

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

STR10XX-SR-M7

SPRING RETURN SERIES

PNEUMATIC ACTUATORS

PART NUMBER: 111588

REVISION: "A"

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1.0 **INTRODUCTION**

- 1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis STR10XX-SR-M7 Spring Return Series pneumatic 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 well trained, well equipped, well 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 does not include M7 Disassembly and Reassembly Instruction. GH Bettis does not recommend periodic maintenance for the M7 itself. The M7 needs only to be serviced when it malfunctions. Complete M7 refurbishment should be done by GH Bettis.

1.7 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. **NOTE: DO NOT REMOVE THE M7 HYDRAULIC CONTROL PACKAGE AND ITS PIPING UNTIL SECTION 5 HAS BEEN COMPLETED.**

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 1-3/8 inch 12 UNC hex nuts and non-hardening thread sealant.

2.2 **Tools:** All tools are American Standard inch. Large adjustable wrench, two (2) 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, 1/2" drive socket set.

3.0 **BETTIS REFERENCE MATERIALS**

- 3.1 Assembly Drawing part number 109838 for STR102XX-SR(CW)-M7 Fail Close actuators.
- 3.2 Adapter piece drawing part number B-064899.

4.0 **GENERAL DETAILS**

- 4.1 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
- 4.2 Numbers in parentheses (), indicate the bubble number (reference number) used on the Bettis Assembly Drawing and Actuator Parts List.
- 4.3 As referenced in this procedure the front of the actuator is: Yoke bore nearest workman. The top of the actuator will be the housing cover.
- 4.4 When removing seals from seal groove, use a commercial seal removing tool or use a small standard screwdriver with the sharp edges rounded off.
- 4.5 Use a non-hardening thread sealant on all pipe threads. **NOTE: Apply the thread sealant per the manufacturer's instructions.**
- 4.6 Disassembly should be done in a clean area near a work bench.
- 4.7 Some components of this actuator are very heavy and will require a means of assistance.

4.8 **LUBRICATION REQUIREMENTS**

- 4.8.1 Standard and high temperature service (-20°F to 350°F) use Kronaplate 100 lubricant. This lubricant is furnished in the GH Bettis Service/Seal Kit.
- 4.8.2 Low temperature service (-50°F to +150°F) use Kronaplate 50. This lubricant is not furnished in the Service/Seal Kit.

4.9 **FLUID REQUIREMENTS (for the M7 Hydraulic Control Package)**

- 4.9.1 Standard and high temperature service (-20°F to 350°F) use Dextron II Automatic Transmission fluid.
- 4.9.2 Low temperature service (-50°F to 150°F) use Exxon Univis J13 Hydraulic Fluid.
- 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. **CAUTION: Pressure is not to exceed the maximum pressure ratings listed on the name tag.**

5.0 **GENERAL DISASSEMBLY**

- 5.1 Remove stop screw nut (2-120) and the spring cartridge stop screw nut. Measure and record the exposed length of the stop screws (2-110) and the spring cartridge stop screw.
- 5.2 Remove breather (11) from the outer end cap (2-30).

- 5.3 Remove the snubber valve (1-230) from the housing cover (1-130).
- 5.4 Mark and record location of the hydraulic inlet ports on the hydraulic cylinder outer end cap (2-190) and inner end cap (2-180).
- 5.5 The spring cartridge "pre-load" should be removed before the M7 control package has it hydraulic fluid drained. Remove the spring cartridge "pre-load" as follows: Close the block/by-pass valve located on the M7 block. Insert the pump handle into the pump handle holder and hand jack the pump until the actuator has moved a few degrees off of the spring cartridge stop. Unscrew and remove the spring cartridge stop screw located on the spring cartridge (3-10). Open the block/bypass valve on the M7 block and allow the spring to return the actuator to its fail position.
- 5.6 Drain the hydraulic fluid from Hydraulic Cylinder (2-160) by opening the bleed valves (2-140) and then removing the cylinder drain pipe plugs (2-150). One is located on outboard end of hydraulic cylinder and the other on the inboard end of hydraulic cylinder.
- 5.7 If the M7 is mounted on the actuator then remove the M7 control package from hydraulic cylinder (2-160). **CAUTION: Plug the inlet ports in the M7 as foreign material may enter the system and cause the package to malfunction.**

6.0 SPRING CARTRIDGE REMOVAL

- 6.1 If step 5.5 was not done or the M7 package was not available for use then use this step for removing the spring cartridge "pre-load". Remove the SR "pre-load" as follows: Apply only sufficient pneumatic pressure to the cylinder inlet port, located on the inner end cap (2-40), to drive the actuator load off of the SR stop screw. The SR stop screw is located on the outboard end of the spring cartridge (3-10). Unscrew and remove the SR stop screw. Remove the pressure from the pressure inlet port.

WARNING: THE SPRING CARTRIDGE "PRE-LOAD" MUST BE REMOVED BEFORE THE ACTUATOR IS DISASSEMBLED.

CAUTION: DUE TO THE WEIGHT AND SIZE OF THE SPRING CARTRIDGE SUPPORT EQUIPMENT WILL BE REQUIRED.

- 6.2 Unscrew the spring cartridge pull rod from the yoke pin nut (1-110). The pull rod can be rotated for removal by going through the spring cartridge stop screw hole with a 1/2 inch square drive extension.
- 6.3 Remove hex head screws (3-40) from adapter plate (3-20).
- 6.4 Loosen spring cartridge tie bar hex head nuts one turn.
- 6.5 Unscrew the spring cartridge tie bars from the housing (1-10). **CAUTION: Do not allow tie bars to fall into the housing.** Flats are provided on the outboard end of the tie bars for wrench placement. Pull the cartridge (3-10) away from and off of the housing (1-10).
- 6.6 To keep from inadvertently pulling the tie bars back into the spring cartridge use 1-3/8 inch 12 UNC hex nuts and screw them on to inboard end of the spring cartridge tie bars. Place the spring cartridge to one side.

WARNING: Under no circumstances should the spring cartridge be cut apart, as the spring is pre-loaded and the spring cartridge welded together.

- 6.7 Remove adapter plate (3-20).

7.0 PNEUMATIC AND HYDRAULIC CONTROL CYLINDER DISASSEMBLY

- 7.1 Remove tie bar nuts (2-100), thread seals (5-60) and counter sunk washers (5-70).
- 7.2 Remove outer end cap (2-190) from the cylinder (2-160). The fit between the cylinder and the outer end cap is very tight. Break the end cap free by tapping with a breaker bar on lip provided on the end cap. **DO NOT** damage o-ring groove when removing end cap.
- 7.3 Pry hydraulic cylinder inner end cap (2-180) away from the pneumatic cylinder outer end cap (2-30). Break the hydraulic cylinder inner end cap free from the hydraulic cylinder (2-160) by tapping with a breaker bar on the lip provided on the end cap.
- 7.4 Remove the hydraulic cylinder (2-160). **NOTE:** When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod (2-70). When sliding the cylinder off, tilt the cylinder 15□ to 30□ degrees with respect to actuator centerline to help facilitate removal.
- 7.5 Remove a set of split rings (2-80) and a split ring retainer (2-90) from outboard end of piston rod (2-70). **NOTE: Keep the split rings in matched sets.**
- 7.6 Slide hydraulic piston (2-170) off piston rod (2-70) and tie bars (2-60).
- 7.7 Remove second set of hydraulic piston split rings (2-80) and a split ring retainer (2-90). **NOTE: Keep the split rings in matched sets.**
- 7.8 Remove o-ring seal (5-20) and slide hydraulic cylinder inner end cap (2-180) off piston rod (2-70) and tie bars (2-60).
- 7.9 Remove the rod bushing (2-200) from the pneumatic outer end cap (2-30).
- 7.10 Remove the pneumatic outer end cap (2-30). The fit between the cylinder (2-10) and this end cap is very tight. Break the end cap free by tapping with a breaker bar on the lip provided on the end cap. Do not damage o-ring groove on end cap.
- 7.11 Pry the pneumatic inner end cap (2-40) away from the housing (1-10). Break this end cap free from the cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.
- 7.12 Remove the pneumatic cylinder (2-10). When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod.
- 7.13 Remove tie bars (2-60) from housing (1-10). Flats on outboard end are provided for wrench placement. Using flats will prevent damage to surfaces of tie bars. **NOTE: DO NOT USE PIPE WRENCH**
- 7.14 Remove split ring retainer (2-90) and a set of split rings (2-80) from the outboard side of the pneumatic piston (2-20). **NOTE: Keep the split rings in matched sets.**
- 7.15 Remove piston (2-20) from piston rod (2-70). The piston will slide off of the piston rod (2-70). Refer to step 7.21 for 24" piston bushing (2-220) disassembly.
- 7.16 Remove the o-ring seal (5-20).
- 7.17 Remove the fourth and final set of split rings (2-80) and a split ring retainer (2-90) from the piston rod (3-70). **NOTE: Keep the split rings in matched sets.**

- 7.18 Slide the inner end cap (2-40) off piston rod (2-70). Actuators with 28" cylinder will require the removal of socket cap screw (2-300) from the inner end cap (2-40) before the inner end cap can be removed.
- 7.19 Unscrew and remove piston rod (2-70) from yoke pin nut (1-110). Again, note wrench flats on outboard end. Using flats will prevent damage to surfaces to piston rod. **NOTE: DO NOT USE PIPE WRENCH**
- 7.20 Remove rod bushing (2-50).
- 7.21 Fabricated 24" piston disassembly (refer to assembly drawing sheet 2 of 2 detail "K").
 - 7.21.1 Remove the retaining rings (2-230) from the piston.
 - 7.21.2 Remove the piston bushing (2-220) from the piston. The piston bushing should be replaced each time the actuator is refurbished (refer to section 1 for recommend service interval).
NOTE: The Bettis Service Kit should contain a new piston bushing.

8.0 HOUSING GROUP DISASSEMBLY

- 8.1 Remove position indicator pin (1-290).
- 8.2 Unscrew and remove hex cap screws (1-280) with gasket seals (4-100) from position indicator cover (1-270).
- 8.3 Remove position indicator cover (1-270).
- 8.4 Unscrew and remove set screw (1-250) from position indicator drive assembly (1-260). **NOTE: Mark the hole that the set screw (1-250) is removed from.**
- 8.5 Remove position indicator drive assembly (1-260) from the top of the yoke (1-30).
- 8.6 Remove cover screws (1-150) and gasket seals (4-50). **NOTE:** The cover screws (1-150), that stick up and have hex nut (1-240) on them, are not to be removed.
- 8.7 To help in removing the housing cover (1-130) loosen the eight hex nuts (1-240). Alternately rotate the eight raised cover screws (1-150) clockwise until the cover is clear of the cover pins (1-140).
- 8.8 Remove the cover (1-130).
- 8.9 Cover pins (1-140) should not be removed unless damaged.
- 8.10 Remove the shoulder cap screws (1-80). Remove the rails (1-70).
- 8.11 Remove the yoke pin (1-120).
- 8.12 Remove the short yoke rollers (1-90) and the long yoke roller (1-100).
- 8.13 Remove the yoke pin nut (1-110).
- 8.14 Unscrew and remove socket cap screws (1-60) from upper yoke/segmented retaining rings (1-50).
- 8.15 Remove upper segmented retaining rings (1-50).

- 8.16 Remove upper yoke bushing (1-40).
- 8.17 Remove the yoke (1-30). **NOTE: Use a lifting eye in one of the 1/2-13UNC holes on top of the yoke for means of assisting in removal.**
- 8.18 Position the housing in such a manner so as to allow the lower yoke bushing (1-20) to be removed (refer to assembly drawing page 2 of 2 detail "J").
- 8.19 Unscrew and remove socket cap screws (1-60) from the lower yoke/segmented retaining rings (1-50).
- 8.20 Remove the lower segmented retaining rings (1-50).
- 8.21 Remove lower yoke bushing (1-20).
- 8.22 The following items need not be removed from the actuator housing for standard actuator refurbishment: Lifting lugs (1-160), lockwasher (1-180), hex head screw (1-170), pipe plugs (1-220) and pipe plugs (1-190).

9.0 **GENERAL RE-ASSEMBLY**

- 9.1 Remove all old seals and gaskets, taking care not to scratch or damage sealing surface areas.
- 9.2 All parts should be thoroughly inspected. Particular attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding motion. Sealing surfaces must be free of deep scratches, pitting, corrosion and blistering/flaking coating.
- 9.3 After inspection, the parts should be carefully cleaned to remove all dirt, gaskets and other foreign material.
- 9.4 Coat all surfaces of actuators moving parts with lubricant, refer to step 4.8 for correct lubricant.
- 9.5 Coat all seals with lubricant, before installing into seal grooves.
- 9.6 T-seal set installation - The T-seal is composed of one rubber seal and two split skive-cut back-up rings.
 - 9.6.1 Install the T-seal into the seal grooves.
 - 9.6.2 Install a back-up ring on each side of the T-seal.
 - 9.6.3 When installing the back-up rings, do not align the skive-cuts.
 - 9.6.4 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.
- 9.7 Prime and apply master gasket (510) to all surfaces as indicated on the assembly drawing.

10.0 **HOUSING GROUP RE-ASSEMBLY**

- 10.1 If removed, install pipe plugs (1-190).
- 10.2 Apply lubricant to lower yoke bushing (1-20) and yoke bore in housing.

- 10.3 Install o-ring seals (4-10) and (4-20) into the lower yoke bushing (1-20).
- 10.4 Install lower yoke bushing (1-20) into the housing (1-10).
- 10.5 Install the segment retaining rings (1-50) into the lower yoke bushing (1-20) and retain with the socket cap screws (1-60), Torque to 6 ft. lbs. lubricated.
- 10.6 Apply lubricant to the yoke (1-30) journal and in the lower yoke arm area slots.
- 10.7 If removed install yoke (1-30) into lower yoke bushing the yoke hub with tapped holes faces up). Rotate yoke to mid-stroke position.
- 10.8 Apply lubricant to 'track-rails' (1-70). If removed install inner 'track-rail' (1-70). Slide rail into housing between yoke arms and fasten with shoulder bolts (1-80) **DO NOT TIGHTEN**. Tie bars with 'tipped' ends will be added later to support rail. Until that time, an adapter piece (see Drawing B-64899) may be used as temporary replacements.
- 10.9 Apply lubricant to all surfaces of yoke rollers (1-90) and (1-100). Install one short roller (1-90) into slot of bottom yoke arm.
- 10.10 Apply lubricant to the upper and lower surfaces of yoke pin nut (1-110) and install between the yoke arms and parallel to rail inside housing.
- 10.11 Install second yoke roller (1-100) into slot of the yoke pin nut (1-110). Align holes of both rollers.
- 10.12 Apply lubricant to yoke pin (1-120) and install into middle and bottom yoke rollers.
- 10.13 Install the final short yoke roller (1-90) over the yoke pin (1-20) and into the slot of the upper arm of yoke (1-30).
- 10.14 Install outer 'track-rail' (1-70) with shoulder bolts (1-80) **DO NOT TIGHTEN**. Again, use adapter piece to support rail until tie bars are installed.
- 10.15 Apply lubricant to rod bushings (2-50) and install into housing.
- 10.16 Install piston rod (2-70) into yoke pin nut. Tighten piston rod (2-70) to a torque of approximately 2000 inch pounds (166 ft. lbs.). Flats are provided on the outer end cap for wrenching purposes. **NOTE: DO NOT USE PIPE WRENCH.** Remove any burrs from the flats after tightening.
- 10.17 Remove temporary adapter pieces one at a time and install tie bars (2-60) into the side of the housing with the tipped end of the tie bars being inserted into the rails (1-70). **CAUTION: TIGHTEN TIE BARS UNTIL THREADS BOTTOM OUT, THEN BACK OUT ONE HALF-TURN.**
- 10.18 After tie bars (2-60) are installed and while the temporary adapter pieces are still installed in the SR side of the housing, then tighten all four shoulder bolts (1-80). Torque tighten the shoulder bolts (1-80) to 240 ft. lbs. lubricated.

11.0 **PNEUMATIC AND HYDRAULIC CONTROL CYLINDER RE-ASSEMBLY**

- 11.1 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 4 on assembly drawing).
- 11.2 Install the end cap o-ring seal (4-40) into the inner end cap (2-40).

- 11.3 Install rod seal (5-50) into recess (counter bore) provided in inner end cap (2-40). Install with energizer ring facing outboard side (away from housing).
- 11.4 Install the o-ring seals (5-10) into the inner end cap (2-40) tie bar pass through holes.
- 11.5 Install inner end cap (2-40) by sliding over piston rod (2-70) and rod bushing (2-50). **NOTE: The pressure port should be positioned above the actuator centerline.** Exercise extreme care during installation in order to prevent damage to the rod seal (5-50). For actuators equipped with 28" cylinders, install stat-o-seal (5-120) on to socket cap screw (2-300). Insert socket cap screw (2-300) through the inner end cap (2-40) and thread into the thread insert (2-310).
- 11.6 Coat the grooves on the piston rod (2-70) with lubricant. Install two (2) halves of one matched set of split rings (2-80) into the inner most groove in the piston rod and retain with a retaining ring (2-90).
- 11.7 Install o-ring seal (5-20) onto the o-ring groove in the piston rod (2-70).
- 11.8 Install o-ring seal (5-30) on the outer diameter of inner end cap (2-40).
- 11.9 Install two o-ring seals (5-10) into the tie bar bores in a piston (2-20). Refer to step 11.10 for 24" piston bushing (2-220) reassembly.
- 11.10 Fabricated 24" piston reassembly (refer to assembly drawing sheet 2 of 2 detail "C").
 - 11.10.1 Install the o-ring seals (5-110) into the O.D. groove on piston bushings (2-220).
 - 11.10.2 Install the o-ring seals (5-10) into the I.D. groove in the piston bushing (2-220).
 - 11.10.3 Install the piston bushings (2-220) into the piston.
 - 11.10.4 Install the retaining rings (2-230) into the piston.
- 11.11 Install piston (2-20) onto piston rod (2-70) and up against the split ring installed in step 11.6. **CAUTION: When installing 24" inch diameter, or larger, pistons make certain that the smaller diameter plate faces the outer end cap (2-30).**
- 11.12 Install second set of matched split rings (2-80) and ring retainer (2-90).
- 11.13 Install the piston T-seals (5-40) into the outer diameter groove on the piston (2-20). Refer to section 9, General Reassembly, for T-seal installation instructions.
- 11.14 Apply lubricant to the bore of the cylinder (2-10).
- 11.15 Slide cylinder (2-10) over piston and onto the inner end cap. Cylinder will have to be tilted approximately 15° to 30° across piston to facilitate installation. 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.
- 11.16 Install two end cap tie bar o-ring seals (5-10) into the pneumatic cylinder outer end cap (2-30).
- 11.17 Install the pneumatic cylinder outer end cap o-ring seal (5-30) onto the pneumatic cylinder outer end cap (2-30) O.D. seal groove.

- 11.18 Install the pneumatic cylinder outer end cap (2-30) onto the tie bars and into the end of pneumatic cylinder (2-10). Install with the raised boss away from the cylinder and the inlet port above the centerline of the actuator.
- 11.19 Prepare the mounting surfaces of the outer end cap (2-30) per master gasket instructions (reference note 4 on assembly drawing).
- 11.20 Install the second rod seal (5-50), lip first, into the recess provided in the pneumatic cylinder outer end cap (2-30). **CAUTION: The energizer ring of rod seal (5-50) must be facing into the end cap recess.**
- 11.21 Apply lubricant to rod bushing (2-200) and install it up into the pneumatic cylinder outer end cap (2-30).
- 11.22 Install the rod seal (5-50), lip first, into the recess provided in the hydraulic cylinder inner end cap (2-180). **CAUTION: The energizer ring of rod seal (5-50) must be facing into the end cap recess.**
- 11.23 Install end cap o-ring seal (5-80) onto the inner end cap (2-180).
- 11.24 Apply lubricant to the o-ring seal (5-100) and install into the face seal groove in the hydraulic cylinder inner end cap (2-180).

CAUTION: USE HYDRAULIC FLUID AS THE LUBRICANT FOR STEPS 11.25 THROUGH 11.36

- 11.25 Lubricate two tie bar o-ring seals (5-10) with hydraulic fluid and install into the hydraulic cylinder inner end cap (2-180).
- 11.26 Slide the hydraulic cylinder inner end cap (2-180) over the tie bars (2-60), piston rod (2-70) and rod bushing (2-200). **NOTE: The pressure inlet port should be installed in the position recorded in section 5. CAUTION: Do not damage the o-ring when installing the inner end cap (2-180).**
- 11.27 Coat the outboard end grooves on the piston rod (2-70) with hydraulic fluid. Install two (2) halves of one matched set of split rings (2-80) into the inner most groove in the piston rod and retain with retaining ring (2-90).
- 11.28 Install o-ring seal (5-20) onto the o-ring groove in the piston rod (2-70).
- 11.29 Lubricate two o-ring seals (5-10) with hydraulic fluid and install into the tie bar bores of piston (2-170).
- 11.30 Install piston (2-170) onto piston rod (2-70) and up against the split ring installed in step 11.27.
- 11.31 Install final set of matched split rings (2-80) and ring retainer (2-90) onto the piston rod (2-70).
- 11.32 Install the piston T-seal (5-90) into the outer diameter groove on the piston (2-170). Refer to section 9 for T-seal installation instructions.
- 11.33 Apply hydraulic fluid to the bore of the cylinder (2-160).
- 11.34 Slide cylinder (2-160) over piston (2-170) and onto the inner end cap (2-180). Cylinder will have to be tilted approximately 15° to 30° across piston to facilitate installation. 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.

- 11.35 Install two end cap tie bar o-ring seals (5-10) into the hydraulic cylinder outer end cap (2-190).
- 11.36 Install the hydraulic cylinder outer end cap o-ring seal (5-80) onto the hydraulic cylinder outer end cap (2-190).
- 11.37 Install the hydraulic cylinder outer end cap (2-190) onto the tie bars and into the end of hydraulic cylinder (2-160).
- 11.38 Install the tie bar nuts (2-100) with thread seals (5-60) and countersunk washer (5-70) onto the tie bars (2-60). Torque tie bar nut to 150 ± 15 foot pounds.

CAUTION: WHILE TIE BAR NUTS ARE BEING TIGHTENED, DO NOT ALLOW THE TIE BARS TO TURN.

- 11.39 If removed, install stop screw (2-110) onto outer end cap (2-190). **NOTE: The tie bar nuts will require the flats to be positioned to allow the stop screw nut to be installed.**

12.0 SPRING CARTRIDGE INSTALLATION

- 12.1 Prepare the mounting surface of the adapter plate (3-20), inboard end of spring cartridge (3-10) and spring cartridge side of the housing (1-10) per master gasket instructions (reference note 4 on assembly drawing).
- 12.2 Install the o-ring seal (4-40) into the adapter plate (3-20).
- 12.3 Install the adapter plate (3-20) and retain with socket cap screws (3-30).
- 12.4 Make sure that the stop screw (2-110) has not been screwed into the point that "pre-load" will be created on the spring cartridge.
- 12.5 Remove the tie bar nuts on outboard end of the spring cartridge and install new thread seals (6-10) and countersunk washers (6-20).
- 12.6 Re-install the tie bar nuts onto the tie bars.
- 12.7 Install the o-ring seal (6-30) over the face seal groove of spring cartridge inner end cap o-ring groove.
- 12.8 If installed remove the safety nuts from the inboard end of the spring cartridge.
- 12.9 Bring the spring cartridge up to the housing and insert the pull rod through the housing and then engage the pull rod into the yoke pin nut. The pull rod can be rotated by going through the spring cartridge stop screw hole (in the outboard end of the cartridge) with a 1/2 inch square drive extension. **CAUTION: While installing the pull rod do not allow the spring cartridge tie bars to be pushed back into the cartridge.**
- 12.10 Insert the tie bars into the tapped holes in the housing (1-10). **CAUTION: Screw the SR tie bars into the housing (1-10) and tighten each tie bar until the threads bottom out, then back out one quarter-turn.**
- 12.11 Use the spring cartridge tie bar nuts to draw the spring cartridge firmly against the adapter plate (3-20). **NOTE: While the nuts are being tightened, do not allow the tie bars to turn.** Torque alternately, in 50 ft. lb. increments, until a final torque of 150 ± 15 foot pounds has been achieved.

12.12 Install the hex head screws (3-40) through the adapter plate (3-20) and into the spring cartridge end plate.

12.13 Install the SR stop screw.

13.0 **HOUSING COVER INSTALLATION**

13.1 Apply lubricant to the upper yoke bushing (1-40).

13.2 Install the remaining o-ring seals (4-10) and (4-20) into the upper yoke bushing (1-40).

13.3 Install the upper yoke bushing (1-40) into the housing cover (1-130).

13.4 Install the remaining segmented retaining rings (1-50) into the upper yoke bushing and retain with socket cap screws (1-60).

13.5 Remove all housing cover screws (1-150) and replace the gasket seals (4-50) with new seals.

13.6 Prepare the mounting surfaces of the housing cover (1-130) and the housing (1-10) per master gasket instructions (reference note 4 on the assembly drawing).

13.7 Install the housing cover gasket (4-30) onto the housing (1-10).

13.8 Install the housing cover (1-130) onto the housing (1-10).

13.9 Install the housing cover screws (1-150), with the new gasket seals (4-50), back into the housing cover. Tighten all cover screws but the eight cover screws that have hex nuts (1-240).

13.10 Tighten the eight hex nuts (1-240).

13.11 Position the position indicator drive assembly (1-260) onto the top of yoke (1-30) with the slot positioned over hole that was marked in section 8. Secure with the set screw (1-250).

13.12 Install the o-ring seal (4-80) over the position indicator drive assembly shaft and down against the flat cover plate.

13.13 Install the o-ring seal (4-70) into the bottom seal groove inside the position indicator cover (1-270).

13.14 Install the wiper ring (4-60) into the top groove inside the position indicator cover (1-270).

13.15 Install the o-ring seal (4-90) into the bottom seal groove on the bottom of the position indicator cover (1-270).

13.16 Install the position indicator cover (1-270), being careful not to damage the o-ring seals (4-90), (4-70) and wiper ring (4-60).

13.17 Install new gasket seals (4-100) on to hex head screws (1-280).

13.18 Install and tighten the position indicator cover screws (1-280).

13.19 Install the position indicator pointer (1-290) into the taped hole in the position indicator drive assembly (1-260).

13.20 Adjust stop screw (2-110) and spring cartridge stop screw back to settings recorded in section 5.

14.0 **ACTUATOR TESTING**

- 14.1 Leakage Test - All areas where leakage to atmosphere may occur are to be checked, using a commercial leak testing solution.
- 14.2 Apply NOP pressure, as listed on the actuator name tag, to the pressure port in the inner end cap (2-40) and cycle the actuator five time. If excessive leakage across the pistons is noted, generally a bubble which breaks three seconds or less after starting to form, cycle the actuator five times as this will allow the seals to seek their proper service condition. If excessive leakage across the piston remains, the actuator must be disassembled and the cause of leakage must be determined and corrected.
- 14.3 Apply NOP pressure to the pressure port in the inner end cap (2-40) and allow the actuator to stabilize.
- 14.4 Apply a commercial leak testing solution to the following areas:
 - 14.4.1 Joint between the inner end cap (2-40) and the cylinder (2-10). This checks cylinder to inner end cap o-ring seal.
 - 14.4.2 The breather port hole in the outer end cap (2-30). This checks the inner piston to cylinder (2-10) "T" seal (5-40), the o-ring seals (5-10) and (5-20).
 - 14.4.3 The snubber valve port hole in the housing cover. This checks the o-ring seals (5-10) that seals the tie bars to the inner end cap. Also checks the rod seal (5-50) that seals the piston rod to the inner end cap.
 - 14.4.6 Remove pressure from the pressure inlet port.
- 14.5 If an actuator was disassembled and repaired, the above leakage test must be performed again.
- 14.6 Operational (Functional) Test
 - 14.6.1 This test is used to verify proper function of the actuator and is to be done off of the valve or when the valve stem is not coupled to the actuator yoke.
 - 14.6.2 Adjust the pressure regulator to the NOP pressure.
 - 14.6.3 Apply the above pressure to the actuator pressure inlet ports and allow the actuator to stabilize. The actuator should stroke a full 90° travel.
 - 14.6.4 Any jumpy or jerky operation, not attributed to seal drag or limited flow capacity, must be corrected and above test performed again.
 - 14.6.5 Remove pressure from the pressure inlet ports(s).

15.0 **M7 HYDRAULIC CONTROL PACKAGE INSTALLATION SERVICE**

- 15.1 If removed during disassembly, install bleed valves (2-140) back into each end of the hydraulic control cylinder (2-160). The bleed valves should always be at the top of the cylinder (when the actuator is in it's final mounting position on the device it is operating).
- 15.2 If removed during disassembly, install drain pipe plugs (2-150) back into each end of the hydraulic control cylinder (2-160).

15.3 Re-install the M7 control package (8) on the hydraulic cylinder (4-10).

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

15.4 Hook up piping from the M7 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.

15.5 Refilling of the M7 Hydraulic Control System and actuator cylinder is best accomplished using a pressure pump. If a pressure pump is not available go to step 15.16 for the manual field service refilling procedure.

15.6 Allow the actuator to fully stroke to its fail position.

15.7 Remove the breather from the reservoir.

15.8 Attach the pump discharge line to reservoir breather port.

15.9 Open the two bleed valves located at each end of the hydraulic cylinders.

15.10 Open the M7 block/by-pass valve.

15.11 Slowly pump hydraulic fluid into the reservoir.. Approximately 3 to 5 psi will be required. As the fluid passes through the M7 control module into the cylinder, air will be displaced.

15.12 Close each bleed valve when the air has been displaced and hydraulic fluid appears.

15.13 Remove the pressure pump.

15.14 With the actuator in its "open" position; add fluid to the reservoir so that its level is within approximately 1-1½ inches of full.

15.15 Install the breather.

15.16 Refilling the M7 control system during field service often must be done without the use of a pressure pump. Proceed as follows:

15.17 On hydraulic cylinder on which M7 Control package is piped, the piston must be stroked toward inboard side of the actuator.

15.18 Fill hydraulic cylinder(s) with fluid by removing bleed valves at the top of cylinder.

15.19 Fill the reservoir. Maintain at least 1-1½ inches of fluid within the reservoir at all times.

15.20 Close the by-pass valve.

15.21 Close both speed control valves.

15.22 Open outboard end cylinder bleed valve.

- 15.23 Operate hand pump slowly. Keep handle up for about 4 to 5 seconds before each pressure stroke. This allows time for the pump cylinder to fill in order that full displacement of the pump is utilized. (NOTE: If the pump fails to deliver fluid, open the by-pass valve, rapidly operate the pump 15 to 20 times, close the by-pass valve and continue filling sequence).
- 15.24 Close the outboard end cylinder bleed valve when fluid appears.
- 15.25 Open the inboard end cylinder bleed valve.
- 15.26 Operate the hand pump to fully stroke the actuator. Refill reservoir as required.
- 15.27 Open by-pass valve.
- 15.28 Slightly open the outboard cylinder (right hand) speed control. As the actuator strokes, fluid will be displaced from the greater volume of the outboard cylinder into the lesser volume of the inboard cylinder. Fluid will begin flowing from the inboard end cylinder bleed valve.
- 15.29 Close the inboard end cylinder bleed valve when fluid appears. **NOTE:** If the actuator completes its stroke and fluid does not appear at the inboard end cylinder bleed valve, omit procedure step 15.28 and proceed as follows:
- 15.30 Close the outboard cylinder (right hand) speed control valve.
- 15.31 close the by-pass valve.
- 15.32 Open inboard end cylinder bleed.
- 15.33 Operate hand pump as described to cycle actuator.
- 15.34 Close inboard end cylinder bleed valve when fluid appears. Stop operation of pump. If fluid does not appear, repeat steps 15.24 through 15.30.
- 15.35 Open by-pass valve. Fully open inboard cylinder speed control.
- 15.36 Slowly open outboard speed control.
- 15.37 Stroke the actuator to its open position. Add fluid to reservoir so that level is within approximately 1-1½ inches of full. Install breather. Connect power supply lines and cycle the actuator using available power media. Adjust and lock speed controls. Actuator is in normal service.
- 15.38 **POWER OPERATION CHECK.**
- 15.38.1 Fully open the M7 block/by-pass valve, located on the right hand side of the M7 block.
- 15.38.2 Apply NOP pressure to the power cylinder and cycle the actuator. The actuator should be able to complete a full closed to open stroke in power operation.
- 15.38.3 Remove the pressure from the power cylinder and the actuator should complete an open to full closed position.
- 15.39 **MANUAL OPERATION CHECK.**
- 15.39.1 Manual operation requires that the block/by-pass valve be fully closed.

15.39.2 Operate the hand pump until the actuator strokes from full closed to open. When the actuator is fully stroked against the travel stops, an increased resistance in pumping effort will be noted. Continued operation of the pump simply circulates fluid through a high pressure relief.

15.39.3 Fully open the block/by-pass valve to reverse the actuator rotation or to return to the full closed position or normal power operation position.

16.0 RETURN TO SERVICE

- 16.1 Install breather (11) in the outer end cap (2-30)
- 16.2 If supplied in the service kit, replace the software components of the snubber valve (1-230). If removed, install the snubber valve (1-230) in the housing cover.
- 16.3 Install o-ring seal (5-20) into the stop nut (2-120) and then install the stop nut onto the stop screw (2-110).
- 16.4 Install o-ring seal (6-40) into the spring cartridge stop nut and then install the stop nut onto the SR stop screw.
- 16.5 Tighten both stop nuts securely.
- 16.6 All accessories, including solenoid valves, positioners, pressure switches, etc., should be hooked up and tested for proper operations and replaced, if found defective.
- 16.7 The actuator is ready for return to service.

CHART 1 - WEIGHTS FOR ACTUATORS MODELS

ACTUATOR MODEL	APPROXIMATE WEIGHT (POUNDS) (2)		
	SR1	SR2	SR3
STR1010-SRX	4781	4681	4461
STR1012-SRX	4852	4752	4532
STR1016-SRX	4909	4809	4589
STR1020-SRX	5031	4931	4711
STR1024-SRX	5341	5241	5021
STR1028-SRX	5900	5800	5580

- 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	March 12, 1993	A	COMPILED	BC	12 March 1993
			CHECKED	BJ	12 March 1993
			APPROVED	RMM	12 March 1993

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