

SERVICE INSTRUCTION
ASSEMBLY & DISASSEMBLY
T80X-SRX-M7
HYDRAULIC SERIES ACTUATORS

INTRODUCTION

This service procedure is offered as a guide to enable general maintenance to be performed on GH-Bettis T80X-SRX-M7 "Scotch-Yoke" hydraulic type actuators.

BASIC TOOLS

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

REFERENCE GH-BETTIS MATERIALS

Assembly Drawing 037071 (Fail close - clockwise)
Assembly Drawing 048100 (Fail open - counter clockwise)
Dimensional Base I Drawings 042315 (CW) and 042316 (CCW)
Operating, Storage & Maintenance Instructions (OP/MAINT-002)
GH-Bettis M7, M7A, M7B Hydraulic Override System Operating Instructions (OPER/INST-003)
GH-Bettis Disassembly, Assembly Instructions M7B (Service-035)
M7B Assembly Drawing 029235

GENERAL DISASSEMBLY

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

1. Make sure that the M7 block/bypass valve, located on the right hand side of the control module, is fully open. Turn off operating pressure to power cylinder. Remove all piping and accessories mounted on actuator. Drain hydraulic cylinders by removing pipe plugs.
2. Spring cartridge "pre-load". Locate the stop adjust screw (1-60) that is on the opposite side of the center housing from the spring cartridge (4-10). Loosen the stop nut (1-120) and unscrew the stop screw (1-60) until there isn't any more "pre-load" on the actuator.

CAUTION: DO NOT PROCEED TO NEXT STEP UNTIL YOU ARE SURE THERE IS NO SPRING "PRE-LOAD".

3. Remove hex nuts (10-200) from the spring cartridge brace rods.
4. Remove brace rods (4-80) from the spring cartridge.
5. Drain hydraulic cylinder by removing pipe plugs (2-230).
6. Remove M7 hydraulic override (8) and bracket by loosening hex nuts on Unbolts and sliding assembly off hydraulic cylinder.

TANDEM PRESSURE/HYDRAULIC CYLINDER DISASSEMBLY

1. Remove socket cap screw (2-160), washer (2-150) and nut retainer (2-140).
2. Remove hex nuts (2-130) from tie bars (2-100).
3. Remove outer end cap (2-70). The fit between the cylinder (2-40) 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.
4. Pry hydraulic inner end cap (2-60) away from inner end cap (2-30). Break the inner end cap (2-60) free from the cylinder (2-40) by tapping with a breaker bar on the lip provided on the end cap.
5. Remove the cylinder (2-40). NOTE: When sliding the cylinder off of the piston, cant the cylinder 15° to 30° to the piston rod.
6. Remove the split ring retainer (2-120) and the split ring (2-110) from the outboard side of the piston (2-50).
7. Remove the piston (2-50) from the piston rod (2-170). The piston will slide off of the piston rod. Remove piston head o-ring seal (5-40) from piston rod (2-170).
8. Remove the split ring retainer (2-120) and the split ring (2-100) from the inboard side of the piston rod.
9. Slide the inner end cap (2-60) off over the tie bars (2-100) and piston rod (2-170). Remove end cap gasket (101).
10. Remove rod bushing (2-90). The bushing and seal will slide off of the end of the piston rod.
11. 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. NOTE: Removing end cap will remove second rod seal (5-70) as well.
12. Pry inner end cap (2-30) away from the housing (1-10). Break the inner end cap (2-30) free from the cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.
13. Remove the cylinder (2-10). NOTE: When sliding the cylinder off of the piston, cant the cylinder 15° to 30° to the piston rod.
14. Remove the split ring retainer (2-120) and the split ring (2-110) from the outboard side of the piston (2-20).
15. Remove the piston (2-20) from the piston rod (2-170). The piston will slide off of the piston rod. Remove piston head o-ring seal (3-40) from piston rod (2-170).
16. Remove the split ring retainer (2-120) and the split ring (2-110) from the inboard side of the piston rod.
17. Slide the inner end cap (2-30) off over the tie bars (2-100) and piston rod (2-170).
18. Remove rod bushing (2-80) and rod seal (3-70). The bushing and seal will slide off of the end of the piston rod.

SPRING CARTRIDGE REMOVAL

NOTICE: When the spring cartridge is installed on the actuator the spring is under compression. DO NOT remove the spring cartridge until the actuator has the "preload" removed (refer to step 2 under General Disassembly).

WARNING: Under no circumstances should the spring cartridge be cut open as the spring is pre-loaded and the spring cartridge welded around it.

1. Remove socket head screw (4-60), lockwasher (4-50) and nut retainer (4-40) from the end of the spring cartridge.
2. Alternately loosen the two large hex nuts on the outboard end of the spring cartridge (4-10). These nuts are welded to the tie bars that extend through the spring cartridge and screw into the spacer (10-250). Unscrew the tie bars until the spring cartridge is free from the spacer (10-250). Care should be taken so that the tie bars are not pulled back into the spring cartridge.

NOTE: To keep from inadvertently pulling the tie bars back into the spring cartridge use the hex nuts (2-130) that were removed from the pressure cylinder tie bars (2-100) and screw them on to the spring cartridge tie bars.

HOUSING GROUP DISASSEMBLY

1. Unscrew the tie bars (2-60) from the spacer (10-250). Flats are provided on the outboard end of the tie bars for wrench placement. DO NOT use a pipe wrench on the tie bars as it will mark the bar and cause seal leakage.
2. Unscrew push rod (4-20) from yoke pin nut (1-30) and remove from housing.
3. Unscrew piston rod (2-170) from yoke pin nut (1-30) and remove. 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.
4. Remove four cover/spring brace hex cap screws (10-210) and gasket seals (3-100).
5. Remove four socket cap screws (1-180) from position indicator (1-170)/yoke weather cover (3-130) and remove position indicator/yoke weather cover.
6. Remove cover screws (1-90) and gasket seals (3-100).
7. Remove the housing cover (1-20). Spring brace (10-240) will come off with cover as cover pins (10-230) fit securely in cover.

NOTE: This piece (1-20) will have a very tight fit.

8. Remove the yoke rollers (1-50) and roller spacers (1-110) from the top of the yoke pin (1-40). Remove yoke pin (1-40).
9. Remove yoke pin nut (1-30).
10. Remove yoke rollers and roller spacers from bottom of housing.

11. The yoke (1-160) can now be removed by lifting it from the housing.

NOTE: It is not necessary to remove the stop screws, drain plug or grease fittings to service the actuator.

GENERAL 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

NOTE: Face stop screw side of housing. This will be considered the front side.

1. If removed, install drain plug (1-80) in actuator housing (1-10).
2. If removed, install grease fitting (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 fittings are optional as of 3/1/83.

3. If removed, install stop screws (1-60), stop nut (1-120) and gasket seal (3-110) in both sides of housing.
4. 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.
5. Coat one of the yoke o-ring seals (3-50) with grease and install into the housing (1-10).
6. Inside the housing (1-10) apply grease to the tracks and yoke bore and orientate the housing with the yoke bore nearest you.
7. Apply grease to the slots in the upper and lower yoke arms.

8. 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.
9. 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 and the yoke rollers.
10. Coat the upper and lower surfaces of the yoke pin nut (1-30) with grease and insert into position between the yoke arm, parallel to the track in the housing. Align the yoke pin hole with the yoke rollers and roller spacers.
11. 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).
12. 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.

13. Slide piston rod (2-170) into the side of body and screw into the yoke pin nut (1-30). (~~DO NOT TIGHTEN~~). For spring to open actuators, install the piston rod on the left side of the housing. For spring to close actuators, install the piston rod on the right hand side of the housing. Flats are provided on the outboard end of the piston rod. These flats should be used to put a wrench on to tighten the piston rod. DO NOT use a pipe wrench on the piston rod, as it will cause seal leakage.
14. Slide push rod (4-20) into side of body and screw into the yoke pin nut (1-30). ~~DO NOT TIGHTEN~~.
15. Apply a thin coating of grease to the housing cover gasket (3-20) surface.
16. Place the housing cover gasket (3-20) on the housing (1-10).
17. Coat the remaining yoke o-ring seal (3-50) with grease and install in cover (1-20).
18. 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.
19. Apply grease to the yoke upper bearing surface.
20. Install the housing cover (1-20), being careful not to damage the gasket (3-20) or yoke o-ring seal (3-50).
21. Install the cover screws (1-90) and seal gasket (3-100). ~~LEAVE FINGER TIGHT - DONOT TIGHTEN~~.
22. Do this step only if you have pulled the cover pins (1-130) or if you are replacing the cover pins. Drive the two 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.

23. Place the spring brace (10-240) into position and drive the two cover pins (10-230) thru the brace and cover - into the housing (spring brace could still be mounted to cover). Install cover screws (10-210) and seal gaskets (3-100).
24. Tighten the cover screws (1-90) and (10-210), then tighten push rod (4-20).
25. Tighten the piston rod (2-170) to a torque of approximately 1800 in. lbs. (150 ft. lbs.). Flats are provided on the outer end for wrenching purposes. **DO NOT USE A PIPE WRENCH OR SIMILAR TOOL TO TIGHTEN PISTON ROD.**
- 26A. For spring to close actuators (clockwise) rotate the yoke to the full clockwise (CW) position (as shown on the clockwise assembly drawings) position the yoke weather cover (3-130)/position indicator (1-170) on the yoke with the pointer facing the front and perpendicular to the piston rod (2-170). Secure with the socket head cap screws (1-80).
- 26B. For spring to open actuators (counter-clockwise), rotate the yoke to the full counter clockwise (CCW) position (as shown on the counter clockwise assembly drawings), position the yoke weather cover (3-130)/position indicator (1-170) on the yoke with the pointer facing the right and parallel with the piston rod (2-170). Secure with the socket head cap screws (1-180).
27. Rotate the yoke to a position that will leave a minimum of the piston rod (2-170) protruding from the actuator housing.

TANDEM PRESSURE/HYDRAULIC CYLINDER RE-ASSEMBLY

1. Apply grease to the rod bushing (2-80), install it over the piston rod and slide it up into the housing.
2. Coat the rod seal (3-70) 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 (3-30) with fluid and install into the inner end cap (240).
NOTE: O-ring seals will be installed into counterbores in end caps and retained with "staked-in" washers. Check position and tightness to be sure washers are secured - both inner and outer end caps, pneumatic and hydraulic cylinders.
5. Slide the inner end cap (2-30) over the piston rod (2-170) and the rod bushing (2-80), protruding from the housing. Install with the large raised boss toward the housing (flat side outward). The pressure inlet port should be toward stop screw side of actuator.
NOTE: Exercise extreme care during installation, in order to prevent damage to the rod seal (3-70).
6. Apply fluid to two sets of piston tie bar T-seal components (3-80) and install into the piston (2-20).
7. Apply fluid to the piston o-ring (3-40) and place onto the piston rod (2-170).
8. Coat the first set of split ring grooves on the piston rod (2-170) with fluid.

9. Install the two halves of the split ring (2-110) into the innermost groove in the piston rod and retain with one of the spiral retaining rings (2-120).
10. Slide the piston (2-20) onto the piston rod against the split ring (2-110).
NOTE: Piston seal groove will face housing.
11. Install the two halves of the remaining split ring (2-110) onto the piston rod and retain with the spiral retaining ring (2-120).
12. Apply fluid to the end cap o-ring seal (3-60) and install on the inner end cap (2-30).
13. Coat the piston T seal components (3-90) with fluid and install on the piston (2-20).
14. Take 'housing-end' of tie bars (2-100), end without wrench flat, and install by carefully threading tie bars through the piston (2-20) and inserting through the inner end cap (2-30), housing (1-10), end cap gasket (3-10) and installing into the spacer plate (10-250) on opposite side of the housing.
15. Apply fluid to the bore of the cylinder (2-10) for a distance of approximately four inches (100 mm).
16. Slide the lubricated end of the cylinder (2-10) over the piston (2-20) and onto the inner end cap (2-30).
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. Align bleed valve/drain plug ports vertically.
17. Apply fluid to two end cap tie bar o-ring seals (3-30) and install into the end cap(2-30).
18. Apply fluid to the outer end cap cylinder o-ring seal (3-60) and install onto the end cap (2-30).
19. Install the end cap (2-30) onto the tie bars and into the end of the cylinder (2-10).Pressure port must face stop screw side of actuator.
20. Coat rod seal (5-70) with fluid and install into inner end cap (2-30).
NOTE: Energize ring faces housing. Care should be taken during installation to prevent seal damage.
21. Apply fluid to the rod bushing (2-90), install it over the piston rod and slide it up into the inner end cap (2-30).
22. Coat second rod seal (5-70) with fluid and install into the recess provided in the inner end cap.
NOTE: Energizer ring faces away from housing.
23. Coat the end cap gasket (101) with fluid on both sides and install over the piston rod and rod bushing.
24. Coat two tie bar o-ring seals (5-30) with fluid and install into the hydraulic inner end cap (2-60).

25. Slide the hydraulic inner end cap (2-60) over the piston rod (2-170) and the rod bushing (2-90), protruding from the housing. Install with the large raised boss toward the housing (flat side outward). The pressure inlet port should be toward stop screw side of actuator.

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

26. Apply fluid to two sets of piston tie bar T-seal components (5-80) and install into the piston (2-50).
27. Apply fluid to the piston o-ring (5-40) and place onto the piston rod (2-170).
28. Coat the second set of split ring grooves on the piston rod (2-170) with fluid.
29. Install the two halves of the split ring (2-110) into the innermost groove in the piston rod and retain with one of the spiral retaining rings (2-120).
30. Slide the piston (2-50) onto the piston rod against the split ring (2-110).

NOTE: Piston seal groove will face housing.

31. Install the two halves of the remaining split ring (2-110) onto the piston rod and retain with the spiral retaining ring (2-120).
32. Apply fluid to the end cap o-ring seal (5-60) and install on the inner end cap (2-60).
33. Coat the piston T-seal components (5-90) with fluid and install on the piston (2-50).
34. Apply fluid to the bore of the cylinder (2-40) for a distance of approximately four inches (100 mm).
35. Slide the lubricated end of the cylinder (2-40) over the piston (2-50) and onto the inner end cap (2-60).

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.

36. Apply fluid to two end cap tie bar o-ring seals (5-30) and install into the outer end cap (2-70).
37. Apply fluid to the outer end cap cylinder o-ring seal (5-60) and install onto the outer end cap (2-70).
38. Install the outer end cap (2-70) onto the tie bars and into the end of the cylinder(2-40). Pressure port faces stop screw side of housing.
39. Install the two tie bar nuts (2-130) on the tie bars (2-100), 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.

NOTE: As a reminder, the tie bar nuts (2-130) were used on the spring cartridge tie bars to keep the tie bars from falling inside of the spring cartridge.

40. Install the nut retainer (2-140), securing in place with the retainer screw (2-160) and lockwasher (2-150). It is necessary that the flats on the hex nuts (2-90) be aligned

41. If removed, install breather (4-30) into inner end cap (2-30).
42. Mount M7 override (8) and bracket to hydraulic cylinder (2-40).
43. Reconnect all plumbing between the M7 override and both inboard and outboard of the hydraulic cylinder.
44. By pushing on the exposed spring return push rod (4-20) or tapping it with a soft mallet, stroke the unit until the yoke touches the body at the end adjacent to the installed pressure cylinder.
45. Refer to Service Instructions 018 for M7A Hydraulic Control System and 035 for M7B Hydraulic Control System Service Instructions.

SPRING CYLINDER RE-ASSEMBLY

NOTE: Make sure that the stop screws (1-60) have not been screwed in to the point that "preload" will be created on the spring cartridge.

1. Place the spring cartridge (4-10) on to the push rod (4-20) and align the spring cartridge tie bars with the holes in the spacer (10-250).
2. Screw the tie bars through the spacer (10-250), end cap gasket (4-70) and into the housing (1-10). Alternately tighten tie bar nuts until the spring cartridge is firmly against the spacer.
3. Install nut retainer (4-40), lockwasher (4-50) and socket head cap screw (4-60). It is necessary that the flats on the hex nuts be aligned and parallel before the nut retainer can be installed.
4. Install brace rods (4-80).
5. Install hex nuts (10-200) and tighten.

TESTING HYDRAULIC ACTUATORS

A. Leakage Test

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

Procedure.

1. Cycle the actuator five (5) times at 10% of the nominal operating pressure (NOP), as marked on actuator name tag. This allows the seals to seek their proper working attitude.
2. Apply 100% of the maximum operating pressure (MOP), as marked on actuator name tag, and allow unit to stabilize.
3. If there is any notable leakage, the actuator must be disassembled and the cause of leakage must be determined and corrected.
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.
5. If an actuator was disassembled and repaired, the above leakage test must be performed again.

B. Operational (Functional Test)

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

Procedure:

1. Adjust the pressure regulator to the pressure rating indicated in Column 'B' of Chart 1, on the following pages, for the model actuator being tested.

2. Cycle the actuator five (5) times at the above pressure. This will allow the seals to seek their proper working attitude.

NOTE: Check the spring cartridge to insure that the vent is not plugged and is venting properly to atmosphere.

3. Apply the above pressure to the actuator and allow the unit to stabilize. The actuator should stroke a full (90°) travel, with the stops properly set.

4. Decrease the cylinder pressure slowly, until the actuator strokes approximately (5°) off the opposite stop. The pressure reading attained must be greater than or equal to that listed in Column 'A' of Chart I for the model actuator being tested.

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

RETURN TO SERVICE

1. If removed, install the snubber valve (1-190) in the cover (1-20) of the housing (1-10).

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

3. Refer to GH-Bettis "Operating, Storage and Maintenance Instructions for GH-Bettis Rotary Valve Actuators" (OP/MAINT-002) for actuator start-up procedures.

4. Refer to GH-Bettis "M7, M7A and M7B Hydraulic Override System Operating and Service Instructions" (OPER/INST-003) for start-up procedures.

CHART I

FINAL QUALITY TESTING OF ACTUATORS

MODEL NUMBER	COLUMN —A	COLUMN —B
T805-SR2-M7	720	1357
T805-SR3-M7	534	971
T805-SR4-M7	394	796
T805-SR5-M7	264	484
T807-SR2-M7	353	669
T807-SR3-M7	262	476
T807-SR4-M7	194	245
T807-SR5-M7	129	213