

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR THE FOLLOWING MODEL

NT4XX-SRX(CW)-M7-S

SPRING RETURN

NUCLEAR ACTUATOR

PART NUMBER: 124909

REVISION: "A"

DATE: December, 1997

1.0 INTRODUCTION

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis, NT4XX-SR(CW)-M7-S Spring Return Series Pneumatic Actuators. When the model number has "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

1.2 In order to assure and maintain the present level of qualification and auditable to the Bettis Qualification Test Report Part Number 037274 the following is required:

1.2.1 All maintenance or service work must be performed by a certified technician. A Certified Technician is a person who has successfully completed the manufacture's prescribed course and demonstrated the ability to supervise and/or perform applicable specified product related procedures.

1.2.2 Maintain a service interval of six hundred twenty-five cycles or five years which ever occurs first.

1.3 BASIC SERVICE INFORMATION:

WARNING: Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.

1.3.1 This procedure is written with the understanding that the actuator has been removed from the valve, the air or power gas has been removed from the power cylinders and all piping and accessories mounted on the actuator have been removed.

1.3.2 Bettis does not recommend periodic field maintenance for the M7 module and pump. The **only** time the M7 module and pump should be disassembled is when either one fails to perform its override function. If maintenance is required and when possible the M7 package should be returned to the factory for maintenance.

1.4 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

- 1.5 **SAFETY** 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, 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.

WARNING: This procedure should not supersede or replace any customers plant safety or work procedures. If a conflict arises between this procedure and the customers procedures the differences should be resolved in writing between an authorized customers representative and a authorized Bettis representative.

2.0 **SUPPORT ITEMS AND TOOLS**

- 2.1 **Support Items** - Service Kit, commercial leak testing solution, and non-hardening thread sealant.
- 2.2 **Tools** - All tools are American Standard inch. Two each medium standard screwdriver, small standard screwdriver with corners rounded, putty knife, razor sharp cutting instrument, rubber or leather mallet and a torque wrench (up to 5,000 inch pounds.). For recommended tool style and size chart refer to last page of this procedure.

3.0 **BETTIS REFERENCE MATERIALS**

- 3.1 NT4XX-SRX(CCW)-M7 Assembly Drawing part number 108153 pages 1 of 2 and 2 of 2.

4.0 **GENERAL**

- 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 This procedure is written using the stop screw side of housing (1-10) as a reference and this side will be considered the front of the actuator. Housing cover (1-20) will be considered as 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 standard screwdriver with the sharp edges 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 When possible the disassembly of actuator must be done in a clean area on a work bench.
- 4.8 LUBRICATION REQUIREMENTS: Dow Corning Molykote 44, medium grade (Refer to Bettis Qualification Test Report Part Number 037274 Appendix "D").

CAUTION: Lubricants other than the lubricant qualified in the latest revision of the Bettis Nuclear Qualification Test Report Part Number 037274 cannot be used without prior written approval of Bettis Product Engineering.

- 4.8.1 The actuator should require approximately 16 ounces of lubricant. Excess lubricant in the actuator is not a problem with the exception listed in step 4.8.2.
 - 4.8.2 The actuator cylinder bore is the only critical area where over lubrication can cause a problem. Refer to step 11.15 for proper cylinder bore lubrication.
- 4.9 FLUID REQUIREMENTS: Dexron II Automatic Transmission fluid.
 - 4.9.1 The M7 pump reservoir will require approximately .87 quart of fluid.
 - 4.9.2 The actuator hydraulic control cylinder will require approximately 4.0 quarts of fluid.

NOTE: 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 Make sure that the M7 control package "block/by-pass valve", located on the right-hand side of the control package, is fully open.
- 5.2 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 fail position.
- 5.3 Drain the hydraulic fluid from the hydraulic cylinder (2-40) using the pipe plugs (2-230) and bleed valves (2-240).
- 5.5 Measure the exposed length of right and left stop screws (1-60) and record each before loosening for removal. Mark the stop screws for later identification.
- 5.6 Mark and record the location of hydraulic inlet ports on the hydraulic cylinder outer end cap (2-70) and the inner end cap (2-60).
- 5.7 Remove the socket cap screws (1-180) from position indicator (1-170) yoke weather cover (3-130) and remove position indicator/yoke weather cover.
- 5.8 Remove the snubber (1-190) from the top of housing cover (1-20).

6.0 SPRING CYLINDER REMOVAL

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

ACTUATOR SERIES	APPROXIMATE SR CARTRIDGE WEIGHT (POUNDS)			
	SR2	SR3	SR4	SR5
T4XX-SR-M7	334	343	234	134

CAUTION: When spring cartridge is installed on the actuator the spring is under compression. Do not remove spring cartridge until actuator has "pre-load" removed.

- 6.1 Remove spring cartridge "pre-load" as follows: Apply sufficient operating pressure to the cylinder pressure inlet port, located in outer end cap (2-30), to move the actuator yoke (1-160) off of stop screw (1-60).
- 6.2 Locate stop screw (1-60) that is on the opposite side of the housing from spring cartridge (4-10). Loosen jam nut (1-120).
- 6.3 Unscrew stop screw (1-60) until it runs into inner end cap (2-40).
- 6.4 Remove pressure from pressure inlet port and allow spring to return actuator to the spring extended position (fail position).
- 6.5 Remove socket head screw (4-60), lockwasher (4-50) and nut retainer (4-40) from the outboard end of spring cartridge assembly (4-10).

NOTE: The actuator spring cartridge is equipped with a brace plate (4-80) that bolts to the actuator housing (1-10). There are four brace extension rods (4-90) that connect between the brace support lug (on the spring cartridge band) and brace plate (4-80).

- 6.6 The four hex nuts (4-100) located on the inboard side (next to housing) of the brace plate (4-80), must be removed before proceeding to the next step. The remaining hex nuts (4-100) can remain on brace rods (4-90).
- 6.7 Alternately loosen the two large hex nuts on the outboard end of the spring cartridge (4-10). These nuts are welded to the tie bars that extend through the spring cartridge and screw into the brace plate (4-80). Unscrew the tie bars until the spring cartridge is free from the brace plate. Care should be taken so that the tie bars are not pulled back into the spring cartridge.

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. Face the spring cartridge to one side.

7.0 PNEUMATIC AND HYDRAULIC CONTROL CYLINDER DISASSEMBLY

- 7.1 Remove breather (4-30) from inner end cap (2-30).
- 7.2 Unscrew and remove socket head cap screw (2-160), lockwasher (2-150), and nut retainer (2-140) from the outer end cap (2-70) of hydraulic cylinder (2-40).
- 7.3 Remove heavy hex nuts (2-130) from tie bars (2-100).
- 7.4 Remove outer end cap (2-70). The fit between the hydraulic cylinder (2-40) and the outer end cap is very tight. Break the outer end cap free by tapping with a breaker bar on the lip provided on the end cap. Do not damage o-ring groove on end cap.
- 7.5 Pry inner end cap (2-60) away from the pneumatic cylinder end cap (2-30). Break the inner end cap free from the cylinder (2-40) by tapping with a breaker bar on the lip provided on the end cap.
- 7.6 Remove the cylinder (2-40). When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod.
- 7.7 Remove the o-ring seals (5-30) from the outer end of the tie bars (2-100).
- 7.8 Remove the piston (2-50) and the floating piston rod (2-180). The piston and piston rod will slide out of the actuator and from between the tie bars (2-100).
- 7.9 Remove the split ring retainer (2-120) and the split ring (2-110) from the outboard side of the hydraulic piston (2-50).

CAUTION: Keep the split rings in matched sets.

- 7.10 Remove the piston (2-50) from the piston rod (2-180). The piston will slide off of the piston rod.
- 7.11 Remove the remaining split ring retainer (2-120) and the split ring (2-110) from the floating piston rod (2-180).

CAUTION: Keep the split rings in matched sets.

- 7.12 Slide the inner end cap (2-60) off the tie bars (2-100).
- 7.13 Remove rod bushing (2-90) from the outboard inner end cap (2-30).
- 7.14 Remove the outboard inner 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.
- 7.15 Pry inboard inner end cap (2-30) away from 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.
- 7.16 Remove the cylinder (2-10). When sliding the cylinder off of the piston, tilt the cylinder 15° to 30° degrees to the piston rod.

- 7.17 Unscrew tie bars (2-100) from housing (1-10). Flats are provided on the outboard end of the tie bars for wrench placement. Pull the tie bars out of the housing and inner end cap far enough to expose the o-ring seals (3-30).

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

- 7.18 Remove the o-ring seals (3-30) from the inboard end of tie bars (2-100). Then remove the tie bars (2-100) by pulling the tie bars out and through the piston (2-20).

- 7.19 Remove the split ring retainer (2-120) and the split ring (2-110) from the outboard side of the piston (2-20).

CAUTION: Keep the split rings in matched sets.

- 7.20 Remove the piston (2-20) from the piston rod (2-170). The piston will slide off of the piston rod (2-170).

- 7.21 Remove o-ring seal (3-40) from piston rod (2-170).

- 7.22 Remove split ring retainer (2-120) and split ring (2-110) from piston rod (2-170).

CAUTION: Keep the split rings in matched sets.

- 7.23 Slide inner end cap (2-30) off piston rod (2-170).

8.0 HOUSING GROUP DISASSEMBLY

CAUTION: To maintain qualification of the actuator the housing assembly must be disassembled and refurbished with new seals and lubricant per requirements stated in Section 1.0 step 1.2.2.

- 8.1 Unscrew push rod (4-20) from yoke pin nut (1-30) and remove from housing (1-10).

- 8.2 Unscrew and remove piston rod (2-170) from yoke pin nut (1-30). NOTE: Flats are provided on the outboard end of the piston rod for wrench placement. DO NOT use a pipe wrench on the piston rod as it will mark the rod and cause seal leakage.

- 8.3 Remove rod bushing (2-80). The rod bushing will slide off of the end of piston rod (2-170).

- 8.4 Remove cover screws (1-90) and gasket seals (3-100).

- 8.5 Remove housing cover (1-20) from housing (1-10). NOTE: This piece will have a very tight fit and the cover pins (1-130) will normally stay in the cover. It is not necessary to remove the cover pins from the cover.

- 8.6 Remove the top two yoke rollers (1-50) from the top of the yoke pin nut (1-30).

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

- 8.8 Remove yoke pin nut (1-30) from in between the arms of yoke (1-160).

- 8.9 Remove bottom two yoke rollers (1-50) from the bottom area of housing (1-10).
- 8.10 The yoke (1-160) can now be removed by lifting it from the housing (1-10).
- 8.11 Remove the remaining stop screw (1-60), jam nut (1-120), and seal gasket (3-110). Be sure to mark or identify this stop screw.
- 8.12 It is not necessary to remove the drain pipe plug (1-80) or the two grease fittings (1-70) to service the actuator.
- 8.13 Remove brace plate (4-80) by removing socket cap screws (1-220) from the brace plate.

9.0 GENERAL REASSEMBLY

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

- 9.1 Taking care not to scratch or damage seal grooves, 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. 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 or flaking coating.
- 9.4 Coat all moving parts with a complete film of lubricant. The parts used in the actuator housing assembly, power cylinder and spring cartridge will be assembled using lubricant as identified in step 4.8. The parts used in the hydraulic cylinder assembly will be assembled using the hydraulic fluid identified in step 4.9.
- 9.5 Coat all seals with a complete film of lubricant, before installing into seal grooves. The seal used in the actuator housing assembly, power cylinder and spring cartridge will be assembled using lubricant as identified in step 4.8. The seals used in the hydraulic cylinder assembly will be assembled using the hydraulic fluid identified in step 4.9.

WARNING: The actuator will contain two different seal compounds, Viton (VIT) and Ethylene Propylene (EP). When installing the seals close attention will need to be observed to NOT install the Viton seals in the wrong seal location. All viton seals contained in the Service kits will have a color code. The color code for viton seal compound is a color of continuous Brown or Black with one Red dot. EP seals have individual seal packs or coded with one yellow dot.

- 9.6 In each reassembly step the seal compound will be identified as EP (Ethylene Propylene seal compound) or VIT (Viton seal compound).

10.0 CENTER HOUSING GROUP RE-ASSEMBLY

- 10.1 If removed, install drain plug (1-80) in the actuator housing (1-10).
- 10.2 If removed, install one grease fitting (1-70) into housing (1-10) and on into housing cover (1-20). The fitting in the housing is located on the bottom of the housing, next to the lower yoke bearing area. The fitting in the housing cover is located on top of the cover in the upper yoke bearing area.
- 10.3 Lubricate one EP o-ring seal (3-50) and install it into the bottom area of housing (1-10).
- 10.4 Inside 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 lower bearing surface of the yoke (1-160) and install into the housing (1-10) as follows:
 - 10.5.1 Position the yoke arm to approximately a 45⁰ degree position in either direction and lower into the housing. The hub with tapped holes faces up.
 - 10.5.2 Rotate the yoke back to approximately the mid-stroke (center of housing) position.
- 10.6 Apply lubricant to the slots in the upper and lower yoke arms of yoke (1-160).
- 10.7 Apply lubricant to all surfaces of all four yoke rollers.
- 10.8 Place one yoke roller (1-50) in the track in the bottom of the housing and position it under the slot in the yoke arms.
- 10.9 Place a second yoke roller on top of the first yoke roller in the slot in the lower yoke arm and align the holes in the yoke rollers.
- 10.10 Coat the upper and lower surfaces of the yoke pin nut (1-30) with lubricant and insert into position between the yoke arm, parallel to the track in the housing. Align the yoke pin hole with the yoke rollers.
- 10.11 Lubricate yoke pin (1-40), insert through yoke pin nut (1-30) and the two yoke rollers (1-50).
- 10.12 Install the third yoke roller over the yoke pin in the slot of the upper yoke arm.
- 10.13 Install the fourth yoke roller over the top of the yoke pin. NOTE: The fourth yoke roller will remain above the yoke arm and will engage the cover track when cover is installed.
- 10.14 Lubricate piston rod (2-170) and install into the proper side of housing (as shown on the assembly drawing referenced in step 3.1) and screw into yoke pin nut (1-30). DO NOT TIGHTEN. Flats are provided on the outboard end of the piston rod.
- 10.15 Apply lubricant to rod bushing (2-80), install it over the piston rod and slide it up into the end of housing (1-10).

- 10.16 Lubricate push rod (4-20) and install it into the side of housing and screw into yoke pin nut (1-30).
 - 10.17 Tighten push rod (4-20) with a strap wrench.
 - 10.18 Place gasket seals (3-110) with am nuts (1-120) onto stop screws (1-60).
 - 11.19 Install assembled stop screws into the front of housing (1-10), making sure the stop screw marked "left" is installed into the left stop screw hole.
 - 10.20 Place cover gasket (3-20) onto the top of housing (1-10).
 - 10.21 Lubricate the remaining yoke EP o-ring seal (3-50) and install into housing cover (1-20).
 - 10.22 Apply lubricant to the yoke bore and the track in housing cover (1-20).
 - 10.23 Apply lubricant to the yoke upper bearing surface.
 - 10.24 Install housing cover (1-20), being careful not to damage gasket (3-20) or yoke o-ring (3-50).
 - 10.25 Install seal gasket (3-100) onto hex head screws (1-30).
 - 10.26 Install and leave finger tight cover screws (1-90) with seal gasket (3-100).
 - 10.27 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 cover (1-20) and into housing (1-10) until the pin is flush with the cover.
- NOTE: The pins are deeply grooved at one end, tapering to a smooth diameter at the other end. The pin should be installed smooth end first.
- 10.28 Torque tighten cover screws (1-90) to a lubricated torque to 12 foot pounds.
- NOTE: Flats are provided on the outer end for wrenching purposes. Do not use a pipe wrench or similar tool to tighten piston rod.
- 10.29 Torque tighten piston rod (2-170) to a lubricated torque of 150 \pm 7 foot pounds.
 - 10.30 Rotate the yoke to the full clockwise (CW) position (as shown on the clockwise assembly drawings) position the yoke weather cover (3-130)/position indicator (1-170) on the yoke with the pointer facing the front and perpendicular to the piston rod (2-170).
 - 10.31 Install socket head cap screws (1-180) through position indicator (1-170), weather cover (3-130) and into the top of yoke (1-160).

11.0 PRESSURE CYLINDER RE-ASSEMBLY

- 11.1 Install one gasket (3-10) over piston rod (2-170) and rod bushing (2-80) and up against the end of housing housing (1-10).

- 11.2 Coat EP rod seal (3-70) with lubricant and install, lip first, into the recess provided in the inboard inner end cap (2-30).
- 11.3 Install inner end cap (2-30) over piston rod (2-170), rod bushing (2-80) and up against the end of housing (1-10). Install end cap with the large raised boss toward the housing end (flat side outward). The pressure inlet port should be toward the top of the actuator. Align the tie bar holes with holes in housing.
- 11.4 Install EP o-ring seal (3-60) onto the outer diameter of the inboard inner end cap (2-30).
- 11.5 Install two sets of piston tie bar EP T-seal components (3-80) into the piston internal seal groove as follows.
- NOTE: The T-seal is composed of one rubber seal and two split skive-cut back-up rings.
- 11.5.1 Apply lubricant to two sets of piston tie bar T-seal components (3-80).
- 11.5.2 Install the T-seals into piston (2-20) internal seal grooves.
- 11.5.3 Install a back-up ring on each side of the T-seal.
- 11.5.4 When installing the back-up rings, do not align the skive-cuts.
- 11.6 Coat the end of piston rod (2-170) with lubricant.
- 11.7 Install EP o-ring seal (3-40) onto piston rod (2-170).
- 11.8 Install a matched set of split rings (2-110) into the inner most groove in the piston rod and retain with one of the retaining rings (2-120).
- 11.9 Install piston (2-20) onto piston rod (2-170) against split ring set (2-110).
- 11.10 Install a matched set of split rings (2-110) onto the piston rod and retain with a retaining ring (2-120).
- 11.11 Install piston EP T-seal components (3-90) into the piston external seal groove as follows:
- NOTE: T-seal (3-90) is composed of one rubber seal and two split skive-cut back-up rings. If the skive-cut 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. When trimming back-up rings leave no more than 1/8" inch gap.
- 11.11.1 Install the EP T-seal into the seal groove.
- 11.11.2 Install a back-up ring on each side of the T-seal.
- 11.11.3 When installing the back-up rings, do not align the skive-cuts.
- 11.12 Apply lubricant to the threads and end of the tie bars (2-100), end without wrench flat, and install by carefully pushing tie bars through the piston (2-20).

- 11.13 Install two tie bar EP o-ring seals (3-30) into the seal grooves located on the inboard end of tie bars (2-100).
- 11.14 Insert the tie bars through the inboard inner end cap (2-30) and screw into housing (1-10). Tighten the tie bars until the threads bottom out, then back out each tie bar one half-turn.

CAUTION: Excess lubricant in the cylinder bore may cause erratic or jumpy/jerky operation.

- 11.15 Apply a very light film of lubricant to the entire bore of the cylinder (2-10). After the entire bore of the cylinder has a light film of lubricant wipe away any excess amounts of the lubricant.

CAUTION: If needed when installing cylinder (2-10), hammer on end of cylinder only with a non metallic object.

CAUTION: Make certain back-up rings, components of piston T-seal (3-90), are seated into piston external seal groove. Should back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

- 11.16 Install the lubricated cylinder (2-10) over piston (2-20) and onto the inboard inner end cap (2-30). NOTE: When installing cylinder over the piston tilt cylinder 15° to 30° degrees to piston rod.
- 11.17 Install two end cap tie bar EP o-ring seals (3-30) into the seal grooves located in the middle of tie bars (2-100).
- 11.18 Install end cap EP o-ring seal (3-60) onto the outboard inner end cap (2-30).
- 11.19 Install the outboard inner end cap (2-30) onto the tie bars and into the end of cylinder (2-10). Install with the raised boss away from the cylinder. NOTE: The breather port should be toward the top of the actuator.
- 11.20 Install the second EP rod seal (3-70), lip first, into the recess provided in the second inner end cap (2-30).

CAUTION: The energizer ring of EP rod seal (3-70) must be facing into the end cap recess.

- 11.21 Apply lubricant to rod bushing (2-90) and install it up into the second inner end cap (2-30).
- 11.22 Install floating piston rod (2-180) as follows: Carefully push floating piston rod into the inner end cap (2-60) and through the EP rod seal and continue to push the floating piston rod until it contacts the pneumatic piston rod (2-170).
- 11.23 Install gasket (5-100) over tie bars (2-100), over exposed rod bushing (2-90) and up against the second inner end cap (2-30).

12.0 HYDRAULIC CONTROL CYLINDER REASSEMBLY

- 12.1 Install VIT rod seal (5-70), lip first, into the recess provided in the hydraulic cylinder inner end cap (2-60).

CAUTION: The energizer ring of VIT rod seal (5-70) must be facing into the end cap recess.

- 12.2 Install two tie bar VIT o-ring seals (5-30) into inner end cap (2-60).
- 12.3 Install inner end cap (2-60) over tie bars (2-100) and rod bushing (2-90) and up against the outboard inner end cap(2-30). The pressure inlet port should be installed in the position recorded in step 5.6.
- 12.4 Install VIT o-ring seal (5-60) onto inner end cap (2-60).
- 12.5 Apply hydraulic fluid to the exposed length of floating piston rod (2-180).
- 12.6 Install two sets of VIT rod T-seals (5-80) into two tie bar holes in piston (2-50).
- 12.7 Install a matched set of split rings (2-110) into the inner-most groove in the floating piston rod (2-180) and retain with one of the split ring retainers (2-120), retaining ring groove away from the piston.
- 12.8 Coat the end of floating piston rod (2-180) with hydraulic fluid.
- 12.9 Install VIT o-ring (5-40) onto floating piston rod (2-180).
- 12.10 Install piston (2-50) onto the floating piston rod against split ring set (2-110).
- 12.11 Install the remaining matched set of split rings (2-110) onto the floating piston rod and retain with split ring retainer (2-120).
- 12.12 Install VIT piston T seal components (5-90) into the external groove of piston (2-50) as follows:

NOTE: VIT T-seal (5-90) is composed of one rubber seal and two split skive-cut back-up rings. If the skive-cut 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. When trimming back-up rings leave no more than 1/8" inch gap.

- 12.12.1 Install the EP T-seal into the seal groove.
- 12.12.2 Install a back-up ring on each side of the T-seal.
- 12.12.3 When installing the back-up rings, do not align the skive-cuts.
- 12.13 Apply hydraulic fluid to the exposed areas of the tie bars (2-100).
- 12.14 Apply a coat of hydraulic fluid to the bore of the cylinder (2-40).

CAUTION: If needed when installing cylinder (2-40), hammer on end of cylinder only with a non metallic object.

CAUTION: Make certain back-up rings, components of piston T-seal (5-90), are seated into piston external seal groove. Should back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

12.15 Install lubricated cylinder (2-40) over piston (2-50) and onto inner end cap (2-60). When installing the cylinder over the piston, tilt cylinder 15^o to 30^o degrees to the piston rod.

12.16 Install the remaining VIT o-ring seal (5-60) onto outer end cap (2-70).

12.17 Install two end cap tie bar VIT o-ring seals (5-30) into the seal grooves located on the outboard end of the tie bars (2-100).

12.18 Install the outer end cap (2-70) onto the tie bars (2-100) and into the end of the cylinder (2-40). NOTE: The pressure inlet port should be installed in the position recorded in step 5.6.

CAUTION: Do not allow the tie bars turn when turning the tie bar nuts.

12.19 Install two tie bar nuts (2-130) onto tie bars (2-100), using them to draw all of the cylinder components into position.

12.20 Torque alternately, in 50 foot pounds. increments until a final torque of 65 ±7 foot pounds lubricated has been achieved.

12.21 Install nut retainer (2-140), securing in place with retainer screw (2-160) and lockwasher (2-150). It is necessary that the flats on the hex nuts (2-130) be aligned and parallel before the nut retainer can be installed. It is permissible to exceed the 65 foot pound figure to align the hex nut flats.

12.22 Apply 10 psig air pressure to the breather port in the inner end cap (2-30) and stroke the actuator. Remove the air pressure from the breather port.

12.23 Install both pipe plugs (2-230) and bleed valves (2-240) into cylinder (2-40).

13.0 SPRING CARTRIDGE INSTALLATION

CAUTION: Make sure that the stop screws (1-60) have not been screwed in to the point that "pre-load" will be created on the spring cartridge.

13.1 Install end cap gasket (3-10) over push rod (4-20).

13.2 Install brace plate (4-80) with socket cap screws (1-220) to housing (1-10).

13.3 Torque tighten socket cap screws (1-220) to 100 to 120 foot pounds.

13.4 Install the SR end cap gasket (3-10) over push rod (4-20) and up against brace plate (4-80).

- 13.5 Remove the nuts (installed in step 6.6) from the spring return cartridge.
 - 13.6 Engage spring return cartridge (4-10) onto the push rod (4-20)
 - 13.6.1 Align the spring cartridge tie bars with the holes in the brace plate (4-80).
 - 13.6.2 Align the brace extension rods with the holes in the brace plate (4-80).
 - 13.7 Screw the spring cartridge tie bars into the brace plate (4-80). Alternately tighten the spring cartridge tie bar nuts until the spring cartridge is firmly against brace plate (4-80).
 - 13.8 Torque tighten the spring cartridge tie bars to 65 ± 7 foot pounds lubricated.
- NOTE: It is necessary that the flats on the spring cartridge hex nuts be aligned and parallel before the nut retainer can be installed. It is permissible to exceed the 65 foot pound figure to align the hex nut flats.
- 13.9 Install nut retainer (4-40), securing in place with socket cap screw (4-60) with washer (4-50).
 - 13.10 Install the four hex nuts (4-100), removed in step 6.6, onto the brace extension rods (4-90) on the inboard side of brace plate (4-80).
 - 13.11 Install stop screws (1-60), stop screw gasket seals (3-110), and stop screw jam nuts (1-120).

14.0 ACTUATOR TESTING

- 14.1 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.
- 14.2 All leak testing will use the nominal operating pressure (NOP) 45 psig pressure also listed on the actuator name tag.
- 14.3 Before testing for leaks, alternately apply and release NOP, 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.
- 14.4 Apply NOP to the pressure inlet port in the outboard inner end cap (2-30) of cylinder (2-10).
- 14.5 Apply a leak testing solution to the following areas:
 - 14.5.1 The breather port in the inboard inner end cap (2-30), checks piston to cylinder and piston to piston rod seals.
 - 14.5.2 Joint between the outboard inner end cap (2-30) and the cylinder (2-10). Checks cylinder to end cap o-ring seals.
 - 14.5.3 The pressure port in the hydraulic cylinder (2-40), checks the piston rod seals (3-70), (5-70) and end cap o-ring seals (3-30), (5-30).

14.6 Remove the pressure from pressure inlet port in the outboard inner end cap (2-30).

- 14.7 Apply NOP to the pressure port in the inner end cap (2-60) of cylinder (2-40).
- 14.8 Apply a leak testing solution to the joint between the inner end cap (2-60) and the cylinder (2-40). Checks cylinder to end cap o-ring seals.
- 14.9 Remove the pressure from the inlet port in the inner end cap (2-60).
- 14.10 Apply NOP to the pressure inlet port in the outer end cap (2-70) of cylinder (2-40).
- 14.11 Apply a leak testing solution to the following areas:
 - 14.11.1 The pressure inlet port in the outer end cap (2-70), checks piston to cylinder and piston to piston rod seals.
 - 14.11.2 Around the tie bar nuts on the cylinder end cap (2-70). Checks tie bars to end cap o-ring seals.
 - 14.11.3 Joint between the outer end cap (2-70) and the cylinder (2-40). Checks cylinder to end cap o-ring seals.
- 14.12 Remove the pressure from the inlet port in the outer end cap (2-70).
- 14.13 If an actuator was disassembled and repaired, the above leakage test must be performed again.
- 14.14 Operation test the actuator to verify proper function of the actuator. This test is to be done off of the valve.
- 14.15 Adjust the pressure regulator to 29 PSIG pressure.
- 14.16 Apply the above pressure to the actuator power cylinder inlet ports and allow the actuator to stabilize. The actuator should stroke a full 90° travel.
- 14.17 Any jumpy or jerky operation, not attributed to seal drag or limited flow capacity, must be corrected and the above test performed again.
- 14.18 Remove pressure from the inlet port(s).

15.0 M7 SYSTEM SERVICE

- 15.1 Refilling of the M7 control system and actuator cylinder is accomplished using a pressure pump.
- 15.2 Allow the actuator to fully stroke to its fail position.
- 15.3 Remove the breather from the reservoir.
- 15.4 Attach the pump discharge line to reservoir breather port.
- 15.5 Open the two bleed valves located at each end of the hydraulic cylinders.
- 15.6 Open the M7 block/by-pass valve.

- 15.7 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.
- 15.8 Close each bleed valve when the air has been displaced and hydraulic fluid appears.
- 15.9 Remove the pressure pump.
- 15.10 With the actuator in its "fail" position; add fluid to the reservoir so that its level is within approximately 1-1½ inches of full.
- 15.11 Install the breather.
- 15.12 **POWER OPERATION CHECK.**
 - 15.12.1 Fully open the M7 block/by-pass valve, located on the right hand side of the M7 block.
 - 15.12.2 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.
 - 15.12.3 Remove the pressure from the power cylinder and the actuator should complete an open to full closed position.
- 15.13 **MANUAL OPERATION CHECK.**
 - 15.13.1 Manual operation requires that the block/by-pass valve be fully closed.
 - 15.13.2 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.
 - 15.13.3 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 (4-30) in the inner end cap of the cylinder (2-10). A new breather is provided in the service kit. Use this breather if it is the same size or larger NPT than the original.
- 16.2 If supplied in the service kit, replace the software components of the snubber (1-190) and then install the snubber in the housing cover.
- 16.3 Adjust both stop screws (1-60) back to settings recorded in section five under General Disassembly.
- 16.4 Tighten both jam nuts (1-120) securely, while holding stop screws (1-60).

16.5 Actuator is ready to be returned to service.

16.6 After the actuator is installed on the valve all accessories, including solenoid valves, positioners, pressure switches, etc., should be hooked up and tested for proper operations and replaced if found defective.

RECOMMENDED TOOL STYLE, WRENCH SIZES AND TORQUE CHART

ITEM NO.	ITEM QTY.	WRENCH SIZE (INCHES)	DESCRIPTION	RECOMMENDED WRENCH STYLE	TORQUE FT-LB (+/- 5%)
1-60	2	1/2	Stop Screw	Open End or Adjustable	(2)
1-70	2	7/16	Grease Fitting	Open End or Box	(4)
1-80	1	9/16	Pipe Plug	Open End or Adjustable	(4)
1-90	8	1/2	Hex Cap Screw	Socket	8
1-120	2	1-5/16	Hex Jam Nut	Box End (1)	240
1-180	4	3/16	Socket Cap Screw	Allen (1)	4
1-190	1	7/8	Snubber Valve	Deep Socket	(4)
1-220	4	15/16	Hex Cap Screw	Socket	60
2-100	2	1/2	Tie Bar Flats	Open End or Adjustable	(2)
2-130	2	1-13/16	Heavy Hex Nut	Open End or Adjustable	(3)
2-160	1	3/16	Socket Cap Screw	Allen (1)	(4)
2-170	1	1-1/4	Piston Rod Flats	Crows Foot (1)	(3)
2-230	2	9/32	Pipe Plug, Sq. Head	Open End or Adjustable	45
2-240	2	13/32	Bleed Valve	Box End or Open End (1)	8
4-30	1	11/16	Breather	Thin Open End (1)	(2)
4-60	1	3/16	Socket Cap Screw	Allen	4
4-100	16	1-5/16	Standard Hex Nut	Open End or Adjustable	160
-	1	11/16	Remote Package Breather	Thin Open End (1)	12

(1) No alternate style tool recommended.
(2) Not required.
(3) Torque requirements defined in the body of this procedure.
(4) Tight plus 1/4 turn.

ECN	DATE	REV	BY *	DATE
Released	December, 1997	A	COMPILED Bill Cornelius	1 December 1997
			CHECKED Bill Cornelius	1 December 1997
			APPROVED Tom Jeansonne	1 December 1997

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