

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY & REASSEMBLY

FOR MODELS

T8XX-M4

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS WITH

HYDRAULIC CONTROL PACKAGE

PART NUMBER: 074900

REVISION: "A"

RELEASE DATE: September, 1994

REPLACES: Service-029 (SE-029)

1.0 INTRODUCTION

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis T8XX-M4, T8XXB-H, and T8XX-M2 double acting series pneumatic actuators with MX Hydraulic Control Package . When the actuator 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 **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, 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.

1.3 DEFINITIONS:

WARNING: If not observed, user incurs a high risk of severe damage to actuator and/or fatal injury to personnel.

CAUTION: If not observed, user may incur damage to actuator and/or injury to personnel.

NOTE: Advisory and information comments provided to assist maintenance personnel to carry out maintenance procedures.

1.4 **BASIC SERVICE INFORMATION:** Complete actuator refurbishment requires the actuator be 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 M4 Disassembly and Reassembly Instruction. Bettis does not recommend periodic maintenance for the M4 itself. The M4 needs only to be serviced when it malfunctions. Complete M4 refurbishment should be done by Bettis.

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

2.0 SUPPORT ITEMS AND TOOLS

- 2.1 Support Items - Service/Seal Kit, razor sharp cutting instrument, seal removal tool, commercial leak testing solution, 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 inch pounds), breaker bar, 1/4" drift punch and a 1/2" drive socket set. For recommended tool list refer to Chart 2 on page 19.

3.0 REFERENCE BETTIS MATERIALS

- 3.1 Assembly Drawing part number 037104.
- 3.2 Exploded Detail Drawing part number 063582 (included in the Bettis Service/Seal Kit).
- 3.3 Base I standard dimensional drawing part number 042312.

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 parenthesis, (), indicate the bubble number (reference number) used on the Bettis Assembly Drawing, Exploded Detail Drawing, and Actuator Parts List.
- 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 side of the actuator. The housing cover (1-20) will be the top of the actuator.
- 4.4 Refer to Chart number 1, on page 19, for actuator weights.
- 4.5 Mating parts should be marked for ease of reassembly, i.e. left and right stop screws and cylinder to housing.
- 4.6 When removing seals from seal groove, use a commercial seal removing tool or use a small standard screwdriver with the sharp edges rounded off.
- 4.7 Use a non-hardening thread sealant on all pipe threads.

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

- 4.8 Disassembly should be done in a clean area on a work bench.
- 4.9 LUBRICATION REQUIREMENTS: For use in all areas of the actuator except in the M4 Hydraulic Control Package (8) and the hydraulic cylinder (4-10). 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°F to +350°F) use Bettis ESL-5, Kronaplate 100 lubricant. ESL-5 is contained in the Bettis Service/Seal Kit.

4.9.2 Low temperature service (-50°F to +150°F) use Kronaplate 50 lubricant. Kronaplate 50 is not contained in the Low Temperature Service/Seal Kit.

4.10 **FLUID REQUIREMENTS:** For use in the M4 Hydraulic Control Package (8) and the hydraulic cylinder (4-10). Fluids, other than those listed in steps 4.10.1 and 4.10.2, should not be used without prior written approval of Bettis Product Engineering.

4.10.1 Standard and high temperature service (-20°F to +350°F) use Dexron II Automatic Transmission Fluid.

4.10.2 Low temperature service (-50°F to +150°F) use Exxon Univis J13 Hydraulic Fluid.

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

4.11 Before starting the general disassembly of the actuator, it is a good practice to operate the actuator with the pressure used by the customer to operate the actuator during normal operation. 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).

5.2 Mark stop screws (1-60) left and right. The setting of stop screws (1-60) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screws will be removed later in this procedure.

5.3 Remove socket cap screws (1-180) from position indicator (1-170) yoke weather cover (3-130) and remove position indicator/yoke weather cover.

5.4 Unscrew and remove snubber valve (1-190) from housing cover (1-20).

5.5 Drain the hydraulic fluid from Hydraulic Cylinder (4-10) by opening the bleed valves (4-240) and then removing the cylinder drain plugs (4-230). One is located on outboard end of hydraulic cylinder and the other on the inboard end of hydraulic cylinder.

CAUTION: The bleed valves are 1/8 npt and are made out of brass. Use only the correct size wrench. Refer to tool list at the end of this procedure for recommended wrench style and correct wrench size. Do not use pliers or other style adjustable wrench for bleed valve removal or adjustment.

5.6 If the M4 package is remote mounted then disregard the rest of this step. Remove the cylinder mounted M4 Hydraulic Control package (8) from cylinder (4-10) by loosening the nuts/lockwashers on the mounting bracket u-bolts and then slide the M4/bracket assembly off of the end of cylinder (4-10). NOTE: Before removing the hydraulic cylinder mounted M4 package mark and record the package orientation.

CAUTION: Plug the 3/8" NPT ports in the M4 as foreign material may enter the system and cause the package to malfunction.

- 5.7 Mark and record location of the pneumatic inlet ports on cylinder outer end cap (2-30) and inner end cap (2-40).
- 5.8 Mark and record location of the hydraulic inlet ports on cylinder outer end cap (4-30) and inner end cap (4-40).
- 5.9 Mark and record location of bleed valves (2-240) and drain plugs (4-230), in relationship to outer end cap (4-30) and inner end cap (4-40).

6.0 DISASSEMBLY - HYDRAULIC CONTROL PACKAGE CYLINDER

- 6.1 Remove socket cap screw (4-120), lockwasher (4-110) and nut retainer (4-100) from the end of outer end cap (4-30).
- 6.2 Remove hex nuts (4-90) from tie bars (2-60).
- 6.3 Remove outer end cap (4-30). The fit between the cylinder (4-10) and the outer end cap is very tight. Break the outer end cap free by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: During inner (4-40) and outer end cap (4-30) removal do not damage outer diameter o-ring groove.

- 6.4 Pry inner end cap (4-40) away from housing (1-10). Break the inner end cap free from cylinder (4-10) by trapping on the breaker bar on lip provided on the end cap.
- 6.5 Remove cylinder (4-10). When sliding the cylinder off of the piston, tilt cylinder 15° to 30° degrees to piston rod.
- 6.6 Remove split ring retainer (4-80) and split rings (4-70) from the outboard side of the piston. NOTE: Disregard this step and step 6.10 if the actuator has the piston retained in place with a hex nut and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers..

CAUTION: Keep the split rings in matched sets.

- 6.7 Remove piston (4-20) from piston rod (4-170).
- 6.8 Remove o-ring seal (5-40) from piston rod (4-170).
- 6.9 Remove split ring retainer (4-80) and split rings (4-70) from the inboard side of piston (4-20).

CAUTION: Keep the split rings in matched sets.

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

7.0 PNEUMATIC CYLINDER DISASSEMBLY

- 7.1 Remove socket cap screw (2-120), washer (2-110) and nut retainer (2-100) from end of outer end cap (2-30).

- 7.2 Remove hex nuts (2-90) from tie bars (2-60).
- 7.3 Remove outer end cap (2-30). The fit between the cylinder (2-10) and the outer end cap is very tight. NOTE: Break the outer end cap free by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: When separating cylinder (2-10) from outer end cap (2-30) do not damage o-ring seal groove.

- 7.4 Pry inner end cap (2-40) away from housing (1-10). Break the inner end cap free from cylinder (2-10) by tapping with a breaker bar on the lip provided on the end cap.

CAUTION: When separating cylinder (2-10) from inner end cap (2-40) do not damage o-ring seal groove.

- 7.5 Remove cylinder (2-10). NOTE: When sliding cylinder off of piston, tilt cylinder 15° to 30° degrees to the piston rod.
- 7.6 Remove tie bars (2-60) by pulling them out through housing (1-10), inner end cap (2-40) and piston (2-20).
- 7.7 Remove split ring retainer (2-80) and split rings (2-70) from outboard side of piston (2-20). NOTE: Disregard this step and step 7.13 if the actuator has the piston retained in place with a hex nut and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers.

CAUTION: Keep the split rings in matched sets.

- 7.8 Remove piston (2-20) from piston rod (2-170). Refer to step 7.15 for disassembling tie bar bushings (2-180) from pistons with outer diameters of 24" inches and larger.
- 7.9 Remove o-ring seal (3-40) from piston rod (2-170).
- 7.10 Remove split ring retainer (2-80) and split rings (2-70) from inboard side of the piston.

CAUTION: Keep the split rings in matched sets.

- 7.11 Remove inner end cap (2-40) off piston rod (2-170).
- 7.15 Disassembly of pistons with outer diameters of 24" inches and larger. Refer to assembly drawing detail "A".
- 7.15.1 Remove retaining rings (2-190) from the piston.
- 7.15.2 Remove tie bar bushing (2-180) from the piston.

8.0 HOUSING GROUP DISASSEMBLY

- 8.1 Unscrew and remove piston rods (2-170) and (4-170) from yoke pin nut (1-30). Flats are provided on the outboard end of the piston rods for wrench placement. NOTE: Removal of piston rods 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 rods as it will mark the rod and cause seal leakage.

- 8.2 Remove rod bushing (2-50) from the housing or the piston rod.
- 8.3 Remove cover hex cap screws (1-90) and (10-90) with gasket seals (3-100).
- 8.4 Remove housing cover (1-20). NOTE: The cover will have a very tight fit due to cover pins (10-130) and (1-130). It is not necessary to remove cover pins (10-130) and (1-130) from the cover.
- 8.6 Remove top two yoke rollers (1-50) and roller spacers (1-110) from top of yoke pin (1-40).

NOTE: Early model actuators did not use the roller spacer. When replacing rollers refer to section 16 step 16.2 and it's **CAUTION**.

- 8.7 Remove yoke pin (1-40).
- 8.8 Remove yoke pin nut (1-30).
- 8.9 Remove lower two yoke rollers (1-50) and roller spacers (1-110) from the bottom of yoke and housing.

CAUTION: The yoke/housing bearing must be lubricated and inspected to extend service life and prevent degradation of torque output. This can only be accomplished by removing the yoke from the housing which requires removing the actuator from the valve.

NOTE: Step 8.10 is done if housing cover is equipped with a upper yoke bushing (1-140). The addition of upper yoke bushing (1-140) was implemented during the year 1989. All replacement housing covers will be machined to accept a upper yoke bushing (1-140) and will automatically come fitted with a upper yoke bushing (1-140).

- 8.10 Remove yoke bushing (1-140) from the top of yoke (1-160).
- 8.11 The yoke (1-160) can now be removed by lifting it from the housing.

NOTE: Step 8.12 is done if housing is equipped with a lower yoke bushing (1-140). The addition of lower yoke bushing (1-140) was implemented during the year 1989. All replacement housings will be machined to accept a lower yoke bushing (1-140) and will automatically come fitted with a lower yoke bushing (1-140).

- 8.12 Remove yoke bushing (1-140) from the lower housing area.

- 8.13 Remove stop screws (1-60), stop nuts (1-120), and gaskets (3-110).
- 8.14 It is not necessary to remove the pipe plug (1-80) or grease fittings (1-70) to service the actuator. NOTE: Grease fittings are optional as of March, 1983.

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 Coat all moving parts and all seals with a complete film of lubricant. Parts used in the actuator housing assembly and pneumatic cylinder (2-10) will be assembled using lubricant as identified in step 4.9. Parts used in hydraulic cylinder assembly (4-10) will be assembled using the hydraulic fluid identified in step 4.10.
- 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.

10.0 CENTER HOUSING GROUP RE-ASSEMBLY

- 10.1 If removed install drain plug (1-80) in actuator housing (1-10).
- 10.2 If removed, install grease fitting (1-70) in actuator housing (1-10) and 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 cover is located on top of the cover in the upper yoke bearing area. NOTE: Grease fittings are optional as of March, 1983.
- 10.3 Inside housing (1-10) apply lubricant to the track and yoke bore.
- 10.4 Coat one o-ring seal (3-50) with lubricant and install into housing (1-10).

NOTE: Step 10.5 is done if housing is equipped with a lower yoke bushing (1-140). The addition of lower yoke bushing (1-140) was implemented during the year 1989. All replacement housings will be machined to accept a lower yoke bushing (1-140) and will automatically come fitted with a lower yoke bushing (1-140).

10.5 Coat lower yoke bushing (1-140) with lubricant and install into lower area of housing (1-10)

10.6 Apply lubricant to the slots in the upper/lower yoke arms and the lower bearing surface.

10.7 Install yoke (1-160) into housing (1-10) as follows: Arrange the yoke arms to approximately a 45° degree position in either direction and lower into the housing. NOTE: The yoke hub with tapped holes faces up. Rotate the yoke back to approximately mid-stroke (center) position.

10.8 Apply lubricant to all surfaces of two yoke rollers (1-50) and two roller spacers (1-110).

10.9 Place one yoke roller in the track in bottom of housing and position it under the slot in the yoke arms.

10.10 Place a roller spacer (1-110) on top of lower yoke roller (1-50).

10.11 Place a second yoke roller on top of the roller spacer in the slot in the lower yoke arm.

10.12 Place a second roller spacer (1-110) on top of the second yoke roller (1-50) and align the holes in the roller spacer and the yoke rollers.

NOTE: T8XX-M4 or T8XX-H actuators manufactured before 1978 did not use roller spacers (1-110) with yoke rollers (1-50), refer to section 16 step 16.2 when replacing rollers or roller spacers.

10.13 Coat upper and lower surfaces of 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 yoke rollers (1-50) and roller spacers (1-110).

10.14 Lubricate yoke pin (1-40) and insert through yoke pin nut (1-30), two yoke rollers (1-50) and two roller spacers (1-110).

10.15 Apply lubricant to all surfaces of the two remaining yoke rollers (1-50) and two remaining roller spacers (1-110).

10.16 Place one roller spacer over yoke pin (1-40) and on top of yoke pin nut (1-30).

10.17 Install third yoke roller (1-50) over yoke pin (1-40) and on top of roller spacer (1-110).

10.18 Place the last roller spacer over yoke pin (1-40) and on top of third yoke roller (1-50).

10.19 Place the fourth and final yoke roller over the yoke pin (1-40) and on top of roller spacer (1-110).

NOTE: The top roller will remain above the yoke arm and will engage the cover track when the cover is installed.

10.20 Apply lubricant to piston rod (2-170) and rod bushing (2-50). Install rod bushing over the piston rod.

NOTE: Rod bushing (2-50) should be replaced each time actuator is refurbished. The Bettis Service/Seal Kit should contain a new rod bushing.

CAUTION: If the cycle speed of the actuator is two seconds or faster, apply Loctite 242 to the external threads of the piston rod (2-170). NOTE: Loctite cure time is 10 - 30 minutes.

10.21 Install lubricated piston rod (2-170) with rod bushing (2-50) into right side of housing (1-10). Slide rod bushing along the piston rod and into housing counter bore. Screw piston rod into yoke pin nut (1-30). NOTE: Do not tighten piston rod until the housing cover is installed later in this procedure.

10.22 Apply lubricant to piston rod (4-170) and rod bushing (4-50). Install rod bushing over the piston rod.

NOTE: Rod bushing (4-50) should be replaced each time actuator is refurbished (refer to section 1 for recommend service interval). NOTE: The Bettis Service/Seal Kit should contain a new rod bushing.

CAUTION: If the cycle speed of the actuator is two seconds or faster, apply Loctite 242 to the external threads of the piston rod (4-170). NOTE: Loctite cure time is 10 - 30 minutes.

10.23 Install lubricated piston rod (4-170) with rod bushing (4-50) into left side of housing (1-10). Slide rod bushing along the piston rod and into housing counter bore. Screw piston rod into yoke pin nut (1-30). NOTE: Do not tighten piston rod until the housing cover is installed later in this procedure.

10.24 Place gaskets (3-110) and jam nuts (1-120) on stop screws (1-60). Install both assemblies into the housing (1-10).

10.25 Place housing cover gasket (3-20) on housing (1-10).

10.26 Coat o-ring seal (3-50) with lubricant and install into housing cover (1-20).

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

10.28 Apply lubricant to the yoke upper bearing surface.

NOTE: Step 10.29 is done if housing cover is equipped with a upper yoke bushing (1-140). The addition of upper yoke bushing (1-140) was implemented during the year 1989. All replacement housing covers will be machined to accept a upper yoke bushing (1-140) and will automatically come fitted with a upper yoke bushing (1-140).

10.29 Coat upper yoke bushing (1-140) with lubricant and install onto yoke (1-160).

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

- 10.31 Install seal gaskets (3-100) on to cover screw (3-90) and 10-90.
- 10.32 Install cover screws (1-90) and (10-90) with seal gaskets (3-100). NOTE: Leave finger tight - do not tighten.
- 10.33 Do this step only if you have pulled cover pins (1-130) and (10-130) or if you are replacing the cover pins. Drive the pins through cover (1-20) and into 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.
- 10.34 Tighten cover screws (1-90) and (10-90), torque to 16 ± 1 foot pounds lubricated.
- 10.35 Tighten piston rod (2-170) and (4-170) to a torque of 150 ± 7 foot pounds. NOTE: Flats are provided on the outboard end of the piston rods. These flats should be used to put a wrench on to tighten the piston rod.

CAUTION: Do not use a pipe wrench or similar tool to tighten piston rods.

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

11.0 PNEUMATIC CYLINDER RE-ASSEMBLY

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

CAUTION: Install rod seal with energizer ring facing outboard side (away from housing).

- 11.2 Coat end cap gasket (3-10) with lubricant on both sides and install over piston rod (2-170) rod bushing (2-50) and onto housing end.

- 11.3 Coat two o-ring seals (3-30) with lubricant and install into inner end cap (2-40).

NOTE: Some tie bar o-rings are held in place by "staked" washers. Check end cap to ensure washers are secured. If needed re-stake washers.

- 11.4 Install inner end cap (2-40) over piston rod (2-170) and 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.

CAUTION: Exercise extreme care during end cap installation, in order to prevent damage to rod seal (3-70).

- 11.5 Apply lubricant to o-ring seal (3-60) and install onto inner end cap (2-40).

NOTE: Step 11.6 is done only if actuator has a fabricated piston with greater than 20" inch diameter, i.e. 24", 28" 32" etc. If 20" inch diameter or smaller disregard step 11.6 and proceed to step 11.7.

- 11.6 Fabricated piston, 24" inch diameter and larger, reassembly (refer to assembly drawing detail "A").

CAUTION: Tie bar bushing (2-180) should be replaced each time actuator is refurbished.

NOTE: The Bettis Service/Seal Kit should contain a new tie bar bushing.

- 11.6.1 Install o-ring seals (3-140) into outer diameter seal groove on tie bar bushings (2-180).
- 11.6.2 Apply lubricant to two sets of T-seal components (3-80) and install into inner diameter seal groove in tie bar bushings (2-180).
- 11.6.3 Install tie bar bushings (2-180) into fabricated piston (2-20).
- 11.6.4 Install retaining rings (2-190) into fabricated piston @-20).
- 11.7 Apply lubricant to two sets of piston tie bar T-seal components (3-80) and install into the piston internal seal grooves. Refer to section 8 for proper T-seal installation instructions.
- 11.8 Coat ends of the piston rod (2-170) with lubricant.
- 11.9 Apply lubricant to o-ring (3-40) and place onto piston rod (2-170).
- 11.10 Install a matched set of split rings (2-70) into the inner most groove in the piston rod and retain with one split ring retainer (2-80), retaining ring groove away from piston. NOTE: Disregard this step and step 11.12 if the actuator has the piston retained in place with a hex nut and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers.
- 11.11 Install piston (2-20) onto the piston rod against split rings (2-70). NOTE: When installing cast pistons install with ribbed section of piston facing away from housing.

CAUTION: When installing 24" inch diameter, or larger, fabricated pistons make certain that the smaller diameter plate faces the outer end cap (2-30).

- 11.12 Install a matched set of split rings (2-70) into the outer most groove in the piston rod and retain with one of the split ring retainers (2-80), retaining ring groove away from piston.
- 11.13 Apply lubricant to the threads and end of tie bars (2-60), end without wrench flat.
- 11.14 Install by carefully inserting tie bars through piston (2-20), inner end cap (2-40) and housing (1-10) until tie bars protrude from housing on the left side. NOTE: Tie bars (2-60) must protrude through the housing far enough so hydraulic cylinder can be assembled.
- 11.15 Lubricate all exposed surfaces of piston rod (2-170) and tie bars (2-60).
- 11.16 Apply a light coat of lubricant to the bore of cylinder (2-10).

11.17 Coat the piston T seal components (3-90) with lubricant and install into the piston external seal groove. Refer to section 8 for proper "T" seal installation.

11.18 Install 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 piston rod.

CAUTION: If needed when installing cylinder (2-10), hammer on the 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 the back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

11.19 Apply lubricant to two o-ring seals (3-30) and install into outer end cap (2-30).

NOTE: Some tie bar o-rings are held in place by "staked" washers. Check end cap to ensure washers are secured. If needed re-stake washers.

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

11.21 Install outer end cap (2-30) onto tie bars and into open end of cylinder (2-10). **NOTE:** Make certain that the inlet port(s) are toward the top of the actuator.

11.22 Install two hex nuts (2-90) onto tie bars (2-60). **NOTE:** Do not tighten tie bar nuts.

12.0 HYDRAULIC CYLINDER RE-ASSEMBLY

CAUTION: Seals and parts being used in the assembly of cylinder (4-10) should use hydraulic fluid as the assembly lubricant.

12.1 Coat rod seal (5-70) with hydraulic fluid and install, lip first, into the recess provided in the inner end cap.

CAUTION: Install rod seal (5-70) with the energizer ring facing outboard side (away from housing).

12.2 Install end cap gasket (3-10) over piston rod (4-170) and rod bushing (4-50).

12.3 Coat two o-ring seals (5-30) with fluid and install into inner end cap (4-40).

NOTE: Some tie bar o-rings are held in place by "staked" washers. Check end cap to ensure washers are secured. If needed re-stake washers.

12.4 Install inner end cap (4-40) over tie bars (2-60), piston rod (4-170), and rod bushing (4-50). **NOTE:** The pressure inlet port should be in the same position as recorded in section 5 step 5.8.

CAUTION: Exercise extreme care during end cap installation, in order to prevent damage to rod seal (5-70).

- 12.5 Apply fluid to one o-ring (5-60) and install onto inner end cap (4-40).
- 12.6 Apply fluid to two sets of rod T-seal components (5-80) and install into piston (4-20) internal seal grooves. Refer to step 9.5 for proper installation instructions..
- 12.7 Coat ends of piston rod (4-170) with fluid.
- 12.8 Apply fluid to o-ring (5-40) and place onto piston rod (4-170).
- 12.9 Install a matched set of split rings (4-70) into the inner most groove in the piston rod and retain with one split ring retainer (4-80). Split ring retainer groove to face away from the piston. NOTE: Disregard this step and step 12.11 if the actuator is an early nut retained piston model and refer to section 16 step 16.1 for actuators not equipped with split rings and split ring retainers.
- 12.10 Install piston (4-20) onto the piston rod against split ring (4-70). NOTE: Seal groove on piston will be closest to housing (1-10).
- 12.11 Install a matched split ring set (4-70) onto piston rod and retain with a split ring retainer (4-80). NOTE: Split ring retainer groove to face away from the piston.
- 12.12 Coat piston T-seal components (5-90) with fluid and install on the piston (4-20) external seal groove. NOTE: Refer to step 9.5 for "T" seal installation instructions.
- 12.13 Apply fluid to bore of cylinder (4-10).

CAUTION: If needed when installing cylinder (4-10), hammer on the 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 the back-up rings or seal member be pinched between the piston and cylinder, the component could be damaged, becoming a potential source of leakage.

- 12.14 Install open end of cylinder (4-10) over piston (4-20) and onto inner end cap (4-40). NOTE: When sliding the cylinder over the piston seal tilt the cylinder 15° to 30° degrees to piston rod.
- 12.15 Bleed valves (4-240) should be arranged so the bleed valves will be at cylinder's highest point when actuator is mounted in it's final operational position. Refer to section 5 step 5.9 for correct location of bleed valves (4-240) prior to disassembly.
- 12.16 Apply fluid to two in number o-ring seals (5-30) and install into inner diameter seal grooves of outer end cap (4-30).
- 12.17 Apply fluid to o-ring seal (5-60) and install into outer diameter seal groove of outer end cap (4-30).
- 12.18 Install outer end cap (4-30) onto the tie bars and into open end of cylinder (4-10). NOTE: The pressure inlet port should be in the same position as recorded in section 5 step 5.8.

- 12.19 Install two tie bar nuts (4-90) on tie bars (2-60), using the tie bar nut to draw all of the cylinder components into position.
- 12.20 Alternately, tighten tie bar nuts on both ends of actuator to insure proper engagement of all four tie nuts.
- 12.21 Torque tighten tie bar nuts alternately, in 50 ft. lb. increments until a final torque of 110 ± 11 foot pounds has been achieved.
- 12.22 Install the nut retainer (4-100), securing in place with the retainer screw (4-120) and lockwasher (4-110). It is necessary that the flats on the hex nuts (4-90) be aligned and parallel before the nut retainer can be installed.
- 12.23 Install nut retainer (2-100), securing in place with retainer screw (2-120) and lockwasher (2-110). It is necessary that the flats on hex nuts (2-90) be aligned and parallel before nut retainer (2-100) can be installed.
- 12.24 Rotate yoke to the full clockwise (CW) position (as shown on the assembly drawing).
- 12.25 Install weather cover (3-130) and position indicator (1-170) on yoke (1-160). Arrange the position indicator's pointer perpendicular with piston rods and facing the front of the actuator (stop screw side of the housing).
- 12.26 Secure weather cover (3-130) and position indicator (1-170) to yoke (1-160) with four socket cap screws (1-180).

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.
- 13.2 All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.

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

- 13.3 All leak testing will use 65 psig pressure. NOTE: When testing the actuator use a proper adjusted regulator to apply pressure to the actuator.
- 13.4 Before testing for leaks, alternately apply and release 65 psi pressure to the each side of piston (2-20) to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.

13.5 PNEUMATIC CYLINDER TESTING

13.5.1 Apply 65 psig pressure to the pressure port in the outer end cap (2-30).

13.5.2 Apply a leak testing solution to the following areas:

13.5.2.1 Joint between outer end cap (2-30) and cylinder (2-10).
Checks cylinder to end cap o-ring seal.

- cap.
- 13.5.2.2 Around tie bar nuts (2-90) on the cylinder outer end cap (2-30). Checks tie bars to outer end cap o-ring seals.
 - 13.5.2.3 The pressure inlet port in inner end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.5.2.4 Remove pressure from pressure inlet port in the outer end
- 13.5.3 Apply 65 psig pressure to the pressure port in inner end cap (2-40).
- 13.5.4 Apply a leak testing solution to the following areas:
- 13.5.4.1 Joint between inner end cap (2-40) and cylinder (2-10). Checks cylinder to inner end cap o-ring seal.
 - 13.5.4.2 Around the joint of inner end cap (2-40) and housing (1-10). Checks tie bars to inner end cap o-ring seals and the inner end cap to housing gasket seal (3-10).
 - 13.5.4.3 The pressure inlet port in outer end cap (2-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.5.4.4 The snubber valve port hole in housing cover (1-20). Checks the rod seal and tie bars to end cap o-ring seals.
 - 13.5.4.5 Remove pressure from pressure inlet port in the inner end
- cap.
- 13.5.5 If an actuator was disassembled and repaired, the above leakage test must be performed again.
- 13.6 HYDRAULIC CONTROL CYLINDER TESTING
- 13.6.1 Apply 65 psig pressure to the pressure port in the outer end cap (4-30).
 - 13.6.2 Apply a leak testing solution to the following areas:
 - 13.6.2.1 Joint between outer end cap (4-30) and cylinder (4-10). Checks cylinder to end cap o-ring seal.
 - 13.6.2.2 Around tie bar nuts (4-90) on the cylinder outer end cap (4-30). Checks tie bars to outer end cap o-ring seals.
 - 13.6.2.3 The pressure inlet port in inner end cap (4-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.
 - 13.6.2.4 Remove pressure from pressure inlet port in the outer end
- cap.
- 13.6.3 Apply 65 psig pressure to the pressure port in inner end cap (4-40).

13.6.4 Apply a leak testing solution to the following areas:

13.6.4.1 Joint between inner end cap (4-40) and cylinder (4-10).
Checks cylinder to inner end cap o-ring seal.

13.6.4.2 Around the joint of inner end cap (4-40) and housing (1-10). Checks tie bars to inner end cap o-ring seals and the inner end cap to housing gasket seal (3-10).

13.6.4.3 The pressure inlet port in outer end cap (4-40). Checks piston to cylinder, piston to tie bar, and piston to piston rod seals.

13.6.4.4 The snubber valve port hole in housing cover (1-20). Checks the rod seal and tie bars to end cap o-ring seals.

13.6.4.5 Remove pressure from pressure inlet port in the inner end cap.

13.6.5 If an actuator was disassembled and repaired, the above leakage test must be performed again.

14.0 **M4 HYDRAULIC CONTROL PACKAGE INSTALLATION**

CAUTION: The M4 Hydraulic Control Package must be mounted with reservoir upright with the pump shaft horizontal.

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

14.1 Actuators manufactured after December, 1972 will have a M4 Hydraulic Control Package or one of its revisions and this procedure will be applicable to all M4's. Actuator manufactured prior to December, 1972 will not be a M4 and section 14 will not be applicable.

14.2 If M4 Control Package (8) is not remote mounted then re-install the M4 control package (8) on cylinder (4-10). NOTE: Refer to section 5 step 5.6 for M4 package proper orientation.

14.3 NOTE: Recommend that a non hardening thread sealant, compatible with petroleum base hydraulic fluid be used in this system. Install piping from the M4 hydraulic speed control block to cylinder (4-10) end cap ports.

14.4 **M4 Refilling Instructions** - Refilling of the M4 hydraulic control system and actuator cylinder (4-10) is best accomplished using a pressure pump. Put the actuator in the open position (CCW) and proceed using the following steps.

14.4.1 Remove the breather from the reservoir.

14.4.2 Attach the pump discharge line to reservoir breather port.

14.4.3 Open both speed control valves.

14.4.4 Open the two bleed valves (4-240), located at each end of the hydraulic cylinder.

- 14.4.5 Slowly pump hydraulic fluid into the reservoir. Approximately three to five PSI will be required. As the hydraulic fluid passes through the M4 control block into the cylinder, air will be displaced.
- 14.4.6 Close each bleed valve (4-240) when the air has been displaced and hydraulic fluid appears.
- 14.4.7 Remove pump discharge line from reservoir breather port.
- 14.4.8 Adjust fluid level to 1-1/2" inch (40mm) from top of reservoir with actuator in counter clockwise (CCW) position.
- 14.4.9 Re-install breather removed, in step 14.4.1.

CAUTION: The M4 reservoir must not be plugged during actuator service as the reservoir must be able to vent to the atmosphere.

14.5 Alternate Refilling Instructions: Refilling the M4 hydraulic control system, during field service, often must be done without the use of a pressure pump. Proceed as follows:

- 14.5.1 Put the actuator in its counter clockwise position (CCW).
- 14.5.2 Remove the breather from top of the reservoir.
- 14.5.3 Fill the reservoir approximately three-fourths (3/4) full.
- 14.5.4 Open both speed control valves.
- 14.5.5 Open the bleed valve (4-160) on the outboard end of hydraulic cylinder (4-10).
NOTE: Do not open in board bleed valve.
- 14.5.6 Rotate the M4 handle slowly, clockwise, until all air has escaped from the system.
- 14.5.7 Close the bleed valve opened in step 14.5.5. During the fill procedure, it is important that the lowest level be not less than approximately one-fourth (1/4) of the reservoir volume at any time.
- 14.5.8 Open bleed valve (4-240) on the inboard end of the hydraulic cylinder (4-10).
- 14.5.9 Rotate the M4 handle slowly, counterclockwise, until all air has escaped from the system.
- 14.5.10 Close the bleed valve opened in step 14.5.8. During the fill procedure, the piston will not move. This may be determined by observing the position indicator (1-170) on the actuator center housing.
- 14.5.11 Adjust fluid level to 1-1/2" inch (40mm) from top of reservoir with actuator in its counter clockwise (CCW) positions.

14.5.12 Re-install breather removed in step 14.5.2.

CAUTION: The M4 reservoir must not be plugged during actuator service as the reservoir must be able to vent to the atmosphere.

14.6 Additional M4 Instructions These steps are to be performed to insure air is removed from the system (most likely air in pump) and to test the operation of M4 hydraulic control system.

14.6.1 Turn M4 handle clockwise (CW). The actuator should move clockwise as well. Adjust outboard bleed valve (4-240) to remove air from system.

14.6.2 Turn M4 handle counter clockwise (CCW). The actuator will move counterclockwise. Adjust inboard bleed valve (4-240) to remove air from system.

14.6.3 With both bleed valves (4-240) closed, stroke actuator full 90°, clockwise (CW) and full counter clockwise (CCW), using M4 Hydraulic Control System.

15.0 RETURN TO SERVICE

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

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

15.3 Tighten both jam nuts (1-120) securely, while holding stop screws (1-60).

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

16.0 INFORMATION NOTES

16.1 Actuators manufactured before 1973 will have a hex lock nut retaining the piston on the piston rod. This hex lock nut is used in place of the split rings and split ring retainers. Actuators of this age will use a Service/Seal Kit that has the term "Pre A" in the description after the actuator model number, i.e. SERV K.T816-M4*PRE A* or T816-H*PRE A*.

16.2 Actuators manufactured before 1978 did not use roller spacers (1-110) with yoke rollers (1-50).

CAUTION: When replacing the rollers on pre 1978 actuators order a complete set of both rollers and roller spacers. NOTE: A complete set consists of: four rollers (1-50) and two roller spacers (1-110). The original rollers are the same part number as model T8XX actuators shipped after 1978, but the new rollers are shorter than pre 1978 rollers. Due to the difference in size the top or bottom yoke roller may not engage the actuator track sufficiently, unless roller spacers are used, and may cause actuator failure.

CHART NO. 1 - ACTUATOR WEIGHTS

ACTUATOR MODEL	APPROXIMATE WEIGHT (POUNDS) **
T810-M4	792
T812-M4	822
T816-M4	879
T820-M4	998
T824-M4	1333

** Weights listed for each model are for bare actuators without valve mounting brackets 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"	8	Cover Screws	Socket
1-120	1-7/8"	2	Stop Screw Nut	Box End (1)
1-180	3/16"	4	Weather Cover Screws	Allen
1-190	7/8"	1	Snubber	Deep Socket
2-60	5/8"	2	Tie Bar Flats	Open End or Adjustable
2-90	1-5/8"	2	Tie Bar Nuts	Socket
2-120	3/16"	1	Nut Retainer Screw	Allen
2-170	1-3/8"	1	Piston Rod Flat	Crows Foot (1)
4-90	1-5/8"	2	Tie Bar Nuts	Socket
4-120	3/16"	1	Nut Retainer Screw	Allen
4-170	1-3/8"	1	Piston Rod Flat	Crows Foot (1)
4-230	9/32"	2	1/8" NPT drain plug	Open end or adjustable
4-240	13/32"	2	Bleed valves	Open end or box
8	9/16"	-	M4 Mounting Package	Open end or adjustable
10-90	9/16"	4	Cover Screws	Socket

(1) No alternate style recommended

<u>ECN</u>	<u>DATE</u>	<u>REV</u>	<u>BY</u> *	<u>DATE</u>
Released	September, 1994	A	Bill Cornelius	30 September 1994
			Bill Cornelius	30 September 1994
			Robert McEver	30 September 1994

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