-10). The groove pins should be flush with the cover.

3.3.17 Torque tighten hex cap screws (1-110) until a final lubricated torque of 40 foot pounds ± 10 % percent has been achieved.

3.3.18 Install rod wiper (2-80) into yoke cover (1-150).

3.3.19 Install o-ring seal (2-70) into yoke cover (1-150).

3.3.20 Install yoke cover (1-150) onto housing cover (1-20) and over position indicator assembly (1-140). NOTE: During yoke cover installation be careful not to damage o-ring seal (2-70) and rod wiper (2-80).

3.3.21 Place lockwashers (1-170) onto four hex cap screws (1-160).

3.3.22 Install four hex cap screws (1-160) with lockwashers into yoke cover (1-150).

3.3.23 Torque tighten hex cap screws (1-160) to 16 foot pounds lubricated.

NOTE: Refer to section 2.3 step 2.3.1 for correct position indicator placement.

3.3.24 Install position indicator (1-220) over the exposed shaft of position indicator assembly (1-140).

3.4 PNEUMATIC CYLINDER MODULE REASSEMBLY

3.4.1 Lubricate piston rod (3-40) and insert through the left side of housing (1-10). Screw piston rod (3-40) onto extension rod assembly (1-50).

3.4.2 Refer to assembly drawing page 2 of 2 Detail "C". Install one rod wiper (4-10) into inner end cap (3-10).

3.4.3 Install one rod bushing (4-20) into inner end cap (3-10).

3.4.4 Coat one polypak seal (4-30) with lubricant and install, lip first, into inner end cap (3-10).

CAUTION: Install polypak seal (4-30) with energizer ring facing outboard side (away from housing).

3.4.5 Install one o-ring seal (4-90) into seal groove located on the inboard face of inner end cap (3-10).

3.4.6 Install inner end cap (3-10) on to housing (1-10). NOTE: The pressure inlet port should be positioned in the same position as recorded in section 2.1 step 2.1.4.

3.4.7 Place lockwashers (3-110) onto six hex cap screws (3-100).

3.4.8 Install six hex cap screws (3-100), with lockwashers, through housing (1-10) and into inner end cap (3-10).

3.4.9 Torque tighten hex cap screws (3-100) to 45 foot pounds ± 5 % percent lubricated.

3.4.10 Install one o-ring seal (4-70) into the seal groove located on the outboard end of piston rod (3-40).

NOTE: Refer to section 3.1 step 3.1.5 for proper T-seal installation instructions.

3.4.11 Apply lubricant to two sets of rod T-seal components (4-50). Install the two sets of rod T-seals into the internal diameter seal grooves of piston (3-30).

- 3.4.12 Install two split rings (3-50) into the inner most groove on piston rod (3-40) and retain by installing the recessed area of piston (3-30) onto the piston rod and over the two split rings (3-50).
- 3.4.13 Refer to assembly drawing page 2 of 2 Detail "D". Install lock plate (3-200) into the groove in piston rod (3-40). NOTE: The groove will be located on the inboard side of piston (3-30).
- 3.4.14 Refer to assembly drawing page 2 of 2 Detail "D". Install four socket cap screws (3-140) with lockwashers (3-130) through lock plate (3-200) and into piston (3-30).
- 3.4.15 Torque tighten socket cap screws (3-140) to 6 foot pounds ± 5 % percent lubricated.
- 3.4.16 Install two split rings (3-50) into piston rod (3-40), in front of the piston installed in step 3.4.12, and retain with one retainer ring (3-60).
- 3.4.17 Install one o-ring seal (4-40) onto the outer diameter seal groove of inner end cap (3-10).

NOTE: Refer to section 3.1 step 3.1.5 for proper T-seal installation instructions.

- 3.4.18 Coat one T-seal (4-60) with lubricant and install into the piston external seal groove.
- 3.4.19 Coat two tie bars (3-20) with lubricant and install by carefully pushing tie bars through piston (3-30) and rod T-seals (4-50).
- 3.4.20 Screw tie bars (3-20) into inner end cap (3-10) and tighten until the threads bottom out.
- 3.4.21 Torque tighten piston rod (3-40) to 240 foot pounds lubricated. NOTE: There is a 3/4" inch female square in the outboard end of piston rod (3-40) for tightening purposes.
- 3.4.22 Apply lubricant to the bore of cylinder (3-70).
- 3.4.23 Install lubricated cylinder (3-70) over piston (3-30) and onto inner end cap (3-10). When installing the cylinder over the piston seal tilt cylinder 15° to 30° degrees to piston rod.

CAUTION: If needed, when installing the cylinder, hammer on the end of the cylinder only with a non metallic object.

- 3.4.24 Install outer end cap (3-80) over piston rod (3-40) and into cylinder (3-70). NOTE: The pressure inlet port should be positioned in the same position as recorded in section 2.1 step 2.1.4.
- 3.4.25 Refer to assembly drawing page 2 of 2 Detail "E". Coat two o-ring seals (4-80) with lubricant and install into the internal diameter seal grooves of outer end cap (3-80).
- 3.4.26 Install tie bar nuts (3-90) onto tie bars (3-20). Torque tighten tie bar nuts, alternately in 100 foot pound increments, until a final lubricated torque of 120 foot pounds ± 10 % percent has been achieved.
- 3.4.27 Install lockwashers (3-140) onto two socket cap screws (3-130).

- 3.4.28 Install two socket cap screws (3-130), with lockwashers (3-140), into outer end cap (3-80), Torque tighten socket cap screws, alternately in 50 foot pound increments, until a final lubricated torque 65 foot pounds ± 10 % percent has been achieved.
- 3.4.29 Apply lubricant to one o-ring seal (4-40) and install into the outer diameter o-ring groove of outer end cap (3-80).
- 3.4.30 Apply sufficient pneumatic pressure to outer end cap (3-80) pressure inlet port to move the actuator to its full clockwise position. Remove pneumatic pressure from the outer end cap (3-80).

3.5 ACTUATOR TESTING

- 3.5.1 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.

WARNING: Pressure is not to exceed the maximum operating pressure rating listed on the name tag.

- 3.5.2 Unless otherwise listed all leak testing will use the nominal operating pressure (NOP) as listed on the actuator name tag or the pressure used by the customer to operate actuator during normal operation.

CAUTION: Test the actuator by applying pneumatic pressure through a properly adjusted self relieving regulator, with gauge.

- 3.5.3 Before testing for leaks, alternately apply and release NOP pressure to the pressure side of the piston to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.

- 3.5.4 Apply pressure, as defined in step 3.5.2 to pressure inlet port in inner end cap (3-10) and allow the actuator to stabilize.

NOTE: If excessive leakage is noted, generally a bubble which breaks three seconds or less after starting to form, the actuator must be disassembled and the cause of leakage must be determined and corrected.

- 3.5.5 Apply a commercial leak testing solution to the following areas:

- 3.5.5.1 Joint between inner end cap (3-10) and cylinder (3-70). This checks cylinder to inner end cap o-ring seal.

- 3.5.5.2 Form a leak testing solution bubble over the breather port hole in outer end cap (3-80). This checks the piston seal to cylinder (3-70), o-ring seal (4-70), and rod T seal (4-50).

- 3.5.5.3 The vent check port hole in housing (1-10). This checks seal (4-30) that seals piston rod (3-40) to inner end cap (3-10).

3.5.5.6 Remove pressure from the pressure inlet port of inner end cap (3-10).

3.5.6 If an actuator was disassembled and repaired, the above leakage test must be performed again.

3.6 RETURN TO SERVICE

3.6.1 Install two vent check assemblies (13) into housing (1-10).

3.6.2 Install position indicator (1-220) over position indicator assembly (1-140).

3.6.2 Actuator is ready to be returned to service.

3.6.3 After the actuator is installed on the valve all accessories should be hooked up and tested for proper operation and replaced if found defective.

SECTION 4

4.1 G4 TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE	ITEM QTY	LOCATION OR DESCRIPTION	RECOMMENDED WRENCH STYLE
1-110	9/16"	8	Cover Screws	Socket
1-160	9/16"	4	Yoke Cover Screws	Socket
1-180	3/4" Sq.	2	Stop screws	Open End or Adjustable
1-190	1-13/16"	2	Heavy Hex Jam Nut	Box or Open End
3-20	3/4" Sq.	2	Tie Bar	Male Drive
3-40	3/4" Sq.	1	Piston Rod	Male Drive
3-90	1-5/8"	2	Heavy Hex Nut	Socket
3-100	3/4"	6	Hex Cap Screw	Socket
3-130	3/16"	4	Socket cap screws	Allen
5-20	3/4"	6	Hex Cap Screw	Socket
13	3/4"	2	Vent Check Assembly	Open End

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