

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

ST8XX-SR2, ST8XX-SR3,

ST8XX-SR4 AND ST8XX-SR5

SPRING RETURN SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111583

REVISION: "A"

RELEASE DATE: February, 1994

1.0. INTRODUCTION

- 1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis Models ST8XX-SR2, ST8XX-SR3, ST8XX-SR4 and ST8XX-SR5 "Scotch-Yoke" pneumatic type 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 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 trained, equipped, prepared and competent technician.

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.

SR: Spring Cartridge

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 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 - Seal/Service Kit, razor sharp cutting instrument, Seal removal tool, commercial leak testing solution, two each 1-8 UNC hex nuts, Loctite 242 and non-hardening thread sealant.
- 2.2 Tools - All tools are American Standard inch. Large adjustable wrench, two large screwdrivers, allen wrench set, set of open/box-end wrenches, rubber or leather mallet, torque wrench (up to 5,000 in.lbs.), breaker bar, 1/4" drift punch and a 1/2" drive socket set. For recommended tool list refer to page 14.

3.0 **BETTIS REFERENCE MATERIALS**

- 3.1 Assembly Drawing part number 104825 for ST8XX-SR2 thru -SR5(CW) fail close actuators.
- 3.2 Assembly Drawing part number 109574 for ST8XX-SR2 thru -SR5(CCW) fail open actuators.

4.0 **GENERAL DETAILS**

WARNING: This procedure is only to be used to disassemble the ST8XX-SR2, -SR3, -SR4 and -SR5 series actuators. DO NOT USE THIS PROCEDURE FOR DISASSEMBLY OF ST8XX-SR1 ACTUATORS. Refer to procedure part number 114664 for ST8XX-SR1 actuators.

- 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 and actuator Part 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 Mating parts should be marked for ease of reassembly, i.e. spring cartridge to housing and cylinder to housing.
- 4.5 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp corners rounded off.
- 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 Refer to Chart 1, at the end of this procedure, for actuator weights. NOTE: Some components of this actuator are very heavy and will require a means of assistance.
- 4.9 **LUBRICATION REQUIREMENTS:** For use in all areas of the actuator. Lubricants, other than those listed in steps 4.9.1 and 4.9.2, should not be used without prior written approval of Bettis Product Engineering.
 - 4.9.1 Standard and high temperature service (-20° to 350°) use Bettis ESL-5 (Kronaplate 100). ESL-5 is contained in the Bettis Service/Seal Kit.
 - 4.9.2 Low temperature service (-50° to 150°) use Kronaplate 50. This lubricant is not in the Service/Seal Kit.

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

- 4.10 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), allowing the spring to stroke. The spring will rotate the yoke to the actuator's fail position.
- 5.2 Mark the stop screws (1-60) left and right. The setting of the stop screws (1-60) should be checked and setting recorded before stop screws are loosened or removed.
- 5.4 Remove two in number snubber valves (1-190) from the housing cover (1-20) and the housing (1-10).
- 5.5 Mark and record location of the power cylinder inlet ports on the cylinder outer end cap (2-30) and inner end cap (2-40).

6.0 SPRING CARTRIDGE REMOVAL

WARNING: The SR Cartridge is not field repairable. 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, heavy duty support equipment will be required when removing the spring cartridge from the actuator housing. For the approximate weight of the spring cartridge only refer to the following list:

SR2 = 722 lbs. SR3 = 667 lbs. SR4 = 686 lbs. SR5 = 478 lbs.

WARNING: Do not remove the spring cartridge (4-10) until the actuator has the spring "pre-load" removed.

- 6.1 When the spring cartridge is installed on the actuator the spring is under compression.
- 6.2 **Remove spring cartridge "pre-load" as follows:** Apply sufficient operating pressure to the pressure inlet port located in the cylinder 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 cap screw (4-60), lockwasher (4-50), and nut retainer (4-40) between large hex nut on outboard end of the spring cartridge (4-10).
- 6.4 Remove the hex cap screws (4-100) from the spring cartridge adapter plate (4-80).
- 6.5 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 spring cartridge adapter plate (4-80). 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.

- 6.6 Remove the Spring Cartridge Assembly (4-10) clear of the spring cartridge adapter plate (4-80). To keep from inadvertently pulling the tie bars back into the spring cartridge use two each one inch -8 UNC hex nuts and install them on to the spring cartridge tie bars. Place the spring cartridge (4-10) to one side.

7.0 PRESSURE CYLINDER DISASSEMBLY

- 7.1 Remove breather (11) from the inner end cap (2-40). NOTE: Due to some control systems being of the closed loop design some actuators may not have a breather in this port but will exhaust through a related control valve.
- 7.2 Locate the cylinder outer end cap (2-30) and remove socket cap screw (2-120), lockwasher (2-110) and nut retainer (2-100).
- 7.3 Remove hex nuts (2-90) from tie bars (2-60).
- 7.4 Remove the outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap (2-30) is very tight. NOTE: Break the outer end cap free by tapping with a beaker bar on the lip provided on the end cap.

CAUTION: Do not damage o-ring groove on the outer end cap (2-30).

- 7.5 Pry inner end cap (2-40) away from the housing (1-10). Separate the cylinder (2-10) from the inner end cap (2-40). NOTE: Break the inner end cap (2-40) free from cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.
- 7.6 Remove the cylinder (2-10). NOTE: When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod (2-170).
- 7.7 Unscrew and remove the tie bars (2-60) from spring cartridge adapter plate (4-80). Pull the tie bars out through the housing (1-10), inner end cap (2-40) and piston (2-20). Flats are provided on the outboard end of the tie bars for wrench placement.
- 7.8 Remove a set of split rings (2-70) and a split ring retainer (2-80) from outboard end of piston rod (2-170). NOTE: Keep the split rings in matched sets.
- 7.9 Remove piston (2-20) from piston rod (2-170). Refer to step 7.15 for disassembly of 24" and larger pistons with tie bar bushings (2-180).
- 7.10 Remove o-ring seal (3-40) from the outboard end of piston rod (2-170).
- 7.11 Remove the split ring retainer (2-80) and a set of split rings (2-70) from the inboard side of the piston rod (2-170). NOTE: Keep the split rings in matched sets.
- 7.12 Slide the inner end cap (2-40) off of the piston rod (2-170).
- 7.13 NOTE: Removal of piston rod may require extra amount of torque for break out due to the use of Loctite - 242 during assembly. **CAUTION: Do not use a pipe wrench on the piston rod as it may mark the rod and cause seal leakage.** Unscrew piston rod (2-170) from yoke pin nut (1-30) and remove. Flats are provided on the outboard end of the piston rod for wrench placement.

- 7.14 Remove the rod bushing (2-50) from the housing (1-10).
- 7.15 Fabricated piston disassembly , 24" inch cylinders and larger. Refer to assembly drawing page 1 of 2 detail "B".
 - 7.15.1 Remove the retaining rings (2-190) from piston (2-20).
 - 7.15.2 Remove the piston tie bar bushings (2-180) from the piston.

8.0 HOUSING DISASSEMBLY

- 8.1 Remove four in number socket cap screws (4-90) from the spring cartridge adapter plate (4-80).
- 8.2 Remove the spring cartridge adapter plate (4-80).
- 8.3 Unscrew push rod (4-20) from yoke pin nut (1-30) and remove from the housing (1-10).
- 8.4 Refer to assembly drawing page 2 of 2 Section A-A. Remove position indicator pin (1-170) from position indicator drive (1-230).
- 8.5 Unscrew and remove hex cap screws (1-240) with gasket seals (3-100) from position indicator cover (1-210).
- 8.6 NOTE: Mark and record the orientation of the position indicator drive (1-230) relative to the top of the yoke (1-160). Remove position indicator cover (1-210).
- 8.7 Refer to assembly drawing page 2 of 2 detail "E". NOTE: Mark the hole that the set screw (1-180) is removed from. Unscrew and remove set screw (1-180) from position indicator drive (1-230)/yoke (1-160).
- 8.8 Remove position indicator drive (1-230) from the top of the yoke (1-160).
- 8.9 Remove fourteen in number cover hex cap screws (1-90) and gasket seals (3-100).
- 8.10 NOTE: The cover will have a very tight fit. It is not necessary to remove cover pins (1-130) from the housing cover (1-20). Remove the housing cover (1-20).
- 8.11 Refer to assembly drawing page 2 of 2 detail "E". Remove the yoke rollers (1-50) and roller spacers (1-110) from the top of the yoke pin (1-40).
- 8.12 Remove yoke pin (1-40) from the yoke pin nut (1-30).
- 8.13 Remove yoke pin nut (1-30) from between the yoke arms.
- 8.14 Remove the lower two yoke rollers (1-50) and roller spacers (1-110) from the bottom of the yoke and housing.
- 8.15 The yoke (1-160) can now be removed by lifting it out from the housing cavity.

- 8.16 NOTE: Be sure to mark or identify stop screws (1-60) as left and right. Remove two in number stop screws (1-60), stop screw nuts (1-120), thread seals (3-110) and countersunk washers (3-120).
- 8.17 It is not necessary to remove the yoke bushings (1-200) from the housing cover (1-20) or the housing (1-10) unless these items are being replaced due to damage or wear. It is not necessary to remove two in number pipe plugs (1-80), from the housing and position indicator cover (1-210), to service the actuator.

9.0 GENERAL RE-ASSEMBLY

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

- 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, power cylinder and spring cartridge will be assembled using lubricant as identified in step 4.9.
- 9.5 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 grooves.
- 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.
- 9.6 Prime and apply master gasket (510) to all surfaces as indicated on the assembly drawing (reference note flag number 5). Master Gasket should be applied per the manufactures instructions. In general a small continuous bead of sealant should be applied to one of the jointing surfaces. This sealant bead should be applied as close to the edge of jointing surfaces. This sealant bead should also be applied around any unsealed passages that passes through either surfaces to the atmosphere.

10.0 CENTER HOUSING GROUP RE-ASSEMBLY

- 10.1 If removed install two in number pipe plugs (1-80).
- 10.2 Coat one of the yoke o-ring seal (3-50) with lubricant and install into the housing (1-10).
- 10.3 If the yoke bushings (1-200) was removed then install one in the housing yoke bore and one in the housing cover yoke bore.
- 10.4 Inside the housing (1-10) apply lubricant to the tracks and yoke bore and arrange the housing with the yoke bore nearest you.
- 10.5 Apply lubricant to the slots in the upper/lower yoke arms and the lower yoke bearing surface.
- 10.6 Install the yoke (1-160) into the housing (1-10) as follows: NOTE: The yoke hub with tapped holes faces up. Arrange the yoke arms to approximately a 45° degree position in either direction and lower into the housing. Rotate the yoke back to approximately the mid-stroke (center) position.
- 10.7 Apply lubricant to all surfaces of two of the yoke rollers (1-50) and two roller spacers (1-110). Place one yoke roller in the track in the bottom of the housing and position it under the slot in the yoke arms. Place a roller spacer (1-110) on top of the bottom yoke roller (1-50). Place a second yoke roller on top of the roller spacer in the slot in the lower yoke arm. Place another roller spacer (1-110) on to of the second yoke roller (1-50) and align the holes in the roller spacer and the yoke rollers.
- 10.8 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 rollers (1-50) and roller spacers (1-110).
- 10.9 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).
- 10.10 Apply lubricant to all the surfaces of the two remaining yoke rollers (1-50) and two remaining roller spacers (1-110). Place one roller spacer (1-110) on top of the yoke pin nut (1-30) then install the third yoke roller (1-50). Place the last roller spacer (1-110) on top of the third yoke roller (1-50). Place the fourth and final yoke roller (1-50) on to the yoke pin. The top roller will remain above the yoke arm and will engage the cover track when the cover is installed.
- 10.11 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.
- 10.12 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 10.11. 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.

- 10.13 Prepare the mounting surface of the SR adapter plate (4-80) and spring cartridge side of the housing (1-10) per master gasket instructions (reference step 9.6).
- 10.14 Install the end cap o-ring seal (3-10) into the spring cartridge adapter plate (4-80).
- 10.15 Install the spring cartridge adapter plate (4-80) up against the housing (1-10).
- 10.16 Retain the spring cartridge adapter plate with four in number socket cap screws (4-90). Torque to 90 ±5 foot pounds.
- 10.17 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).

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

- 10.18 Refer to assembly drawing page 2 of 2 details "E" and "F". Install the position indicator drive (1-230) onto the top of yoke (1-160) with the slot positioned over the hole that was marked in section 8. Secure with the set screw (1-180).
- 10.19 Install the o-ring seal (3-150) over the position indicator drive shaft and down against the flat cover plate.
- 10.20 Coat the remaining yoke o-ring seal (3-50) with lubricant and install into the housing cover (1-20).
- 10.21 Apply lubricant to the yoke bore and the track in the housing cover (1-20).
- 10.22 Apply lubricant to the yoke upper bearing surface.
- 10.23 Prepare the mounting surfaces of the housing cover (1-20) and the housing (1-10) per master gasket instructions (reference step 9.6).
- 10.24 Place the housing cover gasket (3-20) on the housing (1-10).
- 10.25 Install the housing cover (1-20) being careful not to damage the cover gasket (3-20) or yoke o-ring seal (3-50). NOTE: If the housing cover does not go down against the housing then the cover may be hanging on the top yoke roller.
- 10.26 Lubricate and install fourteen in number cover screws (1-90) and seal gaskets (3-100). NOTE: Leave finger tight - do not tighten.
- 10.27 Do this step only if you have pulled the cover pins (1-130) or if you are replacing the cover pins. Drive four in number pins (1-130) through the cover (1-20) and into the housing (1-10) until the pins are 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.
- 10.28 Tighten the cover screws (1-90) and torque to 16 ft. lbs. (±5 %).
- 10.29 Tighten the piston rod (2-170) to a torque of 150 ft. lbs. (±5 %). Flats are provided on the outer end for wrenching purposes.

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

- 10.30 Tighten the push rod (4-20) with a strap wrench.
- 10.31 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 8.16 are installed into the same stop screw holes as they were removed from.
- 10.32 Prepare the mounting surface of the position indicator cover (1-210) and the housing cover (1-20) per master gasket instructions (reference step 9.6).
- 10.33 Install o-ring seal (3-140) into the bottom seal groove inside the position indicator cover (1-210).
- 10.34 Install the wiper ring (3-160) into the top groove inside the position indicator cover (1-210).
- 10.35 Refer to assembly drawing page 2 of 2 detail "E". Install the o-ring seal (3-170) into the bottom seal groove on the bottom of the position indicator cover (1-210).
- 10.36 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).
- 10.37 Install six in number new gasket seals (3-100) on to hex cap screws (1-240).
- 10.38 Install and tighten six in number position indicator cover hex screws (1-240).
- 10.39 Install the position indicator pointer (1-170) into the taped hole in the position indicator drive assembly (1-230).
- 10.40 Rotate the yoke to a position that will leave a minimum of the piston rod (2-170) protruding from the actuator housing.

11.0 PRESSURE CYLINDER RE-ASSEMBLY

- 11.1 NOTE: Install the rod seal with energizer ring facing into the seal cavity. 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 Prepare mounting surfaces of inner end cap (2-40) and end cap side of the housing (1-10) per master gasket instructions (reference step 9.6).
- 11.3 Refer to assembly drawing page 1 of 2 detail "A". Install a end cap o-ring seal (3-10) into inner end cap (2-40).
- 11.4 Refer to assembly drawing page 1 of 2 detail "A". Coat two in number tie bar o-ring seals (3-30) with lubricant and install into inner end cap (2-40).
- 11.5 Install inner end cap (2-40) over piston rod (2-170) and the rod bushing (2-50). Install with the large raised boss toward the housing (flat side outward). NOTE: The pressure inlet port should be toward the top of the actuator (as marked in section 5).
- 11.6 Apply lubricant to the end cap o-ring seal (3-60) and install on the inner end cap (2-40).

- 11.7 Skip this step if your piston is 20" inch diameter or less. Fabricated Piston Reassembly , 24" inch diameter and larger. Refer to assembly drawing page 1 of 2 detail "B".
- 11.7.1 Install o-ring seals (3-35) into the O.D. groove on piston tie bar bushings (2-180).
- 11.7.2 Install the rod T-seals (3-80) into the I.D. groove in the piston bushing (2-180).
- 11.7.3 Install the piston bushings (2-180) into the piston.

CAUTION: The piston tie bar bushings should be replaced each time the actuator has its five year refurbishment. **NOTE:** The Bettis Service Kit should contain new piston tie bar bushings.

- 11.7.4 Install the retaining rings (2-190) into the piston.
- 11.8 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into the piston internal seal groove. Refer to section 9 for proper T-seal installation instructions.
- 11.9 Coat the ends of the piston rod (2-170) with lubricant.
- 11.10 Apply lubricant to the o-ring seal (3-40) and place into the seal groove of piston rod (2-170).
- 11.11 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with one of the split ring retainers (2-80). **NOTE:** The retaining ring groove will face away from the piston.
- 11.12 Install the piston (2-20) onto the piston rod against the split ring set (2-70). **NOTE:** When installing cast pistons install with ribbed section of piston is facing away from the housing (1-10). When installing fabricated pistons, 24" inch diameter and larger, make certain that the smaller diameter piston plate is facing away from housing (1-10).
- 11.13 Install a matched set of split rings (2-70) into the groove out board of the piston (2-20) and retain with the split ring retainer (2-80). **NOTE:** The split ring retainer groove will face away from the piston.
- 11.14 Coat the piston T seal components (3-90) with lubricant and install into the piston external seal groove. Refer to section 9 for proper "T" seal installation instructions.
- 11.15 Take "housing-end" of tie bars (2-60), end without wrench flat, and install by carefully inserting tie bars into the piston (2-20) and through the rod T-seal (3-80), inner end cap (2-40), housing (1-10) and screwing into the SR adapter plate (4-80).

CAUTION: Make certain the back-up rings (components of the rod T-seal) are seated into the seal groove. Should the back-up rings or seal member be pinched between the piston and tie bar, the components could be damaged, becoming a potential source of leakage.

- 11.16 Apply lubricant to the bore of the cylinder (2-10).

- 11.17 Slide the lubricated cylinder (2-10) over piston (2-20) and onto inner end cap (2-40). When sliding the cylinder over the piston seal tilt cylinder 15° to 30° degrees to the piston rod.

CAUTION: If needed, when installing the cylinder, 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 components could be damaged, becoming a potential source of leakage.

- 11.18 Apply lubricant to two end cap tie bar o-ring seals (3-30) and install into the outboard end cap (2-30).

- 11.19 Apply lubricant to the outer end cap cylinder o-ring seal (3-60) and install onto outer end cap (2-30).

- 11.20 Install outer end cap (2-30) onto the tie bars and into the end of the cylinder (2-10). NOTE: The pressure inlet port should be installed in the position recorded in section 5.

- 11.21 Install two in number tie bar nuts (2-90) on the tie bars (2-60), using them to draw all of the cylinder components into position. Torque alternately, in 50 ft. lb. increments, until a final torque of 110 ± 11 ft. lbs. has been achieved.

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

- 11.22 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.

- 11.43 Apply sufficient pneumatic pressure to the breather port in the inner end cap (2-40) to stroke the actuator. Remove the pneumatic pressure from the breather port. If air pressure is not available then by pushing on the exposed spring return push rod (4-20) or tapping it with a soft mallet, stroke the actuator until the yoke touches the housing or the stop screw at the end of its stroke.

12.0 **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.

- 12.2 Re-install the tie bar nuts onto the outboard end of the SR tie bars.

- 12.3 Prepare the Interfacing surfaces of the spring cartridge inboard end and the outboard side of the spring cartridge adapter plate (4-80) per master gasket instructions (reference step 9.6).

- 12.4 On the outboard side of the spring cartridge adapter plate (4-80) install o-ring seal (3-200) into the seal groove.

- 12.5 Remove the two nuts, installed in section 6, from the inboard end of the spring cartridge tie bars.
- 12.6 Place the spring cartridge (4-10) onto the push rod (4-20) and align the spring cartridge tie bars with the holes in the spring cartridge adapter plate (4-80).

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

- 12.10 Insert and screw the SR tie bars into the mating holes in the SR adapter plate (4-80). Tighten each tie bar until the threads bottom out, then back out one quarter-turn.
- 12.11 Install and screw four in number hex cap screws (4-100) through spring cartridge adapter plate (4-80) and into holes in spring cartridge (4-10) inboard end.
- 12.12 Use the spring cartridge tie bar nuts to draw the spring cartridge firmly against the adapter plate (4-80).
- 12.13 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). Torque alternately, in 50 ft. lb. increments, until a final torque of 110 ± 11 ft. lbs. has been achieved.

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

- 12.14 Install the nut retainer (4-40), securing in place with the retainer screw (4-60) and lockwasher (4-50). NOTE: It is necessary that the flats on the SR tie bar hex nuts be aligned and parallel before the nut retainer can be installed.

13.0 ACTUATOR TESTING

- 13.1 **Leak Test - General** - A small amount of leakage may be tolerated. Generally, a small bubble which breaks about three seconds after starting to form is considered acceptable.

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

- 13.2 All leak testing will use the nominal operating pressure (NOP) as listed on the actuator name tag or the customer supplied operating pressure.
- 13.3 Before testing for leaks, alternately apply and release actuator name tag NOP pressure, to the pressure side of the pneumatic cylinder piston to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their proper service condition.
- 13.4 Using a pressure regulator apply the name tag NOP pressure to the pressure inlet port in the pneumatic cylinder outboard end cap (2-30).
- 13.5 Apply a leak testing solution to the following areas:
 - 13.5.1 The breather port in cylinder inner end cap (2-40).

- 13.5.2 Joint between the cylinder outer end cap (2-30) and the cylinder (2-10).
- 13.5.3 Joint between the outer end cap (2-30) and the tie bar nuts (2-90).
- 13.6 Remove the pressure from the inlet port in the outer end cap (2-30).
- 13.7 If an actuator was disassembled and repaired, the above leakage test must be performed again.
- 13.8 Operation test the actuator to verify proper function of the actuator. This test is to be done off of the valve.
- 13.9 Adjust the pressure regulator to the name tag NOP pressure.
- 13.10 Apply the above pressure to outer end cap pressure inlet port and allow the actuator to stabilize. The actuator should stroke a full 90° travel.
- 13.14 Any jumpy or jerky operation, not attributed to seal drag or limited flow capacity, must be corrected and the above test performed again.
- 13.15 Remove NOP pressure from the pressure inlet port.

14.0 RETURN TO SERVICE

- 14.1 Install breather (11) in the inner end cap (2-40). NOTE: Due to some control systems being of the closed loop design some actuators may not have a breather in this port but will exhaust through a related control valve.
- 14.2 Replace the software components of the snubber valves (1-190). Install one snubber valve in the housing cover (1-20) and one in the housing (1-10).
- 14.3 Adjust both stop screws (1-60) back to settings recorded in section five under General Disassembly.
- 14.4 Tighten both stop nuts (1-120) securely, while holding stop screw (1-60).
- 14.5 Actuator is ready to be returned to service.
- 14.6 After the actuator is installed on the valve all accessories should be hooked up and tested for proper operation and replaced if found defective.

CHART NO. 1 - ACTUATOR WEIGHTS

ACTUATOR MODEL	APPROXIMATE WEIGHT (POUNDS)**			
	SR2	SR3	SR4	SR5
ST812-SRX	N/A	1315	1334	1125
ST816-SRX	1427	1372	1391	1183
ST820-SRX	1544	1488	1508	1299
ST824-SRX	1872	1817	1836	1627
ST828-SRX	2203	2148	2167	1958

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

CHART NO. 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"	14	Cover Screws	Socket
1-120	1-7/8"	2	Stop Screw nut	Box end (1)
1-180	3/16"	4	Pos. Indicator drive screws	Allen
1-190	7/8"	1	Snubber	Deep socket
1-240	9/16"	6	Pos. Ind. cover screws	Socket
2-60	5/8"	2	Tie bars flats	Open end or adjustable
2-90	1-5/8"	2	Tie bar nuts	Crows foot (1)
2-120	3/16"	1	Nut retainer screw	Allen
2-170	1-3/8"	1	Piston rod flat	Crows foot (1)
None	1-5/8"	2	SR Tie bar nut	Deep socket
4-20	(1)	1	Push rod	Strap wrench
4-60	3/16"	1	Nut retainer screw	Allen
4-90	1/2"	4	SR adapter screws	Allen
4-100	15/16"	4	SR adapter screws	Socket

(1) No alternate style recommended or wrench placement not provided.

ECN	DATE	REV	BY *	DATE	
Released	February 24, 1994	A	COMPILED	BC	24 February 1994
			CHECKED	BJ	24 February 1994
			APPROVED	RMM	24 February 1994

* Signatures on file Waller, Texas