

**BETTIS**  
**SERVICE INSTRUCTIONS**  
**DISASSEMBLY AND REASSEMBLY**  
**FOR MODELS**  
**TR1007**  
**DOUBLE ACTING SERIES**  
**HYDRAULIC ACTUATORS**

PART NUMBER: Service-044 (SE-044)

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## 1.0 **INTRODUCTION**

This service procedure is offered as a guide to enable general maintenance to be performed on Bettis TRI007 "Scotch-Yoke" type hydraulic actuators.

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis TR1007 double acting hydraulic series actuators (includes actuator models that have a -10 or -11 suffix at the end of the model number).

1.2 When the actuator model number has "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

### 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 **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 customer's plant safety or work procedures. If a conflict arises between this procedure and the customer's procedures the differences should be resolved in writing between an authorized customer's representative and an authorized Bettis representative.

## 2.0 **SUPPORT ITEMS AND TOOLS**

2.1 Support Items - Service Kit, commercial leak testing solution, and non-hardening thread sealant.

2.2 Tools - All tools / Hexagons are American Standard inch (Imperial). Two each large standard screwdrivers, small standard screwdriver with corners rounded, putty knife, set of open/box-end wrenches, rubber or leather mallet, Allen wrench set, and a torque wrench (up to 2,000 inch pounds / 226 N-m), breaker bar and an 1/2" drive socket set.

### **3.0 BETTIS REFERENCE MATERIALS**

3.1 Assembly drawing 048015

3.2 Rail Alignment Tool drawing part number 064899 (Refer to last page of this procedure).

### **4.0 LUBRICATION AND FLUID REQUIREMENTS**

NOTE: The actuator should be re-lubricated at the beginning of each service interval using the following recommended lubricant.

#### **4.1 LUBRICATION:**

NOTE: For use in the actuator housing. Lubricants, other than listed in step 4.1.1 should not be used without prior written approval of Bettis Product Engineering.

4.1.1 All temperature services (-50°F to +350°F)/(-45.5°C to 176.6°C) use Bettis ESL-5 lubricant. ESL-5 lubricant is contained in the Bettis Service Kit in tubes or cans and they are marked ESL-4, 5 & 10 lubricant.

#### **4.2 FLUID REQUIREMENTS:**

4.2.1 For use in the hydraulic power cylinder. The following listed fluids are recommended fluids only and does not limit the use of other hydraulic fluids compatible with supplied seals and coatings.

4.2.2 Standard temperature service (-20°F to +350°F) / (-28.9°C to +176.6°C) use Dexron Automatic Transmission Fluid.

4.2.3 High temperature service (0°F to +350°F) / (-17°C to +176.6°C) use Dexron Automatic Transmission Fluid.

4.2.4 Low temperature service (-40°F to +150°F) / (-40°C to 65.6°C) use Exxon Univis J13 Hydraulic Fluid.

### **5.0 GENERAL DISASSEMBLY**

- NOTES:
1. Numbers in parentheses Bettis Assembly Drawing and actuator Bill of Material.
  2. Front view of actuator: Yoke bore nearest worker, side plate with accessory pads facing worker.
  3. Rotate actuator to full counter-clockwise position.
  4. Some components of this actuator are very heavy and will require a means of assistance.

5.1 Remove all operating pressure from actuator power cylinder (2-10). Remove all plumbing and accessories.

- 5.2 Remove four socket cap screws (1-170) and gasket seal (6-80). Remove position indicator (1-410) and yoke weather cover (6-110).
- 5.3 Drain hydraulic cylinder (2-10) by removing pipe plugs (2-160) - located inboard and outboard side of cylinder bottom.

## **6.0 PRESSURE CYLINDER DISASSEMBLY**

- 6.1 Remove stops screw nut (1-100). You may also remove o-ring seal (6-60).
- 6.2 Remove tie bar nuts (2-100). Inspect Teflon insert - excessive damage may require
- 6.3 Remove outer end cap (2-30) from cylinder (2-10). The fit between the cylinder and the outer end cap is very tight. Break the end cap free by tapping with a breaker bar on lip provided on the end cap. DO NOT damage o-ring groove when removing end cap.

NOTE: Stop screw (1-90) may remain in outer end cap. Be careful when setting aside end caps.

- 6.4 Pry inner end cap (2-40) from housing, again using breaker bar. Pry cylinder (2-10) from inner end cap (2-40). DO NOT damage o-ring groove on end caps.
- 6.5 Remove cylinder from actuator. When sliding the cylinder off, tilt cylinder 15° to 30° degrees with respect to piston rod to help facilitate removal. Inspect inside diameter for corrosion and scratches.

**CAUTION: Keep split ring halves (2-80) in matched sets.**

- 6.6 Remove split rings (2-80) and split ring retainer (2-90) set - outboard end of piston.
- 6.7 Removal of piston (2-120):
  - 6.7.1 Remove piston spacer (2-150).
  - 6.7.2 Slide piston off piston rod (2-120).
  - 6.7.3 Remove hex washer screw (2-140) to disassemble tie bar bushing (2-130) from piston.

**CAUTION: Keep split ring halves (2-80) in matched sets.**

- 6.8 Remove second set of split rings (2-80) and split ring retainer (2-90) - inboard end.
- 6.9 Remove o-ring seal (4-20) and slide inner end cap (2-40) off piston rod (2-70) and tie bars (2-60). Set aside. Remove end cap gasket (6-20) as well.
- 6.10 Remove tie bars (2-60) from housing (1-10). NOTE: Flats on outboard end are provided for wrench placement. Using flats will prevent damage to surfaces of tie bars. (DO NOT USE PIPE WRENCH)
- 6.11 Remove rod bushing (2-50) and rod seal (4-60) by carefully sliding both parts over piston rod (2-70).

- 6.12 Remove piston rod (2-70) from yoke pin nut (1-30). Again, note wrench flats on outboard end. Using flats will prevent damage to surfaces to piston rod. (DO NOT USE PIPE WRENCH).

## 7.0 HOUSING DISASSEMBLY

- 7.1 Blind end cap side of actuator: Remove stop screw nut (1-100). You may also remove o-ring seal (6-60).
- 7.2 Remove hex cap screws (3-20).
- 7.3 Remove blind end cap (3-10) and end cap gasket (6-20). Stop screw (1-90) may remain in end cap. Be careful when setting aside blind end cap.
- 7.4 Remove cover screws (1-170) and gasket seal (6-80).
- 7.5 Remove cover (1-20). This should be a very tight fit. Cover pins (1-160) need not be removed. Remove the cover gasket (6-10) as well.
- 7.6 Remove upper yoke bushing (1-110) from around upper yoke trunion.
- 7.7 Remove outer 'track-rail' (1-140) by unscrewing first set of socket cap screws (1-420) and gasket seal (1-430). Because tie bars and blind end cap screws with 'tipped' ends have been removed, the rails should lift out. Hold or support rail when removing socket cap screws to prevent rail falling or shifting in housing.
- 7.8 There are three (3) yoke rollers (1-40) - remove the top yoke roller.
- 7.9 Remove yoke pin (1-50).
- 7.10 Slide yoke pin nut (1-30) out and remove. Located inside yoke pin nut will be second yoke roller. Stop screw stud (3-30) may be removed if necessary - check for excessive wear.
- 7.11 Remove bottom roller (1-40) inside slot of bottom yoke arm.
- 7.12 Remove inner 'track-rail' (1-140) by unscrewing second set of socket cap screws (1-420) and gasket seal (1-430). Slide rail from between yoke arms and remove from housing (1-10).
- 7.13 Remove yoke (1-330) by lifting from lower yoke bushing (1-120).

**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 device it is mounted on.

- 7.14. Remove lower yoke bushing (1-120).

## 8.0 GENERAL REASSEMBLY

**CAUTION:** Only new seals that are still within the seal's expectant shelf life should be installed into actuator being refurbished.

8.1 Remove and discard all used seals and gaskets.

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

**CAUTION:** Actuator parts that reflect any of the following listed characteristics must be replaced with new parts.

8.3 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.

8.4 INSTALLATION LUBRICATION INSTRUCTIONS: Use lubricants and fluids as defined in Section 4.0.

8.4.1 Before installation coat all moving parts with lubricant.

8.4.2 Coat all seals with lubricant, before installing into seal grooves.

## 9.0 HOUSING REASSEMBLY

9.1 If removed, install pipe plugs (1-200).

9.2 Arrange the housing (1-10) with yoke bore toward front.

9.3 Apply lubricant to lower yoke bushing (1-120) and yoke bore in housing. Install lower yoke bushing.

9.4 Apply lubricant to lower yoke trunion and yoke arms (1-330). Install yoke into lower yoke bushing, positioned approximately 45° degrees in either direction. Rotate yoke to mid-stroke position. The yoke hub with tapped "holes" faces up.

9.5 Check if yoke rollers will run freely in slots of yoke arms. Apply lubricant to all surfaces of yoke rollers (1-40) and slots in yoke arms. Install one (1) roller into slot of bottom yoke arm.

9.6 Apply lubricant to 'track-rails' (1-140). Install inner 'track-rail' (1-140). Slide rail into housing between yoke arms and fasten with socket cap screws (1-420) and gasket seal (1-430).

**NOTE:** Tie bars and blind end cap screws (3-20) with 'tipped' ends will be added later to the support rail. Until that time, an adapter piece (see drawing of part number 064899) may be used as temporary replacements.

9.7 Lubricate the upper and lower surfaces of yoke pin nut (1-30) and install between yoke arms and parallel to rail inside housing.

- 9.8 Install second yoke roller (1-40) into slot of yoke pin nut. Align holes of both rollers.
- 9.9 Apply lubricant to yoke pin (1-50) and install into middle and bottom yoke rollers.
- 9.10 Install final yoke roller (1-40).
- 9.11 Apply lubricant to surfaces of upper yoke trunion (1-330) and upper yoke bushing (1-110).
- 9.12 Install upper yoke bushing over yoke trunion.
- 9.13 If removed, install stop screw stud (3-30) into yoke pin nut.
- 9.14 Install outer 'track-rail' (1-140) with socket cap screws (1-420) and gasket seal (1-430). Again, use adapter piece to support rail until tie bars are installed.

NOTE: New rod bushings (2-50) are provided in the standard Bettis Service Kit.

- 9.15 Apply lubricant to the new rod bushing (2-50) and install into housing.
- 9.16 Install piston rod (2-70) into yoke pin nut. **DO NOT TIGHTEN**. Use wrench flats on outboard end.
- 9.17 If removed, install Bettiswitch cover (1-150) and hole cover gasket (6-40) with socket cap screw (1-190) and lockwasher (1-220) onto cover (1-20).
- 9.18 Lightly apply lubricant to cover gasket (6-10) and install cover gasket onto housing.
- 9.19 Install cover (1-20) to housing with hex cap screws (1-170) and gasket seal (6-80). **DO NOT TIGHTEN**.
- 9.20 If removed, install cover pins (1-160) into housing until the cover pins are flush with top of cover.
- 9.21 Tighten the cover screws (1-170).
- 9.22 Tighten piston rod (2-70) to a torque of approximately 166 ±8 foot-pounds / 225 ±22 N-m lubricated. Flats are provided on the outer end cap for wrenching purposes. (DO NOT USE PIPE WRENCH). Remove any burrs from the flats after tightening.
- 9.23 Install position indicator (1-410) and yoke weather cover (6-110) with hex cap screw (1-170) and gasket seal (6-80).

NOTE: With yoke at mid-stroke, position indicator will point away at approximately 45 degrees to the right (about 2 o'clock position).

- 9.24 If removed, install stop screw (1-90) into blind end cap (3-10).
- 9.25 Apply lubricant to end cap gasket (6-20).
- 9.26 Install blind end cap with end cap gasket to housing with hex cap screws (3-20). NOTE: Back stop screw out, as far as possible.

## 10.0 **POWER CYLINDER REASSEMBLY**

10.1 Lightly apply lubricant to end cap gasket (6-20) and install to right-hand housing side by sliding over piston rod.

10.2 Apply fluid to rod seal (4-60) and install into recess (counter bore) provided in inner end cap (2-40). Install with energizer ring facing outboard side (away from housing).

10.3 Apply lubricant to o-ring seals (4-10). Install seals in both inner and outer end caps.

NOTE: When end caps were disassembled and seals removed, one observed seals were kept in place with 'staked' washers. Check position and placement of washers before installing o-ring seals.

10.4 Install inner end cap (2-40) by sliding over piston rod and rod bushing. Align tie bar holes.

NOTE: The pressure ports of inner end cap should be installed above actuator centerline. Exercise care during installation in order to prevent damage to the rod seal (4-60).

NOTE: New spiral ring retainers (2-90).are provided in the standard Bettis Service Kit.

10.5 Coat the grooves on the piston rod (2-70) with fluid. Install a matched set of split ring halves (2-80) into the inner most groove in the piston rod and retain with a spiral retaining ring (2-90).

10.6 Apply fluid to o-ring seals (4-20) and (4-30).

10.6.1 Install seal (4-20) onto piston rod.

10.6.2 Install seal (4-30) on inner end cap.

10.7 Installing piston onto piston rod:

10.7.1 Apply fluid to o-ring seals (4-40) and install into outer o-ring grooves of the tie bar bushing (2-130).

10.7.2 Apply fluid to o-ring seal (4-10) and install into inner o-ring groove of tie bar bushing.

10.7.3 Apply fluid to tie bar piston bores and install tie bar bushing into piston -retain with hex washer screws (2-140).

10.7.4 Install piston onto piston rod.

NOTE: Hex washer screws face outboard.

10.7.5 Install spacer (2-150) behind piston - outboard side.



NOTE: New spiral ring retainers (2-90).are provided in the standard Bettis Service Kit.

10.8 Install second matched set of split ring halves (2-80) into the outer most groove in the piston rod and retain with a spiral retaining ring (2-90).

10.9 Apply fluid to piston seal (4-50).

NOTE: Seal is composed of rubber seal and two (2) back-up rings. The rings serve as anti-extrusion back-ups.

10.10 Install seal (4-50) onto piston (2-120).

10.11 Install tie bars (2-60) into housing by sliding bars through pistons and end caps.

NOTE: Remove temporary adapter pieces one at a time. As the tie bars are installed, all tie bar surfaces, except threads, can be coated with fluid. Be careful not to damage seals in piston when inserting tie bars.

10.12 Tighten tie bars (2-60). Use wrench flats provided on outboard end of tie bars.

10.13 If removed, install stop screw (1-90) into outer end cap. Back screw as far out as possible.

10.14 Apply fluid to the bore of cylinder (2-10).

10.15 Install lubricated cylinder (2-10) over piston and onto inner end cap. Cylinder will have to be tilted approximately 15° to 30° across piston to facilitate installation. Make certain the back-up rings (components of the piston seal) are seated into the seal groove. Should the back-up rings or seal member be pinched between the piston and cylinder, the components could be damaged becoming a potential source of leakage.

**CAUTION: Hammer on the ends of cylinder (2-10) only with a non-metallic object.**

NOTE: Port holes for pipe plugs and bleed valves must align vertically to the mounting plane of the actuator.

10.16 Apply fluid to o-ring seal (4-30) and install onto outer end cap (2-30).

10.17 Install outer end cap (2-30) onto tie bars and slip inside cylinder. Pressure ports should be located above centerline of actuator.

10.18 Secure assembly with tie bar nut assembly (2-100). Use tie bar nuts to draw all cylinder components into position. Tie bar nuts should be torqued tightened to a lubricated torque of approximately 150 ±15 foot-pounds / 169 ±16 N-m.

10.19 Apply lubricant to o-ring seals (6-60) and install in stop screw nuts (1-100).

10.20 Adjust actuator for 90° degree travel using stop screws (1-90).

10.21 Install stop screw nuts (1-100) onto outer end cap (2-30) and blind end cap (3-20), over stop screws (1-90).

NOTE: Sides (faces) of tie bar nut assembly (2-100) must be paroled before stop screw nut can be installed - this will prevent the tie bar nuts from coming loose.

10.22 Install pipe plugs (2-160) and bleed valves (2-170) - bleed valves on topside of hydraulic cylinder.

## 11.0 **TESTING HYDRAULIC ACTUATORS**

### 11.1. Leakage Test

NOTE: All sources of leakage to atmosphere and across the piston are to be checked using hydraulic pressure.

### 11.2 Procedure:

11.2.1 Cycle the actuator five (5) times at 100% of the normal operating pressure (NOP), as marked on actuator nametag. This allows the seals to seek their proper working attitude.

11.2.2 Apply 100% of the maximum operating pressure (MOP), as marked on actuator nametag, and allow the unit to stabilize.

11.2.3 If there is any notable leakage, the actuator must be disassembled and the cause of leakage must be determined and corrected.

11.2.4 Shell tests the actuator by applying 1.5 times the maximum test pressure, as marked on actuator name tag, to both sides of the piston simultaneously for a period of two (2) minutes. If any leakage occurs, the unit must be disassembled and the cause of leakage must be determined and corrected.

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

### 11.3 Operational (Functional Test)

NOTE: This test is used to verify proper function of the actuator and its' related system (accessories).

### 11.4 Procedure:

11.4.1 Cycle the actuator at 100% PSI operating pressure. Any jumpy or jerky operation, not attributed to seal drag or limited flow capacity, must be corrected.

11.4.2 All accessories, including solenoid valves, positioners, pressure switches, etc., must be hooked up and tested for proper operations and replaced if found defective.

## 12.0 **RETURN TO SERVICE**

12.1 Install elbow (1-260) and breather (1-270).

12.2 Re-install all piping and accessories that were removed.

**PRESSURE REQUIREMENTS AND LIMITATIONS FOR**  
**TR1007 HYDRAULIC DOUBLE ACTING ACTUATOR**

AVAILABLE CONFIGURATION MODEL	NOMINAL OPERATING PRESSURE (NOP)	MAXIMUM OPERATING PRESSURE (MOP)		MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)	
		PSIG	barg	PSIG	barg
TR1007	Customer spec or N.A.	1630	112.38	2200	151.68

**RAIL ALIGNMENT TOOL FOR TR/TRQ ACTUATORS**

**PART NUMBER 064899**

