GH-BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

ST30X-M4 AND ST40X-M4

DOUBLE ACTING SERIES

HYDRAULIC ACTUATORS

PART NUMBER: 112984

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 GH-Bettis ST30X-M4 and ST40X-M4 Double Acting Hydraulic series actuators. When the model number has a "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

1.2 **SAFETY STATEMENT:** Products supplied by GH-Bettis, in its "as shipped" condition, are intrinsically safe if the instructions contained within this Service Instruction are strictly adhered to and executed by a well trained, equipped, prepared and competent technician.

WARNING: FOR THE PROTECTION OF PERSONNEL WORKING ON GH-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 DISMOUNTED 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 Instructions. GH-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 GH-Bettis.

1.7 This procedure is applicable with the understanding that all electrical power and hydraulic pressure has been removed from the actuator. Also, it is understood that the actuator has been removed from the valve as well as all piping and accessories that are mounted on the actuator have been removed.

2.0 SUPPORT ITEMS AND TOOLS

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

2.2 Tools - All tools are American Standard inch. Two each medium screwdrivers, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and torque wrench (up to 5,000 in. lbs.). For recommended tool list refer to Chart No. 2 on page 13.

3.0 REFERENCE GH BETTIS MATERIALS

3.1 Assembly Drawing part number 113229 for ST30X-M4 actuators.
3.2 Assembly Drawing part number 109052 for ST40X-M4 actuators.

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 GH Bettis Assembly Drawing and Actuator Parts Lists.

4.3 This procedure is written using the stop screw side of the housing (1-10) as a reference and this side will be considered the front of the actuator. The housing cover (1-20) will be the top of the actuator.

4.4 To help at re-assembly mark or tag all mating surfaces.

4.5 When removing seals from seal grooves, use a small screwdriver with sharp corners rounded off or a commercial seal removing tool.

4.6 Use a non-hardening thread sealant on all pipe threads.

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

4.7 Disassembly of actuator should be done in a clean area on a work bench.

4.8 Some components of this actuator are very heavy and will require a means of assistance. For actuator approximate weight refer to Chart No. 1 on page 12.

4.9 HOUSING LUBRICATION REQUIREMENTS:

4.9.1 Standard and high temperature service (-20°F to 350°F) use ESL-5 lubricant. ESL-5 is contained in the GH-Bettis Service/Seal Kit.

4.9.2 Low temperature service (-50^{0}F to 150^{0}F) use Kronaplate 50. This lubricant is not contained in the Low Temperature Service/Seal Kit.

4.10 FLUID REQUIREMENTS: For use in the M4 Hydraulic Control Package (8) and the hydraulic control package cylinder (4-10).

4.10.1 Standard and high temperature service (35°F to 350°F) use Dexron II Automatic Transmission Fluid.

4.10.2 Low temperature service (-65°F to 180°F) use Exxon Univis J13 Hydraulic Fluid.

5.0 GENERAL DISASSEMBLY

WARNING: Ensure that all operating pressure is removed from the hydraulic cylinder.

5.1 Mark or tag stop screw (1-60) left and right. Measure the exposed length of right and left stop screws (1-60) and record each before loosening for removal.

5.2 To ensure correct re-assembly; that is, with the cylinder's on same end of housing as was, mark or tag right or left and mark mating surfaces.

5.3 Record the locations of the pressure ports in the cylinder assembly (2-10) mounting flange and the hydraulic control cylinder (4-10) end caps.

5.4 Remove snubber valves (1-190) from the housing cover (1-20) and the housing (1-10).

6.0 DISASSEMBLY - HYDRAULIC CONTROL PACKAGE CYLINDER

6.1 Drain the hydraulic fluid from Hydraulic Cylinder (4-10) by opening the bleed valves (4-160) and then removing the cylinder drain pipe plugs (4-150). One is located on outboard end of hydraulic control cylinder and the other on the inboard end of hydraulic control cylinder.

6.2 If the M4 is mounted on the actuator then remove the M4 control package (8) from hydraulic control cylinder (4-10). **NOTE: Plug the 3/8" NPT ports in the M4 as foreign material may enter the system and cause the package to malfunction.**

6.3 Remove socket cap screw (4-120), lockwasher (4-110) and nut retainer (4-100) from the end of the outer end cap (4-30).

6.4 Remove hex nuts (4-90) from tie bars (4-60).

6.5 **NOTE: 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. Remove outer end cap (4-30).

CAUTION: Do not damage o-ring seal groove.

6.6 Pry inner end cap (4-40) away from the 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.

6.7 **NOTE: When pulling the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod.** Remove the cylinder (4-10).

6.8 **NOTE: Flats are provided on the outboard end of the tie bars for wrench placement.** Unscrew the tie bars (4-60) from the housing (1-10). Pull the tie bars out of the housing and inner end cap far enough to expose the o-ring seals (5-30).

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

6.9 Remove the o-ring seals (5-30) from the inboard end of tie bars (4-60). Then remove the tie bars (4-60) by pulling the tie bars out and through the piston (4-20).

6.10 **NOTE: Keep split rings (4-70) in matched sets.** Remove the split ring retainer (4-80) and the split rings (4-70) from the outboard side of piston (4-20).

6.11 Remove the piston (4-20) from the piston rod (4-170).

6.12 Remove the o-ring seal (5-40) from the piston rod (4-170).

6.13 **NOTE: Keep split rings (4-70) in matched sets.** Remove split ring retainer (4-80) and split rings (4-70) from the inboard side of the piston (4-20).

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

6.15 **NOTE: Flats are provided on the outboard end of the piston rod for wrench placement.** Unscrew piston rod (4-170) from yoke pin nut (1-30) and remove, including the rod bushing (4-50).

7.0 HYDRAULIC POWER CYLINDER ASSEMBLY REMOVAL

7.1 Using a 1/2 inch square drive extension through the outer end of cylinder assembly (2-10), unscrew the piston rod (2-80) from the yoke pin nut (1-30).

7.2 Use suitable lifting equipment to support the cylinder assembly (2).

7.3 Around the large flange of the cylinder assembly (2-10) are eight in number socket cap screws (2-110) and (2-120). To identify four in number socket cap screws (2-120), use the top of the cylinder flange as a starting point, go clockwise around the cylinder flange to one o'clock, four o'clock, seven o'clock and ten o'clock these screws will be item (2-120). Remove the four in number socket cap screws (2-120).

7.4 As the socket cap screws (2-120) are removed, the cylinder assembly can be removed from the cylinder adapter (2-130). Remove the cylinder assembly to a clean area for disassembly. See section 8.0 for hydraulic cylinder assembly dismantling procedure.

8.0 HYDRAULIC POWER CYLINDER ASSEMBLY DISASSEMBLY

8.1 Drain any residual hydraulic fluid from cylinder assembly (2-10) by opening the bleed valves (2-100) and then removing the cylinder drain pipe plugs (2-90). One is located on outboard end of cylinder and the other on the inboard end of cylinder.

8.2 Remove the four in number socket cap screws (2-110). Remove the cylinder inner end cap (2-20) from the cylinder assembly (2-10)

8.3 Carefully withdraw the piston rod (2-80) and piston (2-30) from the cylinder assembly (2-10)

8.4 **NOTE: Keep the split rings in matched sets.** Remove the split ring retainer (2-70) and the split rings (2-60) from the outboard side of the piston (2-30). Remove the piston (2-30) from the piston rod (2-80). Remove the inboard split ring retainer (2-70) and the split rings (2-60).

8.5 Remove the retaining ring (2-50) from the inner end cap (2-20).

8.6 Remove the piston rod bushing (2-40) from the inner end cap (2-20).

9.0 HOUSING GROUP DISASSEMBLY

9.1 Remove position indicator pin (1-170) from the position indicator drive assembly (1-230).

9.2 Unscrew and remove four in number hex cap screws* with gasket seals (3-100) from position indicator cover (1-210). *Item number for ST3 hex cap screw is (1-260) and for ST4 hex cap screws is (1-90).

9.3 Remove position indicator cover (1-210) from the housing cover (1-20).

9.4 **NOTE: Mark and record the orientation of the position indicator drive (1-230) relative to the top of the yoke (1-160). Mark the hole location of the set screw (1-180).** Unscrew and remove set screw (1-180) from position indicator drive (1-230).

9.5 Remove position indicator drive (1-230) from the top of the yoke (1-160).

9.6 Remove the housing cover hex cap screws (1-90) and gasket seals (3-100).

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

9.8 Remove the upper two yoke rollers (1-50) from the top of the yoke pin (1-40).

9.9 Remove yoke pin (1-40) from the yoke pin nut (1-30).

9.10 Remove yoke pin nut (1-30) from the yoke (1-160).

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

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

9.13 Remove the stop screws (1-60), jam nuts (1-120), thread seals (3-110) and countersunk washer (3-120). Be sure to mark or identify as left and right stop screws.

9.14 Remove the two socket cap screws (2-140) and remove the cylinder adapter (2-130) from the housing (1-10).

9.15 It is not necessary to remove the yoke bushings (1-200) from the housing (1-10) or the housing cover (1-20) unless these items are being replaced due damage or wear. It is not necessary to remove the pipe plugs (1-80) or (1-250), to service the actuator.

10.0 GENERAL RE-ASSEMBLY

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

10.1 Remove and discard all seals and gaskets.

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

10.3 All parts should be thoroughly inspected for excessive wear, stress cracking, gauling 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.

10.4 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 will be assembled using lubricant as identified in step 4.9. The parts and seals used in the cylinder assembly (2-10) and the hydraulic control package cylinder (4-10) will be assembled using the hydraulic fluid identified in step 4.10.**

10.5 T Seal Set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.

10.5.1 Install the T-seal into the seal groove.

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

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

10.5.4 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.

10.6 Prime and apply master gasket (510) to all surfaces as indicated on the assembly drawing, reference note number 5.

11.0 CENTER HOUSING GROUP RE-ASSEMBLY

11.1 If removed install pipe plugs (1-80) and (1-250).

11.2 Coat one of the yoke o-ring seal (3-50) with lubricant and install into the housing (1-10).

11.3 If the yoke bushings (1-200) was removed then install one in the housing yoke bore and one in the housing cover yoke bore.

11.4 Inside the housing (1-10) apply lubricant to the tracks and yoke bore and arrange the housing with the yoke bore nearest you.

11.5 Apply lubricant to the slots in the upper and lower arms of the yoke (1-160).

11.6 Apply lubricant to the yoke (1-160) lower bearing surface and install into the housing (1-10) as follows: Position the yoke arm to approximately 45° degrees 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.

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

11.8 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 pin rollers.

11.9 Lubricate yoke pin (1-40) and insert through the yoke pin nut (1-30) and the two yoke pin rollers (1-50).

11.10 Install the third yoke pin roller (1-50) over the yoke pin in the slot in the upper yoke arm and now install the fourth and last remaining yoke pin roller (1-50) on top of the yoke roller you just installed in the upper yoke arm slot. The top roller will remain partially above the yoke and will engage the cover track when cover is installed.

11.11 Apply hydraulic fluid to the rod bushing (4-50), install it into the left side of the housing (1-10).

11.12 Apply Loctite - 242 to external threads on the piston rod (4-170). **NOTE: loctite cure time is 10 - 30 minutes.** Lubricate the piston rod (4-170) with hydraulic fluid and insert it into and through the rod bushing installed in step 11.11. Screw the piston rod into the yoke pin nut (1-30).

CAUTION: Do not tighten the piston rod until the housing cover is installed later in the procedure.

11.13 Position the position indicator drive (1-230) onto the top of the yoke (1-160) with the slot positioned over the hole that was marked in step 9.4. Secure with the set screw (1-180).

11.14 Install the o-ring seal (3-150) over the position indicator drive shaft and down against the flat cover plate.

11.15 Prepare the mounting surfaces of the housing cover (1-20) and the housing (1-10) per master gasket instructions (reference note 5 on the assembly drawing).

11.16 Place the housing cover gasket (3-20) onto the master gasket prepared housing (1-10).

11.17 Install the remaining yoke o-ring seal (3-50) into cover (1-20).

11.18 Apply lubricant to the yoke bore and the track in the housing cover (1-20).

11.19 Apply lubricant to the upper bearing surface of the yoke (1-160).

11.20 Install the housing cover (1-20), being careful not to damage the gasket (3-20) or yoke o-ring (3-50).

11.21 Install eight in number cover screws (1-90) and seal gaskets (3-100). **NOTE: Leave finger tight-do not tighten.**

11.22 **NOTE: 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) through the cover (1-20) and into the housing (1-10) until the pin is flush with the cover. 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.

11.23 Tighten the cover screws (1-90).

11.24 Tighten the piston rod (4-170) to a torque of approximately 1800 in. lbs. (150 ft. lbs.). 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.

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

11.25 Place thread seals (3-110), countersunk washers (3-120) and jam nuts (1-120) on the stop screws (1-60). Install the stop screws into the housing, making sure the stop screws marked in step 9.13 are installed into the same stop screw holes as they where removed from.

11.26 Prepare the mounting surface of the position indicator cover (1-210) and the housing cover (1-20) per master gasket instructions (reference note 5 on assembly drawing).

11.27 Install the o-ring seal (3-140) into the bottom seal groove inside the position indicator cover (1-210).

11.28 Install the wiper ring (3-160) into the top groove inside the position indicator cover (1-210).

11.29 Install the o-ring seal (3-170) into the bottom seal groove on the bottom of the position indicator cover (1-210).

11.30 Install the position indicator cover (1-210), being careful not to damage the oring seals (3-140), (3-170) and wiper ring (3-160).

11.31 Install eight in number new gasket seals (3-100) on to hex cap screws*****. *****Item number for ST3 hex cap screw is (1-260) and for ST4 hex cap screws is (1-90).

11.32 Install and tighten the position indicator cover hex screws*****. *****Item number for ST3 hex cap screw is (1-260) and for ST4 hex cap screws is (1-90).

11.33 Install the position indicator pointer (1-170) into the taped hole in the position indicator drive assembly (1-230).

12.0 HYDRAULIC POWER CYLINDER ASSEMBLY RE-ASSEMBLY

NOTE: Where the procedure indicates to "coat or apply fluid", use hydraulic fluid for lubricating the part being installed.

12.1 Apply fluid to the o-ring seal (3-40) and install on the piston rod (2-80).

12.2 Install a set of matched split rings (2-60) into the inboard groove of the piston rod (2-80) and retain with retaining ring (2-70). Install the piston (2-30) onto the piston rod (2-80) and over the set of split rings. Install a set of split rings (2-60) into the outboard groove and retain with retaining ring (2-70).

12.3 Apply fluid and install two in number polypak seals (3-90), ensuring that they are both facing outwards and are back to back. Install two in number back-up rings (3-200). Install two in number piston wear rings (3-80).

12.4 Apply fluid to the cylinder wall of cylinder assembly (2-10) and then carefully insert the piston assembly into the cylinder assembly.

12.5 Apply fluid and install two in number polypak seals (3-70). Install one, lip first, into the recess provided in the inner end cap (2-20). Install the second polypak, lip facing the rod bushing short side, into the rod bushing (2-40).

12.6 Apply fluid and install three in number o-ring seals (3-60), (3-180) and (3-190) to the inner end cap (2-20).

12.7 **NOTE: Make sure that both polypaks (3-70) have their lips facing outwards and are back to back.** Install the rod bushing (2-40) into the inner end cap (2-20) and retain with the retaining ring (2-50).

12.8 Prepare the mounting surface of the cylinder assembly flange and both mounting surfaces of inner end cap (2-20) per master gasket instructions (reference note 5 on assembly drawing).

12.9 Install four in number stat-o-seals (3-210) on to four in number socket cap screws (2-110).

12.10 Carefully install the inner end cap (2-20) over the piston rod (2-80) and into the open end of cylinder assembly (2-10). Install four in number socket cap screws (2-110) and torque tighten to 240 ft lbs lubricated.

12.11 **NOTE: GH-Bettis does not require any special hydraulic fluid cleaning standard for this actuator.** If required by customers facility, flush the hydraulic cylinder assembly to meet that facilities standard. Seal all openings after flushing.

13.0 HYDRAULIC POWER CYLINDER ASSEMBLY REPLACEMENT

13.1 Prepare both mounting surfaces of the cylinder adapter (2-130) and the cylinder adapter side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).

13.2 Install o-ring seal (3-10) into the housing side of cylinder adapter (2-130).

13.3 Install the cylinder adapter (2-130) on to the housing (1-10) and retain with two in number socket cap screws (2-140).

13.4 Apply loctite - 242 to external threads on the piston rod (2-80). **NOTE: loctite cure time is ten to thirty minutes.**

13.5 Install four in number stat-o-seals (3-210) on to four in number socket cap screws (2-120).

13.6 **NOTE: Refer to step 5.3 for correct location for the cylinder assembly flange.** Carefully install the piston rod (2-80) through the cylinder adapter (2-130) and bring the cylinder assembly (2-10), with the inner end cap (2-20), up to the cylinder adapter (2-130). Align the four in number cylinder assembly flange through holes with the tapped holes in the cylinder adapter (2-130). Retain the cylinder assembly (2-10) with four in number socket cap screws (2-120) equipped with the stat-o-seals (3-210) installed at step 13.5. Torque tighten to 150 ft-lbs lubricated.

13.7 Using a 1/2 inch square drive extension through the port in the outer end of cylinder assembly (2-10), screw the piston rod (2-80) into the yoke pin nut (1-30) and torque tighten to 150 ft-lbs.

14.0 HYDRAULIC CONTROL CYLINDER RE-ASSEMBLY

NOTE: Where the procedure indicates to "coat or apply fluid", use hydraulic fluid for lubricating the part being installed.

14.1 Rotate the yoke (1-160) to a position that will leave a minimum of the piston rod (2-170) protruding from the actuator housing.

14.2 Coat the rod seal (5-70) with lubricant and install, lip first, into the recess provided in the inner end cap ((4-40).

CAUTION: Install with energizer ring facing into the end cap recess.

14.3 Install end cap o-ring seal (3-10) into the inner end cap (4-40).

14.4 Prepare the mounting surfaces of the inner end cap (4-40) and inner end cap side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).

14.5 **NOTE: Refer to step 5.3 for correct location for the inner end cap inlet port.** Install the inner end cap (4-40) over the piston rod (4-170) and the rod bushing (4-50).

14.6 Apply fluid and install o-ring seal (5-60) onto the O.D. seal groove of inner end cap (4-40).

14.7 Apply fluid and install two sets of piston tie bar T-seal components (5-80) into the piston internal seal groove. Refer to section 10 for proper T-seal installation instructions.

14.8 Coat the ends of the piston rod (4-170) with fluid.

14.9 Apply fluid and install piston o-ring seal (5-40) onto the piston rod (4-170).

14.10 Install a matched set of split rings (4-70) into the inner most groove in the piston rod and retain with one of the retaining rings (4-80).

14.11 Install the piston (4-20) onto the piston rod against the split ring (4-70).

14.12 Install a matched set of split rings (4-70) onto the piston rod and retain with the retaining ring (4-80).

14.13 Apply fluid to the threads and ends of tie bars (4-60), end without wrench flat, and install by carefully pushing tie bars through the piston (4-20).

14.14 Apply fluid and install two tie bar o-ring seals (5-30) onto the inboard end of the tie bars (4-60) into the o-ring grooves provided.

14.15 Insert the tie bars through the inner end cap (4-40) and screw into the housing (1-10). Tighten until threads bottom out, then back out a half-turn.

14.16 Apply fluid to the entire bore of the cylinder (4-10).

14.17 Apply fluid and install piston T-seal components (5-90) into the piston external seal groove. Refer to section 10 for proper "T" seal installation.

14.18 Install the lubricated 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, tilt cylinder 15° to 30° degrees to the piston rod.**

CAUTION: 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.

14.19 Install two end cap tie bar o-ring seals (5-30) onto the outboard end of the tie bars (4-60).

14.20 Install the outer end cap cylinder o-ring seal (5-60) onto the outer end cap (4-30).

14.21 Install the outer end cap (4-30) onto the tie bars (4-60) and into the end of the cylinder (4-10).

14.22 Install the two tie bar nuts (4-90) onto the tie bars (4-60), using them to draw all of the cylinder components into position.

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

14.23 Torque the tie bar nuts (4-90) alternately until a final torque of 65 ±7 foot pounds has been achieved. **NOTE: It is necessary that the flats on the hex nuts (4-90) be aligned and parallel before the nut retainer (4-100) can be installed.**

14.24 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.

15.0 M4 HYDRAULIC CONTROL PACKAGE INSTALLATION

15.1 If the M4 was mounted on the actuator then reinstall it on the hydraulic control cylinder (4-10). **NOTE: The unit must be mounted with reservoir upright with the pump shaft horizontal.**

15.2 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 be used in this system.**

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

15.3 M4 Refilling Instructions Refilling of the M4 hydraulic control system and actuator cylinder is best accomplished using a pressure pump. If a pressure pump is not available go to step 15.4 for alternate refilling instructions. Put the actuator in the closed position (CW) and proceed using the following steps.

15.3.1 Remove the breather from the reservoir.

15.3.2 Attach the pump discharge line to reservoir breather port.

15.3.3 Open both speed control valves.

15.3.4 Open the two bleed valves (4-160), located at each end of the hydraulic cylinder.

15.3.5 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.

15.3.6 Close each bleed valve (4-160) when the air has been displaced and hydraulic fluid appears.

15.3.7 Remove pump discharge line from reservoir breather port.

15.3.8 Adjust fluid level to 1½" (40mm) from top of reservoir with actuator in open (CCW) position.

15.3.9 Re-install breather removed, in step 15.3.1.

15.4 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:

15.4.1 Put the actuator in the closed position (CW).

15.4.2 Remove the breather from the reservoir.

15.4.3 Fill the reservoir approximately three-fourths (3/4) full.

15.4.4 Open both speed control valves.

15.4.5 Open the bleed valve (4-160) on the outboard end of the hydraulic cylinder only.

15.4.6 Rotate the handle slowly, clockwise, until all air has escaped from the system.

15.4.7 Close the bleed valve opened in step 15.4.5. During the fill procedure, it is important that the lowest level be not less than approximately one-fourth (¼) of the reservoir volume at any time.

15.4.8 Open the bleed valve (4-160) on the inboard end of the hydraulic cylinder.

15.4.9 Rotate the handle slowly, counterclockwise, until all air has escaped from the system.

15.4.10 Close the bleed valve opened in step 15.4.8. During the fill procedure, the piston will not move. This may be determined by observing the position indicator (1-170) on the actuator.

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

15.4.12 Re-install breather removed in step 15.4.2.

15.5 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.

15.5.1 Turn M4 crank arm CW. The actuator should move clockwise as well. Adjust outboard bleed valve (4-160) to remove air from system.

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

15.5.3 With bleed valves closed, stroke actuator full 90°, CW and CCW, using M4 override.

16.0 RETURN TO SERVICE

16.1 Replace the software components of the snubber valves (1-190) and then install the snubbers in the housing cover port and the housing port.

16.2 Adjust both stop screws (1-60) back to settings recorded in section 5 under General Disassembly.

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

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

CHART 1

ACTUATOR WEIGHTS

ACTUATOR MODEL (1)	APPROXIMATE WEIGHT (LBS)	ACTUATOR MODEL (1)	APPROXIMATE WEIGHT (LBS)
ST302.5-M4	255	ST403-M4	324
ST303-M4	262	ST403.5-M4	334
ST303.5-M4	271	ST404-M4	345
ST304-M4	282	ST405-M4	387

NOTES: (1) Weights listed for each actuator model are for bare actuators without accessories or valve mounting brackets.

CHART NO. 2

RECOMMENDED TOOL STYLE & WRENCH SIZES

ITEM NO.	WRENCH SIZE	LOCATION	RECOMMENDED WRENCH STYLE
1-60	1/2"	Stop Screw	Open End or Adjustable
1-90	1/2"	T3 Cover Screws	Socket
1-90	9/16"	T4 Cover Screws	Socket
1-120	1-5/16"	Stop Screw Nut	Box End **(1)**
1-180	3/16"	Pos. Ind. Cover Set Screws	Allen
1-190	7/8"	Snubber Valve	Deep Socket
2-80	1/2"	Piston Rod Square	Square drive extension
2-90	9/32"	1/8 NPT Drain Plug	Open End or Adjustable
2-100	13/32"	Bleed Valve	Open End or Box
2-110	5/8"	Cylinder Screws	Allen
2-120	5/8"	End Cap Screws	Allen
2-140	3/4"	Cylinder Adapt. Screws	Allen
4-90	1-5/16"	Cylinder Tie Bar Nuts	Deep Socket
4-120	3/16"	Cylinder Nut Retainer Screw	Allen
4-150	9/32"	1/8 NPT Drain Plug	Open End or Adjustable
4-160	13/32"	Bleed Valve	Open End or Box
4-170	1-1/4"	Piston Rod Flat	Crows Foot **(1)**
8	----	M4 Mounting Hardware	Adjustable

NOTES: (1) No alternate style recommended

ECN	DATE	REV		BY *	DATE
Released	08-23-93	A	COMPILED	BC	08-23-93
			CHECKED	BJ	08-23-93
			APPROVED	RMM	08-23-93

* **Signatures on file Waller, Texas**