

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

T3XX-S

DOUBLE ACTING HIGH CYCLE

SERIES PNEUMATIC ACTUATORS

PART NUMBER: 118052

REVISION: "B"

RELEASE DATE: November 29, 1995

1.0 **INTRODUCTION**

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis T3XX-S double acting High Cycle pneumatic series actuators.

1.2 **SAFETY STATEMENT:** 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.

1.3 **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.

1.4 **BASIC SERVICE INFORMATION:** Complete actuator refurbishment will require the actuator to be dismantled from the valve or device it is operating.

1.5 The maximum recommended service interval for this actuator series is five years. Storage time is counted as part of the service interval.

1.6 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.

2.0 **SUPPORT ITEMS AND TOOLS**

2.1 **Support Items** - Service/Seal Kit, razor sharp cutting instrument, commercial leak testing solution, and non-hardening thread sealant.

2.2 **Tools** - All tools are American Standard inch. Two each medium standard screwdriver, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and a torque wrench (up to 5,000 in.lbs.). For recommended tool list refer to Chart number 1 on page 12.

3.0 BETTIS REFERENCE MATERIALS

- 3.1 Actuator model T3XX-S series Assembly Drawing part number 118053.

4.0 GENERAL DETAILS

- 4.1 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
- 4.2 Numbers in parenthesis, (), indicate the bubble number (reference number) used on the Bettis Assembly Drawing and actuator parts list.
- 4.3 Mating parts should be marked for ease of reassembly, i.e. left and right stop screws and cylinder to housing.
- 4.4 When removing seals from seal groove, use a commercial seal removing tool or use a small standard screwdriver with the sharp edges rounded off.
- 4.5 Use a non-hardening thread sealant on all pipe threads.

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

- 4.6 Disassembly should be done in a clean area on a work bench.
- 4.7 LUBRICATION REQUIREMENTS: Lubricants, other than those listed in steps 4.7.1 and 4.7.2, should not be used without prior written approval of Bettis Product Engineering.
- 4.7.1 Standard and high temperature service (-20°F to +350°F) use Bettis ESL-5, Kronaplate 100 lubricant. ESL-5 is contained in the Bettis Service/Seal Kit.
- 4.7.2 Low temperature service (-50°F to +150°F) use Kronaplate 50 lubricant. Kronaplate 50 is not contained in the Low Temperature Service/Seal Kit.

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

- 4.8 Before starting the general disassembly of the actuator, it is a good practice to operate the actuator with the pressure used by the customer to operate the actuator during normal operation. Notate and record any abnormal symptoms such as jerky or erratic operation.

5.0 GENERAL DISASSEMBLY

- 5.1 If not already removed disconnect all operating pressure from the actuator power cylinder (2-10).
- 5.2 Identify (tag) the cylinder stop screw (2-210) and blind end cap stop screw (6-40). The setting of stop screws (2-210) and (6-40) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screws will be removed later in this procedure.

- 5.3 Mark and record location of the pneumatic inlet ports on cylinder outer end cap (2-30) and inner end cap (2-40).
- 5.4 Remove snubber valve (1-190) from housing cover (1-20).
- 5.5 Remove socket cap screws (1-180) from position indicator (1-170) yoke weather cover (3-130) and remove position indicator/yoke weather cover.

6.0 PRESSURE CYLINDER DISASSEMBLY

- 6.1 Loosen and rotate seal nut (2-130) all the way back to the stop screw outboard nut.
- 6.2 Loosen and remove socket cap screws (2-200) from jackscrew adapt (2-190).
- 6.3 Rotate jackscrew adapter (2-190) out until clear of hex nuts (2-90).
- 6.4 Remove hex nuts (2-90) from tie bars (2-60).
- 6.5 Remove outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap is very tight. Break the outer end cap free by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: When separating cylinder (2-10) from outer end cap (2-30) do not damage o-ring groove.

- 6.6 Pry inner end cap (2-40) away from housing (1-10). Break the inner end cap free from cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: When separating cylinder (2-10) from inner end cap (2-40) do not damage o-ring groove.

- 6.7 Remove cylinder (2-10). When sliding the cylinder off of the piston, tilt the cylinder at an angle to the piston rod, approximately 15° to 30° degrees.
- 6.8 Move the piston so that there is at least four to six inches of distance between inner end cap (2-40) and piston (2-20).

NOTE: Flats are provided on the outboard end of the tie bars for wrench placement.

- 6.9 Unscrew tie bars (2-60) from housing (1-10).

CAUTION: Do not use a pipe wrench on the tie bars as it will mark the bar and cause seal leakage.

- 6.10 Pull the tie bars out of inner end cap (2-40) far enough to expose o-rings (3-30). Remove o-rings (3-30) from inboard end of tie bars.
- 6.11 Remove tie bars (2-60) by pulling them out of piston (2-20).

6.12 Remove split ring retainer (2-80) and split ring (2-70) from the outboard side of piston (2-20).

NOTE: Keep the split rings in matched sets.

6.13 Remove piston (2-20) from piston rod (2-170).

6.14 Remove o-ring seal (3-40) from piston rod (2-170).

6.15 Remove inboard split ring retainer (2-80) and split ring (2-70) from piston rod (2-170).

NOTE: Keep the split rings in matched sets.

6.16 Remove inner end cap (2-40) from piston rod (2-170).

7.0 BLIND END CAP REMOVAL

7.1 Loosen and rotate seal nut (6-60) all the way back to stop screw outboard nut.

7.2 Remove two hex cap screws (6-20) with seal gaskets (6-30).

7.3 Remove blind end cap (6-10) from housing (1-10).

8.0 HOUSING GROUP DISASSEMBLY

8.1 Remove cover screws (1-90) and gasket seals (3-100).

8.2 Remove housing cover (1-20). NOTE: The cover will have a very tight fit. It is not necessary to remove cover pins (1-130) from the cover.

8.3 Remove top two yoke rollers (1-50) from top of yoke pin (1-40).

8.4 Remove yoke pin (1-40) from the yoke and piston rod/yoke pin nut assembly (1-30).

8.5 Move piston rod/yoke pin nut assembly (1-30) toward the cylinder side of housing (1-10).

8.6 Remove yoke (1-160) by lifting it from housing (1-10).

CAUTION: The yoke/housing bearing area must be lubricated and inspected to extend service life and prevent degradation of torque output. This can only be accomplished by removing the yoke from the housing which requires removing the actuator from the valve.

8.7 Remove lower two yoke rollers (1-50) from housing (1-10).

8.8 Remove roll pin from piston rod/yoke pin nut assembly (1-30).

8.9 Unscrew piston rod (2-170) from piston rod/yoke pin nut assembly (1-30).

CAUTION: Do not use a pipe wrench on the piston rods as it may mark the rod and cause seal leakage. Flats are provided on the outboard end of the piston rod for wrench placement.

8.10 Remove piston rod from housing (1-10), including rod bushing (2-50).

NOTE: A new rod bushing is provided in the standard Bettis Service/Seal Kit.

8.11 If not already removed in step 8.9, remove rod bushing (2-50) from housing (1-10) or piston rod (2-170).

8.12 Remove hex cap screws (1-60) with seal gasket (3-110).

8.13 It is not necessary to remove pipe plugs (1-80) or (1-210) to service the actuator.

9.0 GENERAL RE-ASSEMBLY

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

9.1 Remove and discard all old seals and gaskets.

9.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.

9.3 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 must be replaced with new parts.

9.4 INSTALLATION LUBRICATION INSTRUCTIONS: Use the correct lubrication as defined in section 4.0 step 4.7.

9.4.1 Before installation coat all moving parts with lubricant.

9.4.2 Coat all seals with lubricant, before installing into grooves.

9.5 T-seal set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.

9.5.1 Install the T-seal into the seal grooves.

9.5.2 Install a back-up ring on each side of the T-seal.

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

9.5.4 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.

10.0 HOUSING RE-ASSEMBLY

CAUTION: All components inside housing (1-10) are to be liberally coated with the lubricant defined in step 4.7.

- 10.1 If removed install pipe plugs (1-80) and (2-210) in actuator housing (1-10).
- 10.2 If yoke bushings (1-200) were removed then install one into the bore of housing (1-10) and one into the yoke bore of cover (1-20).
- 10.3 Inside housing (1-10) apply lubricant to the tracks and yoke bore.
- 10.4 Coat one yoke o-ring seal (3-50) with lubricant and install into seal groove located in bottom area of housing (1-10).
- 10.5 Apply lubricant to yoke pin nut (1-30).
- 10.6 Apply lubricant to piston rod (2-170).
- 10.7 Apply lubricant to rod bushing (2-50).

NOTE: A new rod bushing is provided in the standard Bettis Service/Seal Kit.

- 10.8 Screw piston rod (2-170) into yoke pin nut (1-30).
- 10.9 Align roll pin hole in yoke pin nut (1-30) with through hole in the threads of piston rod (2-170).
- 10.10 Install roll pin into and through the piston rod/yoke pin nut assembly.
- 10.11 Install lubricated rod bushing (2-50) into right side of housing (1-10).
- 10.12 Install the pre-assembled, and pinned, yoke pin nut assembly (1-30)/piston rod (2-170) into housing (1-10) and through rod bushing (2-50).
- 10.13 Apply lubricant to the slots in the upper/lower yoke arms and the lower bearing surface.
- 10.14 Install yoke (1-160) into housing (1-10) as follows: Rotate yoke arms to approximately a 45° degree counter clockwise (CCW) position and lower into housing (1-10).

NOTE: The yoke hub with tapped holes faces up. Rotate the yoke arms back to approximately mid-stroke (center) position.

- 10.15 Apply lubricant to the surfaces of all four yoke pin rollers (1-50).
- 10.16 Place one yoke roller (1-50) in the track in the bottom of the housing and position it under the slot in the yoke arms.
- 10.17 Place a second yoke roller (1-50) on top of the first yoke roller in the slot in the lower yoke arm and align the holes in the yoke rollers.

- 10.18 Insert piston rod/yoke pin nut assembly into position between the yoke arms, parallel to the track in the housing. Align the yoke pin hole with the yoke rollers.
 - 10.19 Lubricate the yoke pin (1-40) and insert through the piston rod/yoke pin nut assembly (1-30) and the two yoke rollers (1-50).
 - 10.20 Install a third yoke pin roller (1-50) over the yoke pin located in the slot in the upper yoke arm. Install the fourth and last remaining yoke roller (1-50) on top of the yoke roller you just installed in the upper yoke arm slot.
- NOTE: The top yoke pin roller (1-50) will remain partially above the upper yoke arm and will engage the cover track when cover (1-20) is installed.
- 10.21 Place new gaskets (3-110) on hex cap screws (1-60). Install the pre-assembled hex cap screws into housing (1-10).
 - 10.22 Coat remaining o-ring seal (3-50) with lubricant and install into cover (1-20).
 - 10.23 Place cover gasket (3-20) onto housing (1-10).
 - 10.24 Apply lubricant to the yoke bore and track in cover (1-20).
 - 10.25 Apply lubricant to upper bearing surface of yoke (1-160).
 - 10.26 Install cover (1-20), being careful not to damage gasket (3-20) or o-ring seal (3-50).
 - 10.27 Install new seal gaskets (3-100) onto hex cap screws (1-90).
 - 10.28 Install hex cap screws (1-90), with new seal gaskets (3-100), through cover (1-20) and screw into housing (1-10).
 - 10.29 Do this step only if you have pulled cover pins (1-130) or if you are replacing the cover pins.
- NOTE: Cover pins (1-130) are grooved at one end and tapering to a smooth diameter at the other end.
- 10.29.1 Install four cover pins (1-130) smooth end first into cover (1-20).
 - 10.29.2 Drive four cover pins (1-130) through cover (1-20) and into housing (1-10) until each pin is flush with the cover.
- 10.30 Torque tighten hex cap screws (1-90) to 12 foot pounds lubricated.
 - 10.31 Rotate yoke to a position that will leave a minimum of piston rod/yoke pin nut assembly (1-30) protruding from actuator housing.

11.0 BLIND END CAP RE-ASSEMBLY

- 11.1 Apply a light coating of lubricant to left end of housing (1-10).

- 11.2 Coat one end cap gasket (3-10) with lubricant on both sides and install onto lubricated housing end.
- 11.3 Install new seal gaskets (6-30) onto hex cap screws (6-20).
- 11.4 Install blind end cap (6-10) onto left end of housing and retain using hex cap screws (6-20) with seal gaskets (6-30).
- 11.5 Torque tighten hex cap screws (6-20) to 126 foot pounds lubricated.

12.0 PRESSURE CYLINDER RE-ASSEMBLY

- 12.1 Apply lubricant to rod seal (3-70) and install, lip first, into the recess provided in inner end cap (2-40).

CAUTION: Install rod seal (3-70) with the energizer ring facing outboard side (away from housing).

- 12.2 Apply lubricant to end cap gasket (3-10) and install over piston rod and rod bushing (2-50).

- 12.3 Install inner end cap (2-40) over piston rod and rod bushing (2-50).

NOTE: Install inner end cap with large raised boss toward the housing (flat side outward). End cap pressure inlet port should be toward the top of actuator.

- 12.4 Apply lubricant to o-ring seal (3-60) and install into outer diameter seal groove on inner end cap (2-40).

- 12.5 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into piston internal seal groove. Refer to step 9.5 for proper T-seal installation instructions.

- 12.6 Apply lubricant to o-ring seal (3-40) and place onto piston rod.

- 12.7 Install matched set of split rings (2-70) into inner most groove on piston rod and retain with retaining ring (2-80).

- 12.8 Install piston (2-20) onto piston rod and up against split rings (2-70).

- 12.9 Install matched set of split rings (2-70) onto piston rod and retain with retaining ring (2-80).

- 12.10 Apply lubricant to threads and end of tie bars (2-60), end without wrench flat.

- 12.11 Install two tie bars (2-60) by carefully inserting through piston (2-20).

NOTE: Install tie bars far enough through piston to expose inboard o-ring seal groove.

- 12.12 Apply lubricant to two o-ring seals (3-30) and install into exposed seal groove on inboard end of tie bars.

- 12.13 Insert tie bars through inner end cap (2-40) and screw into housing (1-10).

CAUTION: **Tighten the tie bars until the threads bottom out, then back out each tie bar one-half (1/2) turn.**

12.14 Apply a light coat of lubricant to the bore of cylinder (2-10).

12.15 Apply lubricant to piston T-seal components (3-90) and install into piston outer diameter seal groove. Refer to step 9.5 for proper T-seal installation instructions.

CAUTION: **If needed when installing cylinder (2-10), hammer on end of cylinder only with a non metallic object.**

CAUTION: **Make certain back-up rings, components of piston T-seal (3-90), are seated into piston external seal groove. Should back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.**

12.16 Install end of cylinder (2-10) over piston (2-20) and onto inner end cap (2-40). When installing cylinder over the piston seal, tilt cylinder 15° to 30° degrees to piston rod.

12.17 Apply lubricant to two o-ring seals (3-30) and install into seal groove on outboard end of tie bars (2-60).

12.18 Apply a light coating of lubricant to threads of cylinder stop screw stud (2-210).

12.19 Insert cylinder stop screw stud (2-210) through outer end cap (2-30), with the welded nut on the flat side of outer end cap (2-30).

12.20 Lightly lubricate o-ring groove area on jackscrew adapter (2-190).

12.21 Lightly lubricate o-ring seal (100) and install into o-ring groove on jackscrew adapter (2-190).

12.22 Screw jackscrew adapter (2-190) onto stop screw stud (2-210).

12.23 Install socket cap screws (2-200) through jackscrew adapter (2-190) and into outer end cap (2-30). Leave socket cap screws (2-200) finger tight.

12.24 Screw M3 seal nut onto cylinder stop screw stud (2-210).

12.25 Rotate cylinder stop assembly (2-210) counterclockwise until welded nut is up against outer end cap (2-30).

12.26 Apply lubricant to o-ring seal (3-60) and install into outer diameter seal groove on outer end cap (2-30).

12.27 Install outer end cap (2-30) onto tie bars and into end of cylinder (2-10). NOTE: Make certain that outer end cap inlet port(s) are toward top of actuator.

12.28 Rotate cylinder stop screw stud clockwise until the jackscrew adapter will clear the end of the tie bars (2-60).

- 12.29 Remove socket head cap screws (2-200) from jackscrew adapter (2-190).
- 12.30 Pull out jackscrew assembly (2-190) from outer end cap (2-30) until enough clearance is available to install hex nuts (2-90).
- 12.31 Install two hex nuts (2-90) onto tie bars (2-60), using them to draw all of the cylinder components into position.

CAUTION: While the tie bar nuts are being tightened do not allow tie bars to rotate.

- 12.32 Torque tighten tie bar nut (2-90) alternately, until a final torque of 65 ± 7 foot pounds lubricated has been achieved.

NOTE: It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the jackscrew adapter can be installed.

- 12.33 Install jackscrew adapter (2-190) and cylinder stop screw assembly (2-210) back into position on outer end cap (2-30).

- 12.34 Retain jackscrew adapter (2-190) with socket head cap screws (2-200).

- 12.35 Tighten seal nut (2-130).

- 12.36 Screw slotted nut onto outboard end of cylinder stop screw assembly (2-210) with slots facing toward outer end cap (2-30).

NOTE: Screw the slotted nut past the pin hole in cylinder stop screw stud.

- 12.37 When nut slot lines up with pin hole. Insert spiral pin through cylinder stop screw stud, retaining slotted nut in its position.

- 12.38 POSITION INDICATOR INSTALLATION:

- 12.38.1 Rotate the yoke to full clockwise (CW) position (as shown on the assembly drawing).

- 12.38.2 Position yoke weather cover (3-130) /position indicator (1-170) on the yoke with pointer facing the front and perpendicular to piston rod.

- 12.38.3 Secure position indicator with socket head cap screws (1-180).

13.0 **ACTUATOR TESTING**

- 13.1 **Leak Test - General** - A small amount of leakage may be tolerated. Generally, a small bubble which breaks about three seconds after starting to form is considered acceptable.
- 13.2 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.

- 13.3 All leak testing will use 65 pig pressure. NOTE: When testing the actuator use a proper adjusted regulator to apply pressure to the actuator.
- 13.4 Before testing for leaks, alternately apply and release 65 psi pressure to the each 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 ready condition.
- 13.5 Apply 65 pig pressure to the pressure port in the outer end cap (2-30).
- 13.6 Apply a leak testing solution to the following areas:
- 13.6.1 Joint between outer end cap (2-30) and cylinder (2-10). Checks cylinder to end cap o-ring seal.
 - 13.6.2 Around tie bar nuts (2-90) on the cylinder outer end cap (2-30). Checks tie bars to outer end cap o-ring seals.
 - 13.6.3 Around seal nut (2-130).
 - 13.6.4 The pressure inlet port in inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.6.5 Remove pressure from pressure inlet port in the outer end cap.
- 13.7 Apply 65 pig pressure to the pressure port in inner end cap (2-40).
- 13.8 Apply a leak testing solution to the following areas:
- 13.8.1 Joint between inner end cap (2-40) and cylinder (2-10). Checks cylinder to inner end cap o-ring seal.
 - 13.8.2 Around the joint of inner end cap (2-40) and housing (1-10). Checks tie bars to inner end cap o-ring seals and the inner end cap to housing gasket seal (3-10).
 - 13.8.3 The snubber valve port hole in housing cover (1-20). Checks the rod seal and tie bars to end cap o-ring seals.
 - 13.8.4 Remove pressure from pressure inlet port in the inner end cap.
- 13.9 If an actuator was disassembled and repaired, the above leakage test must be performed again.

14.0 RETURN TO SERVICE

- 14.1 Replace software components of snubber (1-190) and then install snubber (1-190) in the housing cover port.
- 14.2 Adjust cylinder stop screw (2-210) back to setting recorded in section 5 under General Disassembly.
- 14.3 Adjust blind end cap stop screw (6-40) back to setting recorded in section 5 under General Disassembly.

- 14.4 Tighten seal nut (2-130) securely, while holding cylinder stop screw (2-210).
- 14.5 Tighten seal nut (6-60) securely, while holding blind end cap stop screw (6-40).
- 14.6 After the actuator is installed on the valve all accessories should be hooked up and tested for proper operation and replaced, if found defective.

CHART NO. 1 - TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE	LOCATION	RECOMMENDED WRENCH STYLE
1-30	1-1/4"	Piston Rod Flats	Open end or Adjustable
1-60	1/2"	Hex Cap Screw	Open End or Adjustable
1-80	9/16"	Pipe Plug	Open End or Adjustable
1-90	1/2"	Hex Cap Screws	Socket
1-180	3/16"	Socket Cap Screws	Allen
1-190	7/8"	Snubber Valve	Deep Socket
1-210	7/16" Sq.	Pipe Plug	Open End or Adjustable
2-60	1/2"	Tie Bar Flats	Open End or Adjustable
2-90	1-7/16"	Heavy Hex Nuts	Deep Socket
2-130	1-13/16"	M3 Seal Nut	Open End or Adjustable
6-20	1-7/16"	Blind End Cap Screw	Socket
6-40	1-13/16"	Stop Screw Nut	Open End or Adjustable
6-50	1-1/2"	Yoke Nut Screw	Socket or Open End
6-60	1-11/16"	M3 Seal Nut	Open End or Adjustable

ECN	DATE	REV		BY *	DATE
Released	August, 1995	A	COMPILED	Bill Cornelius	29 November 1995
15177	November, 1995	B	CHECKED	Bill Cornelius	29 November 1995
			APPROVED	Robert McEver	29 November 1995

* Signatures on file Waller, Texas