

## **SERVICE INSTRUCTIONS**

### **ASSEMBLY & DISASSEMBLY**

#### **T80X.X-M4 (5000 PSI) HYDRAULIC SERIES ACTUATORS**

##### **INTRODUCTION**

This service procedure is offered as a guide to enable general maintenance to be performed on GH-Bettis T80X.X-M4 "Scotch-Yoke" type hydraulic actuators.

##### **BASIC TOOLS**

Large Adjustable Wrench, Screwdriver, 1/4" Drift Punch, 24 oz. Ball Peen Hammer, Torque Wrench (up to 2000 in. lbs.), 1/2" Drive Socket Set, Allen Wrench Set and Pry Bar.

##### **REFERENCE GH-BETTIS MATERIALS**

T80X.X-M4 Assembly Drawing 042380 & Base I Dimensional Drawing 042351  
Operating, Storage & Maintenance Instruction for Bettis Hydraulic Valve Actuators (OP/MAINT-002)  
M4, M4A & M4B Hydraulic Override System Operating Instructions.(OPER INST-002).

##### **DISASSEMBLY - M4 HYDRAULIC CYLINDER**

**NOTE:** Numbers in parentheses, ( ), indicate the bubble number (reference number) used on the GH-Bettis Assembly Drawing and actuator Bill of Material.

1. Rotate actuator to mid-stroke position and turn off air or power gas and depressurize air cylinder. Remove all piping and accessories mounted on actuator.
2. Remove M4 Hydraulic Control (8).

**NOTE:** Plug 3/8" NPT ports in the M4 control block as foreign material may enter the system and cause the unit to malfunction.

3. Drain the hydraulic fluid from Hydraulic Cylinder (4-10) by removing the cylinder drain plugs (4-150). One is located on outboard end of hydraulic cylinder and the other on the inboard end of hydraulic cylinder.
4. Remove socket cap screw (4-120), lockwasher (4-110) and nut retainer (4-100).
5. Remove hex nuts (4-90) from tie bars (2-380).
6. Remove outer end cap (4-30). The fit between the cylinder (4-10) 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.

**NOTE:** Do not damage o-ring groove on end cap.

7. Pry inner end cap (4-40) away from housing (1-10). Break the inner end cap free from the cylinder (4-10) by tapping with a breaker bar on the lip provided on the end cap.
8. Remove the cylinder (4-10).
9. Remove the ring retainer (4-80) and the split ring (4-70) from the outboard side of the piston (4-20).
10. Remove the piston (4-20) from the piston rod (4-170). The piston will slide off of the piston rod and tie bars (2-380).
11. Remove piston head o-ring seal (5-40) from piston rod.
12. Remove the split ring retainer (4-80) and the split ring (4-70) from the inboard side of the piston.
13. Slide the inner end cap (4-40) off over the tie bars (2-380) and piston rod (4-170).
14. Remove rod bushing (4-50) and rod seal (5-70). The bushing and rod seal will slide off of the end of the piston rod.
15. Unscrew piston rod (4-170) from yoke pin nut (1-30). Flats are provided on the outboard end of the piston rod for wrench placement. **DO NOT** use a pipe wrench on the piston rod as it will mark the rod and cause seal leakage.

#### **HOUSING GROUP/HYDRAULIC CYLINDER DISASSEMBLY - RIGHT SIDE**

1. Remove four socket cap screws (1-180) from position indicator (1-170)/yoke weather cover (3-130) and remove position indicator/yoke weather cover.
2. Remove cover bolts (1-90) and seal gaskets (3-100).
3. Remove the housing cover (1-20).  
**NOTE:** This piece will have a very tight fit.
4. Loosen piston rod jam nut (2-340) and back away from yoke pin nut (1-30).
5. Unscrew piston rod (4-170) from yoke pin nut (1-30). Flats are provided on the inboard end of the piston rod for wrench placement. **DO NOT** use a pipe wrench on the piston rod as it will mark the rod and cause seal leakage.
6. Remove cylinder assembly (2-310) by unscrewing socket cap screws (2-360).  
**NOTE:** Carefully pull cylinder assembly (2-310) away from cylinder adapter (2-320) to prevent scratching rod bushing (2-50). Remove cylinder gasket (2-330).
7. Remove cylinder adapter (2-320) by unscrewing tie bars (2-380) and sliding adapter away from housing. Slide the bars out left side of housing (1-10).
8. Remove rod bushing (2-50) and end cap gasket (3-10).

9. Remove the yoke rollers (1-50) and roller spacers (1-110) from the top of the yoke pin (1-40). Remove the yoke pin (1-40).
10. Remove yoke pin nut (1-30).
11. Remove roller spacers and bottom two yoke rollers from the housing.
12. The yoke (1-160) can now be removed by lifting it from the housing.
13. It is not necessary to remove the stop screws, drain plug or grease fittings to service the actuator.

#### **GENERAL RE-ASSEMBLY**

Remove all old seals and gaskets, taking care not to scratch or damage seal grooves. New seals and gaskets should be used during actuator re-assembly.

Before starting the assembly of an actuator, all parts should be thoroughly cleaned, inspected and de-burred. Particular attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding motion. After inspection, the parts should be carefully cleaned to remove all dirt, gaskets and other foreign material.

#### **LUBRICATION REQUIREMENTS**

1. Standard and high temperature service (-20°F to 350°F) use Kronaplate 100. Reference GH-Bettis Engineering Standard ESL-5.
2. Low temperature service (-100°F to 300°F) use Aeroshell 17. Reference GH-Bettis Engineering Standard ESL-4.

#### **FLUID REQUIREMENTS**

1. Standard and high temperature service (-35°F to 350°F) use Exxon Dexron II Automatic Transmission Fluid. Identification #D-20106. Reference GH-Bettis Engineering Standard ESF-1.
2. Low temperature service (-65°F to 180°F) use Exxon Univis J13 Hydraulic Fluid. Reference GH-Bettis Engineering Standard ESF-2.

#### **CENTER HOUSING GROUP RE-ASSEMBLY**

1. If removed, install drain plug (1-80) in actuator housing (1-10).
2. If removed, install the grease fittings (1-70) in the actuator housing (1-10) and cover 1-20). The fitting in the housing is located on the bottom of the housing, next to the lower yoke bearing area. The fitting in the cover is located on top of the cover in the upper yoke bearing area.

**NOTE:** Grease fitting is optional, as of 3/1/83.

3. Take all the yoke rollers (1-50) and check to see if they will run (move) freely thru the tracks in the bottom of the housing and the housing cover.
  4. Coat the yoke o-ring seal (3-50) with grease and install into the housing (1-10).
  5. Inside the housing (1-10) apply grease to the tracks and yoke bore and orientate the housing with the yoke bore nearest you.
  6. Apply grease to the yoke (1-160) lower bearing surface and install into the housing (1-10) as follows: Orientate the yoke arm to approximately a 45° position in either direction and lower into the housing. The hub with tapped holes faces up. Rotate the yoke back to approximately the mid-stroke (center) position. Grease both slots in yoke arms.
  7. Apply grease to all surfaces of two of the yoke rollers (1-50) and two roller spacers (1-110). Place one yoke roller in the track in the bottom of the housing and position it under the slot in the yoke arms. Place a roller spacer (1-110) on top of the bottom yoke roller (1-50). Place a second yoke roller on top of the roller spacer in the slot in the lower yoke arm. Place another roller spacer (1-110) on top of the second yoke roller (1-50) and align the holes in the roller spacer and the yoke rollers.
  8. Coat the upper and lower surfaces of the yoke pin nut (1-30) with grease and insert into position between the yoke arms, parallel to the track in the housing. Align the yoke pin hole with the yoke rollers and roller spacers.
  9. Grease the yoke pin (1-40) and insert through the yoke pin nut (1-30), the two yoke rollers (1-50) and the two roller spacers (1-110).
  10. Apply grease to all the surfaces of the two remaining yoke rollers (1-50) and two remaining roller spacers (1-110). Place one roller spacer on top of the yoke pin nut (1-30) then install the third yoke roller (1-50). Place the last roller spacer on top of the third yoke roller (1-50). Place the fourth and final yoke roller on to the yoke pin.
- NOTE:** The top roller will remain above the yoke arm and will engage the cover track when cover is installed.
11. Slide piston rod (4-170) into left side of body and screw into the yoke pin nut (1-30). Tighten the piston rod (4-170) to a torque of approximately 150 ft. lbs. (1,800 in. lbs.). Wrench flats are provided on outboard end of piston rod. **DO NOT** use a pipe wrench on piston rod.
  12. Apply grease to rod bushing (2-50) and install bushing into right side of housing.
  13. Apply a thin coat of grease to end cap gasket (3-10) and install over rod bushing.
  14. Install cylinder adapter (2-320) with tie bars (2-380) by sliding tie bars through left side of housing.
  15. Apply a thin coat of grease to cylinder adapter gasket (2-330).
  16. Install cylinder assembly (2-310) and adapter gasket (2-330) with socket cap screws (2-360) and lockwashers (2-370). **DO NOT** tighten screws.

**NOTE:** Slide piston rod through rod bushing and align bolt holes when installing cylinder assembly.

17. Install jam nut (2-340) onto cylinder assembly piston rod.
18. Install piston rod into yoke pin nut (1-30), thread jam nut against yoke pin nut and tighten jam nut.
19. Tighten socket cap screws (2-360) one at a time and one across from one another.
20. Apply a thin coating of grease to the housing cover gasket (3-20) surface.
21. Place the housing cover gasket (3-20) on the housing (1-10).
22. Coat the yoke o-ring seal (3-50) with grease and install in cover (1-20).
23. Apply grease to the yoke bore and the track in the housing cover (1-20). Apply a thin coat of grease to the gasket surface.
24. Apply grease to the yoke upper bearing surface.
25. Install the housing cover (1-20), being careful not to damage the gasket (3-20) or yoke o-ring seal (3-50).
26. Install the cover screws (1-90) and seal gaskets (3-100). ~~LEAVE FINGER TIGHT -DO NOT TIGHTEN.~~
27. Do this step ~~only~~ if you have pulled the cover pins (1-130) or if you are replacing the cover pins. Drive the four pins (1-130) thru the cover (1-20) and into the housing (1-10) until the pin is flush with the cover.  
**NOTE:** The pins are deeply grooved at one end, tapering to a smooth diameter at the other end. The pin should be installed smooth end first.
28. Tighten the cover screws (1-90).
29. With the yoke rotated to the full clockwise (CW) position (as shown on the assembly drawing) position the yoke weather cover (3-130)/position indicator (1-170) on the yoke with the pointer facing the front and perpendicular to the cylinder assemblies. Secure with socket head cap screws (1-180).

#### **HYDRAULIC CYLINDER RE-ASSEMBLY**

1. Apply grease to the rod bushing (4-50), install it over the piston rod and slide it up into the housing.
2. Coat the rod seal (5-70) with fluid and install, lip first, into the recess provided in the inner end cap.  
**NOTE:** Rod seal is a bi-directional seal and will seal in both directions.
3. Coat the end cap gasket (3-10) with grease on both sides and install over the piston rod and rod bushing.
4. Coat two tie bar o-ring seals (5-30) with fluid and install into the inner end cap (4-40).
5. Slide the inner end cap (4-40) over the tie bars (2-380), piston rod (4-170), and rod bushing (4-50), protruding from the housing.

**NOTE:** Exercise extreme care during installation, in order to prevent damage to the rod seal (5-70).

6. Apply fluid to two sets of piston tie bar T-seal components (5-80) and install into the piston (4-20).
7. Apply fluid to the piston o-ring (5-40) and place onto the piston rod (4-170).
8. Coat the end of the piston rod (4-170) with fluid.
9. Install the two halves of the split ring (4-70) into the inner most groove in the piston rod and retain with one of the spiral retaining rings (4-80).
10. Slide the piston (4-20) over the tie bars (2-380) and onto the piston rod against the split ring (4-70).  
**NOTE:** Piston seal groove will face housing.
11. Install the two halves of the remaining split ring (4-70) onto the piston rod and retain with the remaining retaining ring (4-80).
12. Apply fluid to the end cap o-ring seal (5-60) and install on the inner end cap (4-40).
13. Coat the piston T seal components (5-90) with fluid and install on the piston (4-20).
14. Apply fluid to the bore of the cylinder (4-10) for a distance of approximately four inches (100 mm).
15. Slide the lubricated end of the cylinder (4-10) over the piston (4-20) and onto the inner end cap (4-40).  
**NOTE:** When sliding the cylinder over the piston seal cant cylinder 15° to 30° degrees to piston rod, 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. **DO NOT** hammer on ends of cylinder. Port holes for plugs and bleed valves must be aligned vertically.  
  
Bleed valve (4-160) and cylinder pipe plug (4-150) should be orientated so the bleed valve is at the cylinders' highest point when actuator is mounted in its' final operational position.
16. Apply fluid to two end cap tie bar o-ring seals (5-30) and install into the outer end cap (4-30).
17. Apply fluid to the outer end cap cylinder o-ring seal (5-60) and install onto the outer end cap (4-30).
18. Install the outer end cap (4-30) onto the tie bars and into the end of the cylinder (4-10).
19. Install the two tie bar nuts (4-90) on the tie bars (4-60), using them to draw all of the cylinder components into position. Torque alternately, in 50 ft. lb. increments, until a final torque of 125 ft. lbs. (1500 in. lbs.) has been achieved.
20. Install the nut retainer (4-100), securing in place with the retainer screw (4-120) and lockwasher (4-110). It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the nut retainer can be installed.

#### **M4 HYDRAULIC CYLINDER TESTING**

Before testing for leaks apply air at 30 psig to each side of the piston allowing the actuator to stroke fully in each direction. Repeat this cycle twice. This will allow the seals to seek a normal working attitude.

1. Apply 30 psig air pressure to the inner end of the cylinder (4-10).
2. Apply a leak testing soap solution, using a soft one inch wide brush, to the following areas:
  - a. Around the joint between the inner end cap (4-40) and the cylinder (4-10). (Checks the end cap to cylinder seal.)
  - b. The air inlet in the outer end of the cylinder. (Checks piston seals.) Generally, a small bubble, which breaks 3 or more seconds after starting to form is considered acceptable leakage past the piston, seals only. Leakage to the outside atmosphere past any cylinder assembly seals is not acceptable.
  - c. Around the joint between the inner end cap (4-40) and the housing (1-10).
  - d. The hole in the cover into which the breather (1-190) is to be installed. (Checks the following seals: inner end cap tie bar and piston rod seals.)
3. Apply 30 psig air pressure to the outer end of the cylinder (4-10).
4. Apply a leak testing soap solution, using a soft one inch wide brush, to the following areas.
  - a. Around the joint between the outer end cap (4-30) and the cylinder (4-10). (Checks cylinder to end cap seal.)
  - b. Around the tie bar nuts (4-90) on the cylinder end. (Checks tie bar to end cap seals.)
  - c. The air inlet in the inner end of the cylinder (4-10). (Checks piston seals.)

#### **M4 HYDRAULIC CONTROL INSTALLATION**

1. Re-install the M4 control package (8) on the hydraulic cylinder (4-10).

**NOTE:** The unit must be mounted with reservoir upright with the pump shaft horizontal.

2. Hook up piping from the M4 hydraulic control block to cylinder ports.

**NOTE:** Recommend that a non-hardening thread sealant, compatible with petroleum base hydraulic fluid (example: Rector seal #5 be used in this system). **NOTE: DO NOT USE TEFLON TAPE TO SEAL HYDRAULIC SYSTEM THREADS.**

### **M4 REFILLING INSTRUCTIONS**

Refilling the M4 hydraulic control system, during field service, often must be done without the use of a pressure pump. Proceed as follows:

1. Put the actuator in the closed position (CW).
2. Remove the breather from the reservoir.
3. Fill the reservoir approximately three-fourths (3/4) full (see 'Fluid Requirements' for proper fluid specifications).
4. Open both speed control valves.
5. Open the bleed valve (4-160) on the outboard end of the hydraulic cylinder ~~only~~.
6. Rotate the handle slowly, clockwise, until all air has escaped from the system.
7. Close the bleed valve opened in step 5.

**NOTE:** During the fill procedure, it is important that the lowest fluid level be not less than approximately one-fourth (1/4) of the reservoir volume at any time.

8. open the bleed valve (4-160) on the inboard end of the hydraulic cylinder.
9. Open the handle slowly, counter-clockwise, until all air has escaped from the system.
10. Close the bleed valve opened in step 8.

**NOTE:** During the fill procedure, the piston will not move. This may be determined by observing the position indicator (1-170) on the actuator.

11. Adjust fluid level to 1-1/2" (40mm) from top of reservoir with actuator in open (CCW) position.

### **ADDITIONAL M4 INSTRUCTIONS**

This is performed to insure air is removed from the system (most likely air in pump) and to test the operation of M4 override.

1. Turn M4 crank arm CW. The actuator should move clockwise as well. Adjust outboard bleed valve (4-160) to remove air from system.
2. Turn M4 crank arm CCW. The actuator will move counter-clockwise. Adjust inboard bleed valve to remove air from system.
3. With bleed valves closed, stroke actuator full 90°, CW and CCW, using M4 override.

**TESTING HYDRAULIC POWER CYLINDER**

1. Leakage Test

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

Procedure

- a. Cycle the actuator five times at 100% of nominal operating pressure (NOP), as marked on actuator name tag. This allows the seals to seek their proper working attitude.
- b. Apply 100% of the maximum operating pressure (MOP), as marked on actuator name tag, and allow unit to stabilize.
- c. If there is any notable leakage, the actuator must be disassembled and the cause of the leakage must be determined and corrected.
- d. Shell test the cylinder 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 minutes. If any leakage occurs, the unit must be disassembled and the cause of leakage must be determined and corrected.
- e. If an actuator was disassembled and repaired, the above leakage test must be performed again.

2. Operational (Functional Test)

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

Procedure

Cycle the actuator at 10% of the maximum operating pressure (MOP) as marked on actuator name tag. Any jumpy or jerky operation, not attributed to seal drag or limited flow capacity, must be corrected.

**PRESSURE REQUIREMENTS & LIMITATIONS**

**FOR**

**T80X.X-M4 5000 PSI HYDRAULIC ACTUATORS**

<u>MODEL</u>	<u>NOMINAL OPERATING PRESSURE (NOP)</u>	<u>MAXIMUM OPERATING PRESSURE (MOP)</u>	<u>MAXIMUM ALLOWABLE WORKING PRESSURE (MAWP)</u>
T803.2-M4	Customer spec or N.A.	5000	6000

**RETURN TO SERVICE**

1. Re-install all piping and accessories that were removed.
2. Refer to GH-Bettis "Operating, Storage and Maintenance Instructions for Bettis Rotary Valve Actuators" for actuator start-up procedures.
3. Refer to GH-Bettis M4, M4A & M4B Hydraulic Override System Operating Instructions for override start-up and operating instructions.