

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR MODELS

T5XX-M4 DOUBLE ACTING

SERIES ACTUATORS

WITH A HYDRAULIC

CONTROL PACKAGE

PART NUMBER: 074896

REVISION: "A"

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1.0 **INTRODUCTION**

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis T5XX-M4 double acting series actuators equipped with a M4 Hydraulic Control package. When the model number has "-S" as a suffix then the actuator has modifications and is considered special and may have some differences that are not included in this procedure.

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.

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 requires the actuator 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 does not include M4 Disassembly and Reassembly Instruction. Bettis does not recommend periodic maintenance for the M4 itself. The M4 needs only to be serviced when it malfunctions. Complete M4 refurbishment should be done by Bettis.

1.7 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 Kit, 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 No. 2 on page 16 of 16.

3.0 REFERENCE BETTIS MATERIALS

- 3.1 Assembly Drawing part number 036834.
- 3.2 Exploded Detail Drawing part number 063578. (Supplied in Bettis Service/Seal Kit)

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 parentheses, (), indicate the bubble number (reference number) used on the Bettis Assembly Drawing, Exploded Detail Drawing and actuator parts lists.
- 4.3 This procedure is written using the stop screw side of the housing as a reference and will be considered as the front of the actuator. The housing cover will be considered the top of the actuator.
- 4.4 Refer to Chart 1, on page 15, for appropriate actuator weights.
- 4.5 Mating parts should be marked for ease of reassembly, i.e. hydraulic control package cylinder and pneumatic cylinder on same ends of the housing.
- 4.6 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp edges rounded off.
- 4.7 Use a non-hardening thread sealant on all pipe threads.

CAUTION: Apply the thread sealant per the manufactures instructions.

- 4.8 Disassembly should be done in a clean area on a work bench.
- 4.9 Lubrication Requirements: For use in all areas of actuator except in M4 Hydraulic Control package (8) and hydraulic cylinder (4-10). Lubricants, other than those listed in steps 4.9.1 and 4.9.2, should not be supplied without prior written approval of Bettis Product Engineering.
- 4.9.1 Standard and high temperature service (-20°F to 350°F) use Kronaplate 100, this lubricant is provided in the Bettis Service/Seal Kit.
- 4.9.2 Low temperature service (-50° to 150°) use Kronaplate 50 lubricant. This lubricant is not in the Service/Seal Kit.

4.10 Fluid Requirements: For use in the M4 Hydraulic Control Package (8) and the hydraulic cylinder (4-10). Fluids, other than those listed in steps 4.10.1 and 4.10.2, should not be used without prior written approval of Bettis Product Engineering.

4.10.1 Standard and high temperature service (-20°F to 350°F) use Dexron II Automatic Transmission fluid.

4.10.2 Low temperature service (-50°F to 150°F) use Exxon Unavis J13 Hydraulic Fluid.

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

4.11 It is a good practice to operate the actuator with the nominal operating pressure (NOP), as listed on the actuator nametag or the pressure used by the customer to operate the actuator during normal operation, before starting the general disassembly of the actuator. 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 actuator power cylinder (2-10).

5.2 Mark stop screws (1-60) left and right. Measure and record the exposed length of the right and left stop screws (1-60). The stop screws will be removed later in this procedure.

5.3 Remove socket cap screws (1-180) from position indicator (1-170) yoke weather cover (3-130) and remove position indicator/yoke weather cover.

5.4 Remove the snubber (1-190) from the housing cover.

5.5 Drain the hydraulic fluid from Hydraulic Cylinder (4-10) by opening the bleed valves (4-240) and then removing the cylinder drain plugs (4-230). One is located on outboard end of hydraulic cylinder and the other on the inboard end of hydraulic cylinder.

CAUTION: The bleed valves are 1/8 npt and are made out of brass. Use only the correct size wrench. Refer to tool list at the end of this procedure for recommended wrench style and correct wrench size. Do not use pliers or other style adjustable wrench for bleed valve removal or adjustment.

5.6 If the M4 package is remote mounted then disregard the rest of this step. Remove the cylinder mounted M4 Hydraulic Control package (8) from cylinder (4-10) by loosening the nuts/lockwashers on the mounting bracket u-bolts and then slid the M4/bracket assembly off of the end of cylinder (4-10).

CAUTION: Plug the 3/8" NPT ports in the M4 as foreign material may enter the system and cause the package to malfunction.

6.0 DISASSEMBLY - HYDRAULIC CONTROL PACKAGE CYLINDER

- 6.1 Remove socket cap screw (4-120), lockwasher (4-110) and nut retainer (4-100) from the end of outer end cap (4-30).
- 6.2 Remove hex nuts (4-90) from tie bars (4-60).
- 6.3 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.

CAUTION: During inner (4-40) and outer end cap (4-30) removal do not damage outer diameter o-ring groove.

- 6.4 Pry inner end cap (4-40) away from housing (1-10). Break the inner end cap free from cylinder (4-10) by trapping on the breaker bar on lip provided on the end cap.
- 6.5 Remove cylinder (4-10). When sliding the cylinder off of the piston, tilt cylinder 15° to 30° degrees to piston rod.
- 6.6 Unscrew and remove tie bars (4-60) from the actuator. NOTE: Flats are provided on outboard end of the tie bars for wrench placement.

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

- 6.7 Remove the split ring retainer (4-80) and the split ring (4-70) from the outboard side of the piston. NOTE: Disregard this step and step 6.10 if the actuator has the piston retained in place with a hex nut and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers.

CAUTION: Keep the split rings in matched sets.

- 6.8 Remove piston (4-20) from piston rod (4-170). The piston will slide off of the piston rod.
- 6.9 Remove o-ring seal (5-40) from piston rod (4-170).
- 6.10 Remove split ring retainer (4-80) and split ring set (4-70) from the inboard side of piston (4-20).

CAUTION: Keep the split rings in matched sets.

- 6.11 Remove inner end cap (4-40) from piston rod (4-170).

7.0 DISASSEMBLY - POWER CYLINDER

- 7.1 Remove socket cap screw (2-120), lockwasher (2-110) and nut retainer (2-100) from the end of outer end cap (2-30).
- 7.2 Remove hex nuts (2-90) from tie bars (2-60).

- 7.3 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: During inner end cap (2-40) and outer end cap (2-30) removal do not damage outer diameter o-ring groove.

- 7.4 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 lip provided on the end cap.
- 7.5 Remove cylinder (2-10). When sliding cylinder off of the piston, tilt the cylinder 15° to 30° degrees to piston rod.
- 7.6 Unscrew and remove tie bars (2-60) from the actuator. NOTE: Flats are provided on outboard end of the tie bars for wrench placement.

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

- 7.7 Remove split ring retainer (2-80) and split ring set (2-70) from the outboard side of the piston (2-20). NOTE: Disregard this step and step 6.10 if the actuator has the piston retained in place with a hex nut and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers.

CAUTION: Keep the split rings in matched sets.

- 7.8 Remove piston (2-20) from piston rod (2-170). The piston will slide off of the piston rod. Refer to step 7.12 for 24" diameter piston tie bar bushing (2-180) disassembly.
- 7.9 Remove o-ring seal (3-40) from piston rod (2-170).
- 7.10 Remove split ring retainer (2-80) and split ring set (2-70) from the inboard side of piston (2-20).

CAUTION: Keep the split rings in matched sets.

- 7.11 Remove inner end cap (2-40) from piston rod (2-170).
- 7.12 Fabricated 24" diameter piston disassembly (refer to assembly drawing detail "A").
- 7.12.1 Remove the retaining rings (2-190) from the piston (2-20).
- 7.12.2 Remove tie bar bushings (2-180) from piston (2-20). NOTE: The tie bar bushings should be replaced each time actuator is refurbished. The Bettis Service/Seal Kit should contain a new tie bar bushings (2-180).

8.0 HOUSING GROUP DISASSEMBLY

- 8.1 Unscrew piston rods (2-170) and (4-170) from yoke pin nut (1-30). Remove piston rods (2-170) and (4-170) with rod bushings (2-50) and (4-50) from housing (1-10). Flats are provided on the outboard end of the piston rod for wrench placement. NOTE: Removal of piston rod may require extra amount of torque for break out if Loctite - 242 was used during assembly.

CAUTION: Do not use a pipe wrench on piston rod as it will mark the rod and cause seal leakage.

- 8.2 Remove hex cap screws (1-90) and (10-90) with seal gaskets (3-100) from top of the housing cover (1-20).
- 8.3 Remove housing cover (1-20). NOTE: This piece will have a very tight fit. It is not necessary to remove cover pins (10-130) and (1-130).
- 8.4 Remove top two yoke rollers (1-50) and roller spacers (1-110) from top of yoke pin (1-40). NOTE: Actuators manufactured before 1978 did not use roller spacers (1-110), refer to section 16 step 16.2 and the **CAUTION** given when replacing pre 1978 rollers (1-50).
- 8.5 Remove yoke pin (1-40) from the slot in yoke arm and yoke pin nut (1-30).
- 8.6 Remove yoke pin nut (1-30) from between the top and bottom yoke arms.
- 8.7 Remove lower two yoke rollers (1-50) and roller spacers (1-110) from lower yoke arm and housing track.

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.

- 8.8 The yoke (1-160) can now be removed by lifting it from the housing.
- 8.9 It is not necessary to remove the housing drain plug, cylinder bleed valves, or lubricant fittings to service the actuator.

9.0 GENERAL REASSEMBLY

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 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 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 housing assembly and power cylinder (2-10) will be assembled using lubricant as identified in step 4.9. Parts and seals used in hydraulic cylinder (4-10) will be assembled using the hydraulic fluid identified in step 4.10.
- 9.5 Low Temperature or trim -11 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 groove.
- 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 CENTER HOUSING GROUP RE-ASSEMBLY

- 10.1 If removed, install drain plug (1-80) in actuator housing (1-10).
- 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.
- 10.3 Inside the housing (1-10) apply lubricant to the tracks and yoke bore and arrange the housing with the yoke bore nearest you.
- 10.4 Coat one of the yoke o-ring seals (3-50) with lubricant and install into the housing (1-10).
- 10.5 On yoke (1-160) apply lubricant to the slots in the upper, lower arms and lower bearing surface.
- 10.6 Install yoke (1-160) into housing (1-10) as follows: Arrange the yoke arm to approximately a 45° degree position in either direction and lower into the housing. NOTE: The hub with tapped holes faces up. Rotate the yoke back to approximately the mid-stroke (center) position.
- 10.7 Apply lubricant to all surfaces of four in number yoke rollers (1-50) and four in number rollers spacers (1-110).

WARNING: When replacing rollers (1-50) in actuators manufactured prior to 1978 read step 16.2 and its Caution in section 16.

- 10.8 LOWER YOKE ROLLERS AND ROLLER SPACER INSTALLATION: If your actuator was manufactured prior to 1978 it was not equipped with roller spacers (1-110), so ignore roller spacer installation steps 10.8.2 and 10.8.4.
- 10.8.1 Place one in number yoke roller (1-50) in the track in the bottom of the housing and position it under the slot in the yoke arms.

- 10.8.2 Place one in number roller spacer (1-110) on top of bottom yoke roller (1-50).
- 10.8.3 Place a second yoke roller (1-50), on top of roller spacer (1-110), in the slot in the lower yoke arm.
- 10.8.4 Place a second roller spacer (1-110) on top of the second yoke roller (1-50) and align the holes in two in number roller spacer and two in number yoke rollers.
- 10.9 Coat the upper and lower surfaces of the yoke pin nut (1-30) with lubricant 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.
- 10.10 Lubricate 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).
- 10.11 UPPER YOKE ROLLERS AND ROLLER SPACER INSTALLATION: If your actuator was manufactured prior to 1978 it was not equipped with roller spacers (1-110), so ignore roller spacer installation steps 10.11.1 and 10.11.3.
- 10.11.1 Place one in number roller spacer (1-110) on top of yoke pin nut (1-30).
- 10.11.2 Install the third yoke roller (1-50) on top of the just installed roller spacer (1-110).
- 10.11.3 Place the last roller spacer (1-110) on top of the third yoke roller (1-50).
- 10.11.4 Place the fourth and final yoke roller (1-50) on the yoke pin. NOTE: The top roller (1-50) will remain above the yoke arm and will engage the cover track when cover is installed.
- NOTE: The Bettis Service/Seal Kit should contain new rod bushings (2-50) and (4-50).
- 10.12 Apply lubricant to rod bushing (2-50) and piston rod (2-170). Install rod bushing (2-50) on to piston rod (2-170) then insert the piston rod and rod bushing combination through the right side of the housing. Make certain that the rod bushing is installed into the side of the housing and then screw the piston rod into the yoke pin nut (1-30). NOTE: Do not tighten the piston rod until the housing cover (1-20) is installed.
- 10.13 Apply lubricant to rod bushing (4-50) and piston rod (4-170). Install rod bushing (4-50) on to piston rod (4-170) then insert the piston rod and rod bushing combination through the left side of the housing. Make certain that the rod bushing is installed into the side of the housing and then screw the piston rod into the yoke pin nut (1-30). NOTE: Do not tighten the piston rod until the housing cover (1-20) is installed.
- 10.14 Place the gasket seal (3-110) and jam nut (1-120) onto two in number stop screws (1-60).
- 10.15 Install both stop screw assemblies into housing (1-10).
- 10.16 Place housing cover gasket (3-20) on housing (1-10).
- 10.17 Coat remaining o-ring seal (3-50) with lubricant and install into housing cover (1-20).
- 10.18 Apply lubricant to the upper bearing surface of yoke (1-160), yoke bore and track in cover (1-20).

- 10.19 Install housing cover (1-20) being careful not to damage gasket (3-20) or o-ring seal (3-50).
- 10.20 Install seal gaskets (3-100) on to cover screws (1-90) and (10-90).
- 10.21 Install cover screws (1-90) and (10-90) with seal gaskets (3-100). NOTE: Do not tighten cover screws.
- 10.22 Do this step only if you have pulled the cover pins (1-130) and (10-130) or if you are replacing the cover pins. Drive four pins through cover (1-20) and into housing (1-10) until each 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.
- 10.23 Tighten the cover screws (1-90) and (10-90).
- 10.24 Torque tighten piston rod (2-170) and (4-170) to 150±7 foot pounds. NOTE: Flats are provided on the outboard end of the piston rod for wrenching purposes.

CAUTION: Do not use a pipe wrench or similar tool to tighten piston rod.

- 10.25 Rotate the yoke to the full counter-clockwise position, leaving a minimum of the piston rod (2-170) protruding from the actuator housing (1-10).

11.0 POWER CYLINDER RE-ASSEMBLY

- 11.1 **CAUTION: Install rod seal (3-70) with the energizer ring facing outboard side (away from housing).** Coat the rod seal (3-70) with lubricant and install, lip first, into the recess provided in the inner end cap (2-40).
- 11.2 Install one in number end cap gasket (3-10) over piston rod (2-70) and rod bushing (2-50).
- 11.3 Coat two in number tie bar o-ring seals (3-30) with lubricant and install into inner end cap (2-40). Refer to section 16 step 16.3.
- 11.4 Install inner end cap (2-40) over piston rod (2-170) and rod bushing (2-50). Install with large raised boss toward the housing (flat side outward). NOTE: The pressure inlet port should be toward the top of the actuator.
- 11.5 Apply lubricant to one in number o-ring seal (3-60) and install onto inner end cap (2-40).
- 11.6 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into piston (2-20) internal seal grooves. Refer to step 9.5 for proper installation instructions.
- 11.7 Coat exposed end of piston rod (2-170) with lubricant.
- 11.8 Apply lubricant to the piston o-ring (3-40) and place onto piston rod (2-170).
- 11.9 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with one in number split ring retainer (2-80). Split ring retainer groove to face away from the piston. NOTE: Disregard this step and step 11.11 if the actuator has the piston retained in place with a hex nut and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers.

- 11.10 Install piston (2-20) onto the piston rod against split ring (2-70). NOTE: Ribbed sections of piston will face away from housing.
- 11.11 Install a matched split ring set (2-70) onto piston rod and retain with a split ring retainer (2-80). NOTE: Split ring retainer groove to face away from the piston.
- 11.12 Coat piston T-seal components (3-90) with lubricant and install into piston (2-20) external seal groove. NOTE: Refer to step 9.5 for "T" seal installation instructions.
- 11.13 Apply lubricant to the threads and end of tie bars (2-60), (end without wrench flat), and install by carefully inserting tie bars through, piston (2-20), inner end cap (2-40) and screwing into housing (1-10).

CAUTION: Tighten tie bars until the threads bottom out, then back out each tie bar one half-turn.

- 11.14 Apply lubricant to all exposed surfaces of piston rod, tie bars and the bore of cylinder (2-10).

CAUTION: During cylinder installation hammer on the end of the cylinder only with a non metallic object.

CAUTION: 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 component could be damaged, becoming a potential source of leakage.

- 11.15 Install end of cylinder (2-10) over piston (2-20) and onto the inner end cap (2-40). When sliding the cylinder over the piston seal tilt the cylinder 15° to 30° degrees to the piston rod.
- 11.16 Apply lubricant to two in number o-ring seals (3-30) and install into inner diameter seal grooves of outer end cap (2-30). Refer to information note step 16.3.
- 11.17 Apply lubricant to one in number o-ring seal (3-60) and install into outer diameter seal groove of outer end cap (2-30).
- 11.18 Install outer end cap (2-30) onto the tie bars and into the end of cylinder (2-10). NOTE: The pressure inlet port should be toward the top of the actuator.
- 11.19 Install the two tie bar nuts (2-90) on the tie bars (2-60), using them to draw all of the cylinder components into position. Torque tighten tie bar nuts (2-90) alternately, in 50 ft. lb. increments until a final torque of 90±9 foot pounds has been achieved.

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

- 11.20 Install the nut retainer (2-100), securing in place with the retainer screw (2-120) and lockwasher (2-110). It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the nut retainer can be installed.

12.0 HYDRAULIC CYLINDER RE-ASSEMBLY

CAUTION: Seals and parts being used in the assembly of cylinder (4-10) should use hydraulic fluid as the assembly lubricant.

- 12.1 **CAUTION: Install rod seal (5-70) with the energizer ring facing outboard side (away from housing).** Coat the rod seal (5-70) with hydraulic fluid and install, lip first, into the recess provided in the inner end cap.
- 12.2 Install one in number end cap gasket (3-10) over piston rod (4-170) and rod bushing (4-50).
- 12.3 Coat two in number tie bar o-ring seals (5-30) with fluid and install into inner end cap (4-40). Refer to section 16 step 16.3.
- 12.4 Install inner end cap (4-40) over piston rod (4-170) and rod bushing (4-50). NOTE: The pressure inlet port should be toward the top of the actuator.
- 12.5 Apply fluid to one in number o-ring (5-60) and install onto inner end cap (4-40).
- 12.6 Apply fluid to two sets of piston tie bar T-seal components (5-80) and install into piston (4-20) internal seal grooves. Refer to step 9.5 for proper installation instructions..
- 12.7 Coat ends of piston rod (4-170) with fluid.
- 12.8 Apply fluid to o-ring (5-40) and place onto piston rod (4-170).
- 12.9 Install a matched set of split rings (4-70) into the inner most groove in the piston rod and retain with one in number split ring retainer (4-80). Split ring retainer groove to face away from the piston. NOTE: Disregard this step and step 12.11 if the actuator is an early nut retained piston model and refer to step 16.1 for actuators not equipped with split rings and split ring retainers.
- 12.10 Install piston (4-20) onto the piston rod against split ring (4-70). NOTE: Seal groove on piston will be closest to the housing.
- 12.11 Install a matched split ring set (4-70) onto piston rod and retain with a split ring retainer (4-80). NOTE: Split ring retainer groove to face away from the piston.
- 12.12 Coat piston T-seal components (5-90) with fluid and install on the piston (4-20) external seal groove. NOTE: Refer to step 9.5 for "T" seal installation instructions.
- 12.13 Apply fluid to the threads and end of tie bars (4-60), end without wrench flat. Install tie bars by carefully inserting through piston (4-20), inner end cap (4-40) and screw tie bars into housing (1-10).

CAUTION: Tighten tie bars until the threads bottom out, then back out each tie bar one half-turn.

- 12.14 Apply fluid to all exposed surfaces of piston rod, tie bars and bore of cylinder (4-10).

CAUTION: During cylinder installation hammer on the end of the cylinder only with a non metallic object.

CAUTION: 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 component could be damaged, becoming a potential source of leakage.

- 12.15 Install the end of cylinder (4-10) over piston (4-20) and onto inner end cap (4-40). When sliding the cylinder over the piston seal tilt the cylinder 15° to 30° degrees to piston rod.
- 12.16 Bleed valves (4-240) should be arranged so the bleed valves will be at cylinder's highest point when actuator is mounted in it's final operational position.
- 12.17 Apply fluid to two in number o-ring seals (5-30) and install into inner diameter seal grooves of outer end cap (4-30).
- 12.18 Apply fluid to one in number o-ring seal (5-60) and install into outer diameter seal groove of outer end cap (4-30).
- 12.19 Install outer end cap (4-30) onto the tie bars and into the end of cylinder (4-10). NOTE: The pressure inlet port should be toward the top of the actuator.
- 12.20 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 tighten tie bar nuts (4-90) alternately, in 50 ft. lb. increments until a final torque of 90±9 foot pounds has been achieved.

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

- 12.21 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 (4-90) be aligned and parallel before the nut retainer can be installed.
- 12.22 With the yoke rotated to the full clockwise (CW) position (as shown on the assembly drawing) position the yoke weather cover (3-130) and position indicator (1-170) on the yoke with the pointer facing the front and perpendicular to the piston rods (2-170) and (4-170). Secure with socket head cap screw (1-180).

13.0 ACTUATOR TESTING

- 13.1 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.
- 13.2 All leak testing will use 65 psig pressure.
- 13.3 If excessive leakage across the piston 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.
- 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 condition.
- 13.5 Apply 65 psig 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 the outer end cap (2-30) and the cylinder (2-10). Checks cylinder to end cap o-ring seal.

- 13.6.2 Around the 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 The pressure inlet port in the inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
- 13.6.4 Remove pressure from pressure inlet port in the outer end cap.
- 13.7 Apply 65 psig pressure to the pressure port in the inner end cap (2-40).
- 13.8 Apply a leak testing solution to the following areas:
 - 13.8.1 Joint between the inner end cap (2-40) and the 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 the 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 the housing cover (1-20). Checks the rod seal and the 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 M4 HYDRAULIC CONTROL PACKAGE INSTALLATION

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

CAUTION: Do not use Teflon tape to seal hydraulic system threads.

- 14.1 Actuators manufactured after December 31, 1972 will have a M4 Hydraulic Control Package or one of its revisions and this procedure will be applicable to all M4's. Actuator manufactured prior to December 31, 1972 will not be an M4 and section 14 will not be applicable.
- 14.2 If the M4 Control Package is not remote mounted then re-install the M4 control package (8) on the hydraulic cylinder (4-10).
- 14.3 NOTE: Recommend that a non hardening thread sealant, compatible with petroleum base hydraulic fluid be used in this system. Hook up piping from the M4 hydraulic speed control block to cylinder ports.
- 14.4 M4 REFILLING INSTRUCTIONS - Refilling of the M4 hydraulic control system and actuator cylinder is best accomplished using a pressure pump. Put the actuator in the open position (CCW) and proceed using the following steps.
 - 14.4.1 Remove the breather from the reservoir.
 - 14.4.2 Attach the pump discharge line to reservoir breather port.

- 14.4.3 Open both speed control valves.
 - 14.4.4 Open two bleed valves (4-240), located at each end of the hydraulic cylinder.
 - 14.4.5 Slowly pump hydraulic fluid into the reservoir. Approximately three to five PSI will be required. As the hydraulic fluid passes through the M4 control block into the cylinder, air will be displaced.
 - 14.4.6 Close each bleed valve (4-240) when the air has been displaced and hydraulic fluid appears.
 - 14.4.7 Remove pump discharge line from reservoir breather port.
 - 14.4.8 Adjust fluid level to 1-1/2" (40mm) from top of reservoir with actuator in open (CCW) position.
 - 14.4.9 Re-install breather removed, in step 14.4.1.
- 14.5 Alternate 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:
- 14.5.1 Put the actuator in the open position (CCW).
 - 14.5.2 Remove the breather from the reservoir.
 - 14.5.3 Fill the reservoir approximately three-fourths (3/4) full.
 - 14.5.4 Open both speed control valves.
 - 14.5.5 Open bleed valve (4-160) on the outboard end of the hydraulic cylinder only.
 - 14.5.6 Rotate the handle slowly, clockwise, until all air has escaped from the system.
 - 14.5.7 Close the bleed valve opened in step 14.5.5. During the fill procedure, it is important that the lowest level be not less than approximately one-fourth (1/4) of the reservoir volume at any time.
 - 14.5.8 Open bleed valve (4-240) on the inboard end of the hydraulic cylinder.
 - 14.5.9 Rotate the M4 handle slowly, counterclockwise, until all air has escaped from the system.
 - 14.5.10 Close the bleed valve opened in step 14.5.8. During the fill procedure, the piston will not move. This may be determined by observing the position indicator (1-170) on the actuator.
 - 14.5.11 Adjust fluid level to 1-1/2" (40mm) from top of reservoir with actuator in open (CCW) positions.
 - 14.5.12 Re-install breather removed in step 14.5.2.

14.6 Additional M4 Instructions These steps are to be performed to insure air is removed from the system (most likely air in pump) and to test the operation of M4 hydraulic control system.

14.6.1 Turn M4 crank arm CW. The actuator should move clockwise as well. Adjust outboard bleed valve (4-240) to remove air from system.

14.6.2 Turn M4 crank arm CCW. The actuator will move counterclockwise. Adjust inboard bleed valves to remove air from system.

14.6.3 With bleed valves closed, stroke actuator full 90°, CW and CCW, using M4 Hydraulic Control System.

15.0 RETURN TO SERVICE

15.1 Replace the software components of the snubber (1-90) and then install the snubber in the housing cover port.

15.2 Adjust both stop screws (1-60) back to settings recorded in section five step 5.2.

15.3 Tighten both stop screw nuts (1-120) securely, while holding the stop screw (1-60).

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

16.0 INFORMATION NOTES

16.1 Actuators manufactured before 1973 will have a hex lock nut retaining the piston on the piston rod. This hex lock nut is used in place of the split rings and split ring retainers.

16.2 Actuators manufactured before 1978 did not use the roller spacers (1-110). When replacing the rollers on pre 1978 actuators order a complete set of both rollers and roller spacers, four in number rollers and four in number roller spacers.

WARNING: If rollers (1-50) are replaced without ordering and installing a complete set of four in number rollers (1-50) and roller spacers (1-110) the top roller to cover "track engagement" will be insufficient to produce max torque output and the actuator may experience failure.

16.3 On outer and inner end caps some o-rings are held in place by "staked" washers. Check all end caps to ensure washers are secured. If needed re-stake washers.

CHART 1 - ACTUATOR WEIGHTS

ACTUATOR MODEL	APPROXIMATE WEIGHT (LBS) ***
T510-M4	Not Available
T512-M4	Not Available
T516-M	740
T520-M4	851

*** Weights listed for each model are for bare actuators without valve mounting and accessories.

CHART 2 - TOOL STYLE AND WRENCH SIZES

ITEM NO.	WRENCH SIZE	QTY	LOCATION	RECOMMENDED WRENCH STYLE
1-60	15/16"	2	Stop screw	Open end or adjustable
1-90	9/16"	8	Cover screws	Socket
1-120	1-7/8"	2	Stop screw nut	Box end (1)
1-180	3/16"	4	Weather cover screws	Allen
1-190	7/8"	1	Snubber	Deep socket
2-60	5/8"	2	Tie bar flats	Open end or adjustable
2-90	1-5/8"	2	Cylinder tie bar nuts	Crows foot (1)
2-120	3/16"	1	Cylinder nut retainer	Allen
2-170	1-3/8"	1	Piston rod flat	Crows foot (1)
4-60	5/8"	2	Tie bar flats	Open end or adjustable
4-90	1-5/8"	2	Cyl tie bar nuts	Crows foot (1)
4-120	3/16"	1	Cyl nut retainer	Allen
4-170	1-3/8"	1	Piston rod flat	Crows foot (1)
10-90	9/16"	8	Cover screws	Socket

NOTES:

(1) No alternate style wrench recommended.

(2) Some actuators used heavy hex nuts in this location - Wrench size will change to 1-7/16

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