

GH-BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR THE FOLLOWING MODELS

ST3XX-SR AND ST4XX-SR

SPRING RETURN SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111575

REVISION: "A"

DATE: August, 1993

1.0 INTRODUCTION

- 1.1 This service procedure is offered as a guide to enable general maintenance to be performed on GH-Bettis ST3XX-SRX, ST3XX-SRX-M3, ST3XX-SRX-M3HW, ST4XX-SRX, ST4XX-SRX-M3, and ST4XX-SRX-M3HW 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.

SR: Spring Cartridge

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 is applicable with the understanding that all electrical power and pneumatic pressure has been removed from the actuator, allowing the spring to stroke and rotate the actuator to its fail position. 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, razor sharp cutting instrument, latex window caulking, commercial leak testing solution, and non-hardening thread sealant, two each 7/8-9 UNC hex nuts.
- 2.2 Tools - All tools are American Standard inch. Two each medium screwdriver, small standard screwdriver with corners rounded, putty knife, strap wrench, allen wrench set, 3/16" pin punch, rubber or leather mallet and torque wrench (up to 5,000 in.lbs.). For recommended tool list refer to Chart No. 1 on page 12.

3.0 REFERENCE GH BETTIS MATERIALS

- 3.1 Assembly Drawing 104619 for ST3XX-SRX(CW) fail close actuators.
- 3.2 Assembly Drawing 109332 for ST3XX-SRX(CCW) fail open actuators.
- 3.3 Assembly Drawing 107274 for ST3XX-SRX(CW)-M3/HW fail close actuators.
- 3.4 Assembly Drawing 107274 for ST3XX-SRX(CCW)-M3/HW fail open actuators.
- 3.5 Assembly Drawing 104618 for ST4XX-SRX(CW) fail close actuators.

- 3.6 Assembly Drawing 109571 for ST4XX-SRX(CCW) fail open actuators.
- 3.7 Assembly Drawing 000000* for ST4XX-SRX(CW)-M3/HW fail close actuators.
- 3.8 Assembly Drawing 000000* for ST4XX-SRX(CCW)-M3/HW fail open actuators.

* Part number not assigned when this procedure was released.

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. 2 on page 13.
- 4.9 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°F to 150°F) use Kronaplate 50. This lubricant is not contained in the Low Temperature Service/Seal Kit.
- 4.10 It is a good practice to operate the actuator with the nominal operating pressure (NOP), as listed on the actuator name tag 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. Also note if the actuators spring rotates back to the full fail position.

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

5.0 GENERAL DISASSEMBLY

- 5.1 If an M3 Jackscrew is mounted in the power cylinder (2-10), the M3 (2-210) should not contact the end of the piston rod (2-170).

- 5.2 Actuators equipped with M3HW jackscrew with handwheel option, remove hex nut (8-30), lockwasher (8-20), and handwheel (8-10).
- 5.3 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.
- 5.4 Remove breather assembly (11) from inner end cap (2-40).
- 5.5 Remove snubber valves (1-190) from the housing cover (1-20) and the housing (1-10).

6.0 SPRING CARTRIDGE REMOVAL

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

CAUTION: Due to the weight and size of the spring cartridge, support equipment will be required when removing the spring cartridge from the actuator housing.

- 6.1 When the spring cartridge is installed on the actuator the spring is under compression.

CAUTION: DO NOT remove the spring cartridge until the actuator has the stop screw "pre-load" removed.

- 6.2 **Remove spring cartridge stop screw "pre-load" as follows:** Apply nominal operating pressure to the pressure inlet port located in the outer end cap (2-30). Locate the stop screw (1-60) that is on the opposite side of the housing from the spring cartridge (4-10). Loosen jam nut (1-120). Unscrew the stop screw (1-60) until it runs into the inner end cap (2-40). Remove the pressure from the pressure inlet port.
- 6.3 Remove socket screw (4-60), lockwasher (4-50) and nut retainer (4-40) from the end of the spring cartridge (4-10).
- 6.4 Loosen the two large hex nuts on the outboard end of the spring cartridge (4-10). Unscrew the tie bars until the spring cartridge is free from the housing (1-10). Flats are provided on the outboard end of the tie bars for wrench placement. Care should be taken so that the tie bars are not pulled back into the spring cartridge. Place the spring cartridge to one side. **NOTE: To keep from inadvertently pulling the tie bars back into the spring cartridge use 7/8 inch 9 UNC hex nuts and screw them on to the spring cartridge tie bars.**

7.0 PRESSURE CYLINDER DISASSEMBLY

- 7.1 **OUTER END CAP REMOVAL:** With M3 use steps 7.2 through 7.4. Without M3 use step 7.5.
- 7.2 **Outer end cap (2-30) with M3 or M3HW jackscrew will be removed as follows:** Loosen and thread seal nut (2-130) all the way back to the outboard nut.
- 7.3 Loosen and remove socket cap screws (2-200) from jackscrew adapter (2-190).
- 7.4 Back jackscrew adapter (2-190) out until clear of hex nuts (2-90), now go to step 7.7.
- 7.5 **Outer end cap (2-30) without M3 or M3HW jackscrew will be removed as follows:** Unscrew and remove socket cap screw (2-120), lockwasher (2-110), and nut retainer (2-100).
- 7.6 Remove heavy hex nuts (2-90) from tie bars (2-60).

- 7.7 Remove outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap is very tight.
- 7.8 Pry inner end cap (2-40) away from the housing (1-10). Break the inner end cap free from the cylinder (2-10).
- 7.9 Remove the cylinder (2-10). **NOTE: When removing the cylinder off of the piston, tilt the cylinder to the piston rod, approximately 15° to 30° degrees.**
- 7.10 Unscrew the tie bars (2-60) from the housing (1-10). Flats are provided on the outboard end of the tie bars for wrench placement.

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

- 7.11 Pull the tie bars out from the inner end cap (2-40) far enough to remove the o-ring seals (3-30) from the inboard side of the piston (2-20).
- 7.12 Remove the tie bars (2-60) from the piston (2-20).
- 7.13 Remove the split ring retainer (2-80) and the split ring (2-70) from the outboard side of the piston (2-20). **NOTE: Keep the split rings in matched sets.**
- 7.14 Remove the piston (2-20) from the piston rod (2-170). The piston will slide off of the piston rod.
- 7.15 Remove the o-ring seal (3-40) from the piston rod (2-170).
- 7.16 Remove the inboard split ring retainer (2-80) and the split ring (2-70) from the piston rod (2-170). **NOTE: Keep the split rings in matched sets.**
- 7.17 Remove the inner end cap (2-40) from the piston rod (2-170).

8.0 JACKSCREW DISASSEMBLY

- 8.1 For actuators equipped with M3 or M3HW jackscrew, use the following procedure for jackscrew disassembly:
- 8.2 Using a pin punch, drive out and remove the pin from M3 stud and slotted thrust nut.
- 8.3 Screw the slotted thrust nut against the timken bearing until the bearing retainer and the retaining ring are forced off of the end of the M3 stud. Then continue to turn the slotted thrust nut until the bearing and the nut are removed from the M3 stud.
- 8.4 Remove the M3 (2-210) from the outer end cap (2-30).

9.0 HOUSING GROUP DISASSEMBLY

- 9.1 Unscrew push rod (4-20) from yoke pin nut (1-30) and remove from housing (1-10).
- 9.2 Unscrew piston rod (2-170) from yoke pin nut (1-30) and remove, including the rod bushing (2-50). Flats are provided on the outboard end of the piston rod for wrench placement.

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

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

- 9.4 Unscrew and remove hex cap screws (1-240) with gasket seals (3-100) from position indicator cover (1-210).
- 9.5 Remove position indicator cover (1-210) from the housing cover (1-20).
- NOTE: Mark and record the orientation of the position indicator drive (1-230) relative to the top of the yoke (1-160).**
- 9.6 Unscrew and remove set screw (1-180) from position indicator drive (1-230). **NOTE: Mark the hole that the set screw (1-180) is removed from.**
- 9.7 Remove position indicator drive (1-230) from the top of the yoke (1-160).
- 9.8 Remove the housing cover hex cap screws (1-90) and gasket seals (3-100).
- 9.9 Remove the housing cover (1-20). **NOTE: The cover will have a very tight fit. It is not necessary to remove cover pins (1-130).**
- 9.10 Remove the upper two yoke rollers (1-50) from the top of the yoke pin (1-40).
- 9.11 Remove yoke pin (1-40).
- 9.12 Remove yoke pin nut (1-30).
- 9.13 Remove lower two yoke rollers (1-50) from the housing.
- 9.14 Remove the yoke (1-160) by lifting it from the housing.
- 9.15 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.

10.0 GENERAL RE-ASSEMBLY

- 10.1 Remove and discard all seals and gaskets.

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

- 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.
- 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 lubricant to the rod bushing (2-50), install it up into the right side of the housing for fail close (CW) actuators or into the left side of the housing for fail open (CCW) actuators.
- 11.12 Apply loctite - 242 to external threads on the piston rod (2-170). **NOTE: loctite cure time is 10 - 30 minutes.** Lubricate the piston rod (2-170) and insert it into and through the rod bushing installed in step 11.10. Screw the piston rod into the yoke pin nut (1-30).

CAUTION: Do not tighten the piston rod or the push rod (4-20) until the housing cover is installed later in the procedure.

- 11.13 Lubricate the push rod (4-20) and slide into the opposite side of housing from the piston rod and screw into the yoke pin nut (1-30).
- 11.14 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 9.6. Secure with the set screw (1-180).
- 11.15 Install the o-ring seal (3-150) over the position indicator drive shaft and down against the flat cover plate.
- 11.16 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).
- 11.17 Place the housing cover gasket (3-20) onto the master gasket prepared housing (1-10).
- 11.18 Install the remaining yoke o-ring seal (3-50) into cover (1-20).
- 11.19 Apply lubricant to the yoke bore and the track in the housing cover (1-20).
- 11.20 Apply lubricant to the upper bearing surface of the yoke (1-60).
- 11.21 Install the housing cover (1-20), being careful not to damage the gasket (3-20) or yoke o-ring (3-50).
- 11.22 Install the cover screws (1-90) and seal gaskets (3-100). **NOTE: Leave finger tight-do not tighten.**
- 11.23 **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.
- 11.24 Tighten the cover screws (1-90).
- 11.25 Tighten the piston rod (2-170) 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 or the push rod, as it may mark them and cause seal leakage.

- 11.26 Tighten the push rod (4-20) securely with a strap wrench.
- 11.27 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 9.15 are installed into the same stop screw holes as they were removed from.
- 11.28 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).
- 11.29 Install the o-ring seal (3-140) into the bottom seal groove inside the position indicator cover (1-210).
- 11.30 Install the wiper ring (3-160) into the top groove inside the position indicator cover (1-210).

- 11.31 Install the o-ring seal (3-170) into the bottom seal groove on the bottom of the position indicator cover (1-210).
- 11.32 Install the position indicator cover (1-210), being careful not to damage the o-ring seals (3-140), (3-170) and wiper ring (3-160).
- 11.33 Install new gasket seals (3-100) on to hex cap screws (1-240).
- 11.34 Install and tighten the position indicator cover hex screws (1-240).
- 11.35 Install the position indicator pointer (1-170) into the taped hole in the position indicator drive assembly (1-230).
- 11.36 Rotate the yoke to a position that will leave a minimum of the piston rod (2-170) protruding from the actuator housing.

12.0 M3 JACKSCREW OUTER END CAP PRE-ASSEMBLY

- 12.1 Apply a light coating of lubricant to the threads of jackscrew assembly (2-210).
- 12.2 If removed, install the nut seal (2-130) onto jackscrew assembly (2-210).
- 12.3 Lubricate the o-ring groove area on the jackscrew adapter (2-190).
- 12.4 Lubricate the o-ring seal (3-180) and install into o-ring groove on jackscrew adapter (2-190).
- 12.5 Screw the jackscrew adapter (2-190) onto jackscrew assembly (2-210).
- 12.6 Insert jackscrew assembly (2-210) through outer end cap (2-30) and retain with socket cap screws (2-200). Leave socket cap screws (2-200) finger tight.
- 12.7 Install slotted thrust nut on to turned-down end of M3 stud with slotted face toward the outer end cap. Screw the nut past the pin hole in the M3 stud.
- 12.8 Assemble the bearing onto the bearing retainer with the inner race facing the retainer flange. Insert the wire "C" ring into the bearing side of the retainer assembly until the "C" ring opens up into its groove.
- 12.9 Press the retainer assembly onto the turned-down end of the stud, using a wood block and a hammer. **NOTE: The wire "C" ring needs to be forced onto the neck of the stud end.**
- 12.10 Begin to un-screw the thrust nut. Continue till the nut mates with face of bearing. Then back off until nut slot lines up with pin hole. Insert spiral pin through the M3 stud retaining the slotted nut in its position.
- 12.11 Rotate jackscrew assembly (2-210) counterclockwise until the slotted thrust nut is up against the outer end cap (2-30).

13.0 PRESSURE CYLINDER RE-ASSEMBLY

- 13.1 Coat the rod seal (3-70) with lubricant and install, lip first, into the recess provided in the inner end cap ((2-40).

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

- 13.2 Install end cap o-ring seal (3-10) into the inner end cap (2-40).

- 13.3 Prepare the mounting surfaces of the inner end cap (2-40) and inner end cap side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).
- 13.4 Install the inner end cap (2-40) over the piston rod (2-170) and the rod bushing (2-50). Install with the large raised boss toward the housing (flat side outward). The inlet port should be toward the top of the actuator.
- 13.5 Install the o-ring seal (3-60) onto the O.D. seal groove of inner end cap (2-40).
- 13.6 Install two sets of piston tie bar T-seal components (3-80) into the piston internal seal groove. Refer to section 10 for proper T-seal installation instructions.
- 13.7 Coat the ends of the piston rod (2-170) with lubricant.
- 13.8 Install the piston o-ring seal (3-40) onto the piston rod (2-170).
- 13.9 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with one of the retaining rings (2-80).
- 13.10 Install the piston (2-20) onto the piston rod against the split ring (2-70). Ribbed section of piston should face away from housing.
- 13.11 Install a matched set of split rings (2-70) onto the piston rod and retain with the retaining ring (2-80).
- 13.12 Apply lubricant to the threads and end of the tie bars (2-60), end without wrench flat, and install by carefully pushing tie bars through the piston (2-20).
- 13.13 Install two tie bar o-ring seals (3-30) onto the inboard end of the tie bars (2-60) into the o-ring grooves provided.
- 13.14 Insert the tie bars through the inner end cap (2-40) and screw into the housing (1-10). Tighten until threads bottom out, then back out a half-turn.
- 13.15 Apply lubricant to the entire bore of the cylinder (2-10).
- 13.16 Install the piston T-seal components (3-90) into the piston external seal groove. Refer to section 10 for proper "T" seal installation.
- 13.17 Install the lubricated cylinder (2-10) over the piston (2-20) and onto the inner end cap (2-40). **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.

- 13.18 Install two end cap tie bar o-ring seals (3-30) onto the outboard end of the tie bars (2-60) into the o-ring groove provided.
- 13.19 Install the outer end cap cylinder o-ring seal (3-60) onto the outer end cap (2-30).

- 13.20 **OUTER END CAP INSTALLATION:** Outer end cap installation with M3 jackscrew use steps 13.21 through 13.28. Outer end cap without M3 jackscrew use steps 13.29 through 13.32.
- 13.21 **Outer end cap (2-30) with M3 or M3HW jackscrew will be installed as follows:** Install the outer end cap (2-30) onto the tie bars (2-60) and into the end of the cylinder (2-10).
- 13.22 Remove socket cap screws (2-200) from jackscrew adapter and pull out jackscrew assembly until enough clearance is available to install tie bar nuts (2-90).
- 13.23 Install the two tie bar nuts (2-90) onto the tie bars (2-60), 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.

- 13.24 Torque the tie bar nuts (2-90) alternately until a final torque of 65 ± 7 foot pounds has been achieved.
NOTE: It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the jackscrew adapter can be installed.
- 13.25 Rotate the jackscrew assembly counterclockwise until end of CCW travel.
- 13.26 Insert jackscrew adapter (2-190) and jackscrew assembly (2-210) back into the outer end cap.
- 13.27 Retain jackscrew adapter (2-190) with socket cap screws (2-200).
- 13.28 Tighten seal nut (2-130).
- 13.29 **Outer end cap (2-30) without M3 or M3HW jackscrew will be installed as follows:** Install the outer end cap (2-30) onto the tie bars (2-60) and into the end of the cylinder (2-10).
- 13.30 Install the two tie bar nuts (2-90) onto the tie bars (2-60), 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.

- 13.31 Torque the tie bar nuts (2-90) alternately until a final torque of 65 ± 7 foot pounds has been achieved.
NOTE: It is necessary that the flats on the hex nuts (2-90) be aligned and parallel before the nut retainer (2-100) can be installed.
- 13.32 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.

14.0 **SPRING CARTRIDGE INSTALLATION**

NOTE: Make sure that the stop screws (1-60) have not been screwed into the point that "pre-load" will be created on the spring cartridge (4-10).

- 14.1 Prepare the mounting surface of the inboard end of spring cartridge (4-10) and spring cartridge side of the housing (1-10) per master gasket instructions (reference note 5 on assembly drawing).
- 14.2 Install the end cap o-ring seal (3-10) into the housing end of the spring cartridge (4-10).
- 14.3 Remove the tie bar nuts on outboard end of the spring cartridge (4-10) and install new thread seals (3-180) and countersunk washers (3-190).
- 14.4 Re-install the tie bar nuts onto the outboard end of the SR tie bars.

- 14.5 Remove the two nuts, installed in section 6, from the inboard end of the spring cartridge tie bars.
- 14.6 Install the SR cartridge (4-10) onto the push rod (4-20). Insert the tie bars into the mating holes in the housing (1-10).

CAUTION: When installing the SR do not allow the spring cartridge tie bars to be pushed back into the cartridge.

- 14.7 **NOTE:** Flats are provided on the outboard end of the SR tie bars. These flats should be used to put a wrench on to tighten the piston rod. Screw the tie bars into the housing (1-10). Tighten the tie bars until the threads bottom out, then back the tie bars back out one half turn.

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

- 14.8 Alternately tighten the tie bars nuts in 50 foot pounds increments until the spring cartridge is firmly against the housing (1-100) and then tighten to 65 ± 7 foot pounds. **NOTE:** It is necessary that the flats on the hex nuts be aligned and parallel before going to the next step.
- 14.9 Install nut retainer (4-40), lockwasher (4-50), and socket cap screw (4-60).

15.0 ACTUATOR TESTING

- 15.1 **Leak Test - General** - All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution. 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.
- 15.2 All leak testing will use the nominal operating pressure (NOP) as listed on the actuator name tag or the normal customer operating pressure.

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

- 15.3 Before testing for leaks, alternately apply and release NOP pressure to the pressure side of the pistons to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their proper working attitude.
- 15.4 **Leakage Test - Procedure** - Apply NOP pressure to the pressure port in the outer end cap (2-30).
- 15.5 Apply a leak testing solution to the following areas:
- 15.5.1 Joint between the outer end cap (2-30) and the cylinder (2-10).
 - 15.5.2 Around the tie bar nuts on the cylinder end cap (2-30).
 - 15.5.3 The breather port hole in the inner end cap (2-40).
- 15.6 Remove pressure from pressure inlet port in the outer end cap.
- 15.7 If an actuator was disassembled and repaired, the above leakage test must be performed again.

16.0 RETURN TO SERVICE

- 16.1 Install breather assembly (11) in the inner end cap of the cylinder (2-10).

- 16.2 Replace the software components of the snubber valves (1-190) and then install them into the housing cover (1-20) and the housing (1-10).
- 16.3 Adjust both stop screws (1-60) back to settings recorded in section 5 under General Disassembly.
- 16.4 Tighten both jam nuts (1-120) securely, while holding stop screws (1-60).
- 16.5 For actuators equipped with a M3 jackscrew override and require an optional handwheel, M3HW, install the handwheel using the following procedure:
- 16.5.1 Place the handwheel (8-10) onto the M3 stud and over the nut (the handwheel hub has a cast hexagon hole that fits over the nut).
- 16.5.2 Place lockwasher (8-20) onto M3 up against handwheel hub.
- 16.5.3 Place hex nut (8-30) onto M3 and thread up against lockwasher.
- 16.6 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 NO. 1

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	9/16"	Cover Screws	Socket
1-120	1-5/16"	Stop Screw Nut	Box End (1)
1-190	7/8"	Snubber Valve	Deep Socket
2-90	1-5/16"	Power Cylinder Tie Bar Nuts	Deep Socket
2-120	3/16"	Power Cylinder Nut Retainer	Allen
2-130	1-13/16"	M3 Jam Nut	Open End or Adjustable
2-170	1-1/4"	Piston Rod Flat	Crows Foot (1)
2-200	3/8"	M3 Adapter Screw	Allen (1)
4-20	(2)	SR Push Rod	Strap Wrench
4-60	3/16"	SR Nut Retainer	Allen
None	1-5/16"	SR Tie Bar Nuts	Deep Socket
8	1-11/16"	M3 Handwheel Nut	Box End

NOTES: (1) No alternate style recommended

(2) Wrench placement not provided

CHART 2 - ACTUATOR WEIGHTS

ACTUATOR MODEL (1)	APPROXIMATE WEIGHT (POUNDS) (2)				
	SR1	SR2	SR3	SR4	SR5
ST310-SRX	535	429	325	332	336
ST310-SRX-M3	545	439	335	342	346
ST310-SRX-M3HW	551	445	341	348	352
ST312-SRX	570	464	361	368	372
ST312-SRX-M3	580	474	371	378	382
ST312-SRX-M3HW	586	480	377	384	388
ST316-SRX	615	509	405	412	
ST316-SRX-M3	625	519	415	422	
ST316-SRX-M3HW	631	525	421	428	
ST410-SRX		594	488	385	396
ST410-SRX-M3		604	498	395	406
ST410-SRX-M3HW		610	504	401	412
ST412-SRX	621	630	524	421	432
ST412-SRX-M3	631	640	534	431	442
ST412-SRX-M3HW	637	646	540	437	448
ST416-SRX	666	675	569	465	476
ST416-SRX-M3	676	685	579	475	486
ST416-SRX-M3HW	682	691	585	481	492
ST420-SRX	732	740	634		
ST420-SRX-M3	742	750	644		
ST420-SRX-M3HW	748	756	650		

- NOTES:**
- (1) Includes both fail clockwise (CW) and fail counterclockwise (CCW) actuator models.
 - (2) Weights listed for each actuator model are for bare actuators without accessories or valve mounting brackets.

ECN	DATE	REV	BY *	DATE	
Released	August 26, 1993	A	COMPILED	BC	27 August 1993
			CHECKED	BJ	27 August 1993
			APPROVED	RMM	27 August 1993

* Signatures on file Bettis Actuator & Controls, Waller, Texas