

BETTIS

SERVICE INSTRUCTIONS

FOR MODELS

G01 THROUGH G13 SERIES

HYDRAULIC ACTUATORS

WITH POWER MODULE TIE

BAR CONSTRUCTION

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SECTION 1 - INTRODUCTION

1.1 GENERAL SERVICE INFORMATION

1.1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis G01X0X, G2X0X, G3X0X, G4X0X, G5X0X, G7X0X, G8X0X, G10X0X and G13X0X Double Acting and Spring Return Series Actuators with one single Hydraulic Power Module - power module utilizing tie bar construction. This procedure can also be used on Bettis GXX20X Double Acting Series Twin Power Modules Hydraulic Actuators.

1.1.2 Normal recommended service interval for this actuator series is five years.

NOTE: Storage time is counted as part of the service interval.

1.1.3 This procedure is applicable with the understanding that all electrical power and hydraulic pressure has been removed from the actuator.

1.1.4 Remove all piping and mounted accessories that will interfere with the module(s) that are to be worked on.

1.1.5 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.

1.1.6 Numbers in parentheses, () indicate the bubble number (reference number) used on the Bettis Assembly Drawing and Actuator Parts List.

1.1.7 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.

1.1.8 Actuator Module weights are listed in Section 6 Table 6.1.

1.1.9 When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp corners rounded off.

1.1.10 Use a non-hardening thread sealant on all pipe threads.

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

1.1.11 Bettis recommends that disassembly of the actuator modules should be done in a clean area on a work bench.

1.2 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.

1.3 GENERAL SAFETY INFORMATION 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 well trained, equipped, prepared and competent personnel.

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.

1.4 BETTIS REFERENCE MATERIALS

1.4.1 Assembly Drawing for G01 through G13 Double Acting One Power Module Hydraulic Series Actuators use part number 116423.

1.4.2 Assembly Drawing for G01 through G13 Double Acting Twin Power Module Hydraulic Series Actuators use part number 115676.

1.4.3 Assembly Drawing for G01 through G13 Spring Return One Power Module Hydraulic Series Actuators use part number 115941.

1.5 SERVICE SUPPORT ITEMS

1.5.1 Bettis Module Service Kits.

1.5.2 For rod extension retainer nut tool, refer to the following table. NOTE: These tools are required only when extension rod assembly (1-50) or (9-50) is removed or when a new extension rod assembly is installed.

| ACTUATOR MODEL | BETTIS PART NUMBER | ACTUATOR MODEL | BETTIS PART NUMBER |
|----------------|--------------------|----------------|--------------------|
| G01 | None required | G5/G7 | 117369 |
| G2 | 123616 | G8/G10 | 117368 |
| G3/G4 | 117370 | G13 | 122849 |

1.5.3 Non-hardening thread sealant.

1.6 **LUBRICATION REQUIREMENTS**

NOTE: Lubricants, other than listed in step 1.6.1 should not be used without prior written approval of Bettis Product Engineering.

1.6.1 All temperature services (-50°F to +350°F)/(-45.5°C to 176.6°C) use Bettis ESL-5 lubricant. ESL-5 lubricant is contained in the Bettis Module Service Kit in tubes or cans and they are marked ESL-4,5 & 10 lubricant.

1.7 **FLUID REQUIREMENTS**

1.7.1 FLUID REQUIREMENTS: For use in the hydraulic power cylinder. The following listed fluids are recommended fluids only and does not limit the use of other hydraulic fluids compatible with supplied seals and coatings.

1.7.1.1 Standard temperature service (-20°F to +350°F)/(-28.9°C to +176.6°C) use Dexron II or Shell Tellus T-32 Automatic Transmission Fluid.

1.7.1.2 High temperature service (0°F to +350°F)/(-17°C to +176.6°C) use Dexron II or Shell Tellus T-32 Automatic Transmission Fluid.

1.7.1.3 Low temperature service (-50°F to +150°F)/(-45.6°C to 65.6°C) use Exxon Unavis J13 or HVI 13 Hydraulic Fluid.

1.8 **GENERAL TOOL INFORMATION**

1.8.1 Tools: All tools/Hexagons 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 1600 foot pounds / 1269 N-m), breaker bar, and a drive socket set. For recommended tool and wrench sizes refer to Section 6 Tables 6.2 through 6.10.

SECTION 2 - ACTUATOR DISASSEMBLY

2.1 GENERAL DISASSEMBLY

WARNING: It is possible, that the actuator may contain a dangerous gas and/or liquids. Ensure that all proper measures have been taken to prevent exposure or release of these types of contaminants before commencing any work.

2.1.1 Section 2 - Actuator Disassembly is written to either completely disassemble the entire actuator or can be used to disassemble individual Modules as needed (Hydraulic Power Module or Drive module).

2.1.2 When the Spring Module is to be removed it should be removed from the Drive Module prior to the Hydraulic Power Module removal or disassembly.

2.1.3 The Hydraulic Power Module can be disassembled while still attached to the Drive Module or the Hydraulic Power Module can be removed from the Drive Module and disassembled separate to the actuator (refer to Section 5 - Module Removal And Installation).

NOTE: Use a means of capturing the hydraulic fluid that will be lost during the removal or disassembly of the power module. Use a bucket, tub, and large container, ECT.

2.1.4 To ensure correct re-assembly; that is, with Hydraulic Power Module or Spring Module on same end of Drive Module as was, mark or tag right (or left) and mark mating surfaces.

2.1.5 For Spring Module removal refer to Section 5 step 5.1.

2.2 HYDRAULIC POWER MODULE DISASSEMBLY

NOTE: 1. Review Section 2 steps 2.1.1 through 2.1.5 General Disassembly before proceeding with Hydraulic Power Module Disassembly.

2. If the actuator model is a GXX20X Series (two same size power modules mounted on both sides of the drive module) then do the following steps on both Power Modules simultaneously or complete one power module and then repeat section 2.2 on the second Power Module

WARNING: If not already removed disconnect all hydraulic pressure from actuator power cylinders.

WARNING: If the actuator is spring return then the spring cartridge must be checked to verify that the spring(s) are in their extended position before the Hydraulic Power Module is disassembled from the Drive Module (refer to Section 5.1 through step 5.1.6).

2.2.1 Mark and record location of the ports on outer end cap (3-80) and inner end cap (3-10).

- 2.2.2 Remove NPT pipe plug or optional SAE o-ring plug (3-120) from outer end cap (3-80).
 - 2.2.3 Remove hex nuts (3-90), with lockwashers (3-95), from tie bars (3-20).
 - 2.2.4 Remove outer end cap (3-80) from cylinder (3-70), and tie bars (3-20).
 - 2.2.5 Unscrew and remove tie bars (3-20) from inner end cap (3-10).
 - 2.2.6 Remove cylinder (3-70) from inner end cap (3-10), piston (3-30) and piston rod (3-40).
 - 2.2.7 Refer to assembly drawing page 2 of 2 Detail "D". Remove two split ring halves (3-50) and one retainer ring (3-60) from piston rod (3-40).
 - 2.2.8 Remove piston (3-30) from piston rod (3-40).
 - 2.2.9 Remove o-ring seal (4-70) from piston rod (3-40).
 - 2.2.10 Refer to assembly drawing page 2 of 2 Detail "D". Remove two split rings (3-50) and one retainer ring (3-60) from piston rod (3-40).
 - 2.2.11 Remove hex cap screws (3-115) with lockwashers (3-110) from inner end cap (3-10).
 - 2.2.12 Remove hex nuts (3-105) from hex cap screws (3-100).
 - 2.2.13 Remove hex cap screws (3-100) with lockwashers (3-110) from inner end cap (3-10) and housing (1-10).
 - 2.2.14 Remove inner end cap (3-10) off of piston rod (3-40).
- NOTE: The piston rod (3-40) removal as outlined in step 2.2.15 is only required when the piston rod is being replaced or when the Drive Module is to be disassembled.
- 2.2.15 Unscrew and remove piston rod (3-40) from the Drive Module.

2.3 DRIVE MODULE DISASSEMBLY

NOTE: Review Section 2 steps 2.1.1 through 2.1.5 General Disassembly before proceeding with Drive Module Disassembly.

- 2.3.1 If not already removed remove piston rod (3-40) from drive module.

NOTE: If the actuator is equipped with submerged stop screws with stop screw covers (1-195) then proceed to and complete steps 2.3.2.1 and 2.3.2.2 prior to doing step 2.3.2.

- 2.3.2 Mark stop screws (1-180) left and right. The setting of stop screws (1-180) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screws will be removed later in this procedure.

- 2.3.2.1 Hold stop screw cover (1-195) in place and remove pipe plug (1-260).

2.3.2.2 Hold submerged stop screw (1-180) in place and remove stop screw cover (1-195).

NOTE: For steps 2.3.3 through 2.3.10 refer to assembly drawing page 2 of 2 Section A-A and Detail "E".

2.3.3 Before removing position indicator (1-220), record or mark it's position. Remove position indicator (1-220).

NOTE: Step 2.3.4 is used only on G01, G2 and G3 Drive Modules. Drive Modules for G4 through G13 will skip steps 2.3.4 and continue with step 2.3.5.

2.3.4 Remove one vent check assembly (13) from top of housing cover (1-20).

2.3.5 Unscrew and remove hex cap screws (1-160) with lockwashers (1-170) from yoke cover (1-150).

2.3.6 Remove yoke cover (1-150) from housing cover (1-20).

2.3.7 Mark and record the orientation of the position indicator assembly (1-140) in relation to the top of yoke (1-70).

2.3.8 Remove position indicator assembly (1-140) from top of yoke (1-70).

2.3.9 Remove spring pin (1-100) from top of yoke (1-70).

2.3.10 Remove hex cap screws (1-110), with lockwashers (1-115) or with lockwashers (1-170), from housing cover (1-20).

NOTE: Steps 2.3.11 and 2.3.12 are used only on G7, G8 and G10 Drive Modules. Drive Modules G01, G2, G3, G4 and G5 will skip steps 2.3.11 and 2.3.12 and continue with step 2.3.13.

2.3.11 Remove hex cap screws (1-120), with lockwashers (1-115), from housing cover (1-20).

2.3.12 Using hex cap screws (1-110), install into holes vacated by hex cap screws (1-120). Use these hex cap screws to jack the housing cover up for removal. Alternately rotate the hex cap screw clockwise until housing cover (1-20) is clear of housing (1-10).

NOTE: G01, G2, G3 and G4 model housing cover (1-20) will have cast tabs for placing prying tools to aid in cover removal.

2.3.13 Remove housing cover (1-20) from housing (1-10).

NOTE: Groove pins (1-130) will remain in housing cover (1-20) when housing cover is removed from housing (1-10). Groove pins (1-130) should not be removed from housing cover (1-20) unless they are damaged and require new replacements.

2.3.14 Refer to assembly drawing page 2 of 2 Detail "B". Remove guide bar (1-90) from housing (1-10).

2.3.15 Remove top yoke pin thrust bearing (2-10) from top of yoke pin (1-80).

- 2.3.16 Rotate the arms of yoke (1-70) to the center position of housing (1-10).
- 2.3.17 Remove yoke (1-70) with yoke pin (1-80), guide block (1-30), two yoke/guide block bushings (2-30), extension rod assembly (1-50) and extension rod assembly (9-50), by lifting yoke up and out of the housing (1-10).
- 2.3.18 Remove bottom yoke pin thrust bearing (2-10) from inside bottom of housing (1-10).
- 2.3.19 Remove yoke pin (1-80) by inserting 3/8"-16 UNC screw into top of the yoke pin and pull straight up and out.
- 2.3.20 Remove guide block (1-30) from between the arms of yoke (1-70)
- 2.3.21 Remove yoke/guide block bushing (2-30) from top of guide block (1-30).
- 2.3.22 Remove yoke/guide block bushing (2-30) from the top of the lower yoke arm of yoke (1-70).
- NOTE: G01 model actuators skip steps 2.3.23 through 2.3.25 and continue disassembly at step 2.3.26.
- 2.3.23 Refer to assembly drawing page 2 of 2 Detail "B". Use Bettis tool part numbers 117368 (G8/G10), 117369 (G5/G7), 117370 (G3/G4), 122849 (G13) or 123616 (G2) and remove retention retainer nut assemblies (1-60) from guide block (1-30). On spring return actuators also remove retention retainer nut assemblies (9-60).
- 2.3.24 Remove rod extension assembly (1-50) from guide block (1-30). On spring return actuators also remove rod extension assembly (9-50).
- NOTE: One spherical washer (1-40) will be removed from guide block (1-30) when extension rod assembly is removed. On spring return actuators also one spherical washer (9-40) will be removed from guide block (1-30).
- 2.3.25 Remove the remaining spherical washer (1-40) from guide block (1-30). On spring return actuators also remove the remaining spherical washer (9-40) from guide block (1-30).
- 2.3.26 Unscrew and remove two stop screw nuts (1-190) from stop screws (1-180).
- 2.3.27 Unscrew and remove two stop screws (1-180) from housing (1-10).
- 2.3.28 Housing (1-10) vent check assembly removal as follows:
- 2.3.28.1 G01, G2 and G3 housing (1-10) unscrew and remove one vent check assembly (13) from the front of housing (1-10).
- 2.3.28.2 G4 through G13 housing (1-10) unscrew and remove two vent check assemblies (13) from the front of housing (1-10).
- 2.3.29 The following items do not need to be removed from their assembled locations unless being replaced by new items: Two guide bar bearings, two yoke bearings (2-40), yoke pin bearing, yoke pin thrust bearing (2-10) and spring pin (1-100).

2.4 **BLIND END CAP MODULE REMOVAL**

- 2.4.1 Remove hex cap screws (5-20), with spring lockwashers (5-30), from blind end cap (5-10).
- 2.4.2 Remove blind end cap (5-10) from end of housing (1-10).

SECTION 3 - ACTUATOR REASSEMBLY

3.1 **GENERAL REASSEMBLY**

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

- 3.1.1 Remove and discard all old seals and gaskets.
- 3.1.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
- 3.1.3 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 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 should be replaced with new parts.

- 3.1.4 Before installation coat all moving parts with a complete film of lubricant. Coat all seals with a complete film of lubricant, before installing into seal grooves.

NOTE: The parts and seals used in the actuator housing module will be assembled using lubricant as identified in Section 1 step 1.6.1. The parts and seals used in the actuator cylinder module will be assembled using lubricant as identified in Section 1 step 1.7.1.

- 3.1.5 For Spring Module Installation refer to Section 5 step 5.2.

3.2 **DRIVE MODULE REASSEMBLY**

NOTE: Review section 3.1 General Reassembly before proceeding with Drive Module Reassembly.

NOTE: Refer to assembly drawing page 2 of 2 Detail "B" for section drawing of guide block.

- 3.2.1 If guide bar bearings (2-20) is being replaced install new bearings into guide block (1-30).

NOTE: The guide bar bearing (2-20) must be press fit into guide block guide bar bore with the seam located $\pm 5^\circ$ degrees of the top or bottom centerline as shown in section A-A.

NOTE: G01 model actuators skip steps 3.2.2 through 3.2.13 and continue reassembly at step 3.2.14.

3.2.2 Lubricate guide block (1-30), two spherical washers (1-40), and one extension rod assembly (1-50).

3.2.3 Install one spherical washer (1-40) into the side of guide block (1-30). NOTE: The spherical side of washer (1-40) will be facing to the outside of guide block (1-30).

3.2.4 Install second spherical washer (1-40) over threaded end of extension rod assembly (1-50). NOTE: The spherical side of the washer will go on the extension rod assembly facing the head of the extension rod assembly.

3.2.5 Install extension rod assembly (1-50) into guide block (1-30) and up against the first spherical washer (1-40).

3.2.6 Install extension retainer nut (1-60) over extension rod assembly (1-50) and screw into guide block (1-30).

3.2.7 Tighten extension retainer nut assembly (1-60) until extension rod assembly (1-50) can not move. Back off the extension retainer nut assembly (1-60) just enough to allow for extension rod assembly (1-50) to move freely.

NOTE: Steps 3.2.8 through 3.2.13 are to be completed when the actuator is equipped with a Spring Module. If the actuator is Double Acting then skip steps 3.2.8 through 3.2.13 and continue actuator reassembly starting with step 3.2.14.

3.2.8 Lubricate guide block (1-30), two spherical washers (9-40) and one extension rod assembly (9-50).

3.2.9 Install one spherical washer (9-40) into the side of guide block (1-30). NOTE: The spherical side of washer (9-40) will be facing to the outside of guide block (1-30).

3.2.10 Install second spherical washer (9-40) over threaded end of extension rod assembly (9-50). NOTE: The spherical side of the washer will go on the extension rod assembly facing the head of the extension rod assembly.

3.2.11 Install extension rod assembly (9-50) into guide block (1-30) and up against the first spherical washer (9-40).

3.2.12 Install extension retainer nut (9-60) over extension rod assembly (9-50) and screw into guide block (1-30).

3.2.13 Tighten extension retainer nut assembly (9-60) until extension rod assembly (9-50) can not move. Back off the extension retainer nut assembly (9-60) just enough to allow for extension rod assembly (9-50) to move freely.

NOTE: Consult Waller Texas Bettis Service Coordinator for "yoke bearing, yoke pin bearing or yoke/guide block bushing installation information.

3.2.14 If the two yoke bearings (2-40) are being replaced, install new bearing into housing cover (1-20) and housing (1-10).

NOTE: The yoke bearing (2-40) must be press fit into housing (1-10) and housing cover (1-20). Install the yoke bearings with the bearing seam located $45^{\circ} \pm 5^{\circ}$ degrees from the yoke arm slot when yoke (1-70) is rotated to its full clockwise position.

3.2.15 If the two yoke pin thrust bearings (2-10) are being replaced install new bearing into housing cover (1-20) and housing (1-10).

3.2.16 Lubricate two yoke/guide block bushings (2-30) and install onto top and bottom sides of guide block (1-30).

NOTE: The guide block (1-30) should be already pre-assembled with extension rod assembly and associated parts assembled in the guide block.

3.2.17 Install guide block (1-30), with yoke/guide block bushings (2-30), between arms of yoke (1-70).

3.2.18 Install o-ring seal (2-50) into inner diameter o-ring groove in the bottom of housing (1-10).

3.2.19 Coat the bearing surfaces of the yoke (1-70) with lubricant and install into housing (1-10).

3.2.20 Align hole in guide block (1-30) with the matching holes in the two yoke/guide block bushings (2-30) and the slots in the arms of yoke (1-70).

NOTE: The yoke pin can be held in place by installing a screw into the .375-16UNC tapped hole in the upper end of yoke pin (1-80).

3.2.21 Install yoke pin (1-80) by inserting into the upper yoke arm, upper yoke/guide block bushing, guide block, lower yoke/guide block bushing, lower yoke arm and resting on lower yoke pin thrust bearing (2-10).

3.2.22 Install guide bar (1-90) into either side of housing (1-10) by inserting through the housing, through guide block and then insert the guide bar into the other side of housing (1-10).

3.2.23 Refer to assembly drawing page 2 of 2 Section A-A. Install spring pin (1-100) into the top of yoke (1-70).

3.2.24 Install position indicator assembly (1-140) onto the top of yoke (1-70) and over spring pin (1-100). NOTE: Refer to Section 2 step 2.3.7 for correct installation position.

3.2.25 Install o-ring (2-50) into housing cover (1-20).

3.2.26 Install housing cover o-ring (2-60) into housing cover (1-20).

3.2.27 Install the housing cover (1-20), being careful not to damage o-ring seals (2-50) and (2-60).

3.2.28 Place lockwashers (1-115) onto hex cap screws (1-110).

NOTE: On G7 through G13 model actuators apply thread adhesive, Loctite 242, to threads of hex cap screws (1-110). Reference assembly drawing note number 9.

3.2.29 Install hex cap screws (1-110) with lockwashers (1-115) through housing cover (1-20) and into housing (1-10). NOTE: Leave hex cap screws (1-110) finger tight - do not tighten.

3.2.30 NOTE: Do this step only if groove pins (1-130) have been pulled or if the pins are being replaced. Drive groove pins (1-130) through housing cover (1-20) and into housing (1-10). The groove pins should be flush with the cover.

3.2.31 Torque tighten hex cap screws (1-110) until a final lubricated torque, as listed in the following table, has been achieved.

| HOUSING COVER SCREW QUANTITY AND TORQUE TABLE | | | | | | | |
|---|-----|-----------------------------|-----|-------|-----|-----------------------------|-----|
| MODEL | QTY | TORQUE (± 5 % Percent) | | MODEL | QTY | TORQUE (± 5 % Percent) | |
| | | FT-lb | N-m | | | FT-lb | N-m |
| G01 | 4 | 40 | 54 | G7 | 8 | 100 | 136 |
| G2 | 6 | 40 | 54 | G8 | 12 | 100 | 136 |
| G3 | 8 | 40 | 54 | G10 | 16 | 100 | 136 |
| G4 | 8 | 40 | 54 | G13 | 20 | 340 | 461 |
| G5 | 8 | 100 | 136 | | | | |

NOTE: Complete step 3.2.32 on G5, through G13 model actuators. For G01 through G4 model actuators skip step 3.2.32 and proceed to step 3.2.33.

3.2.32 On G5 through G13 models

3.2.32.1 Place lockwashers (1-115) onto hex cap screws (1-120).

NOTE: Hex cap screws (1-120) are only used as "hole" fillers and to protect threads from environment.

3.2.32.2 Install and tighten hex cap screws (1-120) with lockwashers (1-115).

3.2.33 Install thrust bearing (2-110) onto position indicator (1-140).

3.2.34 Install o-ring seal (2-100) onto position indicator (1-140).

3.2.35 Install upper bearing (2-120) into yoke cover (1-150).

3.2.36 Install rod wiper (2-80) into yoke cover (1-150).

3.2.37 Install o-ring seal (2-70) into yoke cover (1-150).

- 3.2.38 Install yoke cover (1-150) onto housing cover (1-20) and over position indicator assembly (1-140). NOTE: During yoke cover installation be careful not to damage o-ring seal (2-70) and rod wiper (2-80).
- 3.2.39 Place lockwashers (1-170) onto hex cap screws (1-160).
- 3.2.40 Install and tighten hex cap screws (1-160) with lockwashers through yoke cover (1-150) and into housing cover (1-20).
- 3.2.41 Vent check assembly installation as follows:
- 3.2.41.1 G01, G2 and G3 housing (1-10) using pipe sealant install one vent check assembly (13) into the front of housing (1-10).
 - 3.2.41.2 G2 and G3 housing (1-10) using pipe sealant install one vent check assembly (13) into the top area of housing cover (1-20).
 - 3.2.41.3 G4 through G13 housing (1-10) using pipe sealant install two vent check assemblies (13) into the front of housing (1-10).
- 3.2.42 NOTE: Refer to Section 2 step 2.3.3 for correct position indicator placement. Install position indicator (1-220) over the exposed shaft of position indicator assembly (1-140).
- 3.2.43 Install stop screw nuts (1-190) onto stop screws (1-180).
- 3.2.44 Install o-ring (2-90) onto stop screws (1-180).
- 3.2.45 Install two stop screws (1-180) into two stop screw holes on the front of housing (1-10).
- 3.2.46 Adjust both stop screws (1-180) back to settings recorded earlier in Section 2 at step 2.3.2.
- 3.2.47 Tighten both stop screw nuts (1-190) securely.

3.3 HYDRAULIC POWER MODULE REASSEMBLY

NOTE: Review section 3.1 General Reassembly before proceeding with Hydraulic Power Module Reassembly.

NOTE: In section 3.3 where the step indicates to "lubricate, coat or apply fluid", use hydraulic fluid for lubricating the part being installed.

- 3.3.1 Lubricate piston rod (3-40) with fluid.
- 3.3.2 Install o-ring seal (4-70) into the seal groove in piston rod (3-40).
- 3.3.3 Install two split ring halves (3-50) into the inner most groove in piston rod (3-40) and retain with one retainer ring (3-60).
- 3.3.4 Install piston (3-30) onto piston rod (3-40) and up against split rings install in step 3.3.3.

- 3.3.5 Install two split ring halves (3-50) into the outer most groove in piston rod (3-40) and retain with one retainer ring (3-60).
- 3.3.6 Apply fluid to the bore of cylinder (3-70).
- 3.3.7 Coat one piston bearing (4-45) with fluid and install into the piston external seal groove.
- 3.3.8 Install piston (3-30), with piston rod (3-40), into cylinder (3-70) leave the inner most piston seal groove out side of the cylinder.
- 3.3.9 Coat one piston seal (4-60) with fluid and install into the piston external seal groove.

CAUTION: Install the piston seal with energizer ring facing outside edge of piston (3-30).

- 3.3.10 Push the piston through the cylinder (3-70) until the outboard piston seal groove is exposed.

NOTE: To move the piston (3-30) through the bore of cylinder (3-70) may require mechanical assistance.

- 3.3.11 Coat one piston seal (4-60) with fluid and install into the piston external seal groove.

CAUTION: Install the piston seal with energizer ring facing outside edge of piston (3-30).

- 3.3.12 Refer to assembly drawing page 2 of 2 Detail "C". Coat Polypak seal (4-30) with hydraulic fluid and install, lip first, into inner end cap (3-10).

CAUTION: Install the Polypak seal with energizer ring facing piston side of inner end cap (3-10).

- 3.3.13 Install rod bushing (4-20) into inner end cap (3-10).
- 3.3.14 Install rod wiper (4-10) into inner end cap (3-10).
- 3.3.15 Install one o-ring seal (4-90) into inboard face of inner end cap (3-10).
- 3.3.16 Install inner end cap (3-10) onto piston rod (3-40).
- 3.3.17 Install two tie bars (3-20) into inner end cap (3-10). NOTE: the tie bars should be installed across from each other.
- 3.3.18 Install one o-ring seal (4-40) into inboard face of outer end cap (3-80).
- 3.3.19 Install outer end cap (3-80) into open end of cylinder (3-70).

NOTE: The pressure inlet ports of the inner and outer end caps should be positioned in the same position as recorded in Section 2 step 2.2.1.

- 3.3.20 Install the remaining tie bars (3-20) through outer end cap (3-80) and into inner end cap (3-10). Screw all tie bars (3-20) into inner end cap until dimension "A" (as shown on assembly drawing page 1 of 2) is achieved.

- 3.3.21 Install lockwashers (3-95) onto tie bars (3-20) and up against outer end cap (3-80).
- 3.3.22 Install hex nuts (3-90) onto tie bars (3-20) and up against lockwashers (3-95).
- 3.3.23 Torque tighten hex nuts (3-90) until a final lubricated torque, as listed in the following table, has been achieved.

| TIE BAR NUTS (3-90) TORQUE TABLE | | | | | |
|---|-----------------------|-----|---------------|-----------------------|------|
| HOUSING MODEL | TORQUE (±5 % Percent) | | HOUSING MODEL | TORQUE (±5 % Percent) | |
| | FT-lb | N-m | | FT-lb | N-m |
| G01 | 70 | 95 | G7 | 580 | 786 |
| G2 | 70 | 95 | G8 | 580 | 786 |
| G3 | 70 | 95 | G10 | 1000 | 1356 |
| G4 | 135 | 183 | G13 | 1000 | 1356 |
| G5 | 385 | 522 | | | |

- 3.3.24 Torque tighten piston rod (3-40) per the chart in Section 5.4 step 5.4.4.
- 3.3.25 If the Power Module is reassembled off the actuator then refer to Section 5 step 5.4 for Hydraulic Power Module installation instructions.

3.4 BLIND END CAP MODULE INSTALLATION

- 3.4.1 Install o-ring seal (6-10) into the o-ring groove in blind end cap (5-10).
- 3.4.2 Install lockwashers (5-30) onto hex cap screws (5-20).
- 3.4.3 Install blind end cap (5-10) onto end of housing (1-10).
- 3.4.4 Install and tighten hex cap screws (5-20) with lockwashers (5-30) through housing (1-10) and into blind end cap (5-10).

3.5 ACTUATOR TESTING

- 3.5.1 Leakage Test - All sources of leakage to atmosphere and across piston are to be checked, using hydraulic pressure.
- 3.5.2 Cycle the actuator five time at 10 % percent of the operating pressure, as listed on the cylinder name tag under max. pressure.

NOTE: If excessive leakage across the piston remains, the actuator must be disassembled and the cause of leakage must be determined and corrected.

- 3.5.3 Apply operating pressure as listed in step 3.5.2 to one side of the piston and allow the actuator to stabilize.
- 3.5.4 Repeat the above procedure for the opposite side of the piston.

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

3.5.6 Shell tests the actuator as follows: Apply 1.5 times the pressure listed on the cylinder name tag to both sides of the piston simultaneously for a period of two (2) minutes.

NOTE: If any leakage occurs during step 3.5.6 the actuator must be disassembled and the cause of leakage must be determined and corrected.

3.5.7 If an actuator was disassembled and repaired, the above testing must be performed again.

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

SECTION 4 - FIELD CONVERSIONS

4.1 FAIL MODE REVERSAL (CW TO CCW, OR CCW TO CW)

4.1.1 Remove Spring Module per Section 5.1.

4.1.2 Remove Hydraulic Power Module per Section 5.3.

4.1.3 Re-install the Spring Module onto the opposite end of housing (1-10) as it was previously located per Section 5.2.

4.1.3 Re-install the Hydraulic Power Module onto the opposite end of housing (1-10) as it was previously located per Section 5.4.

4.2 CONVERTING DOUBLE ACTING ACTUATOR TO SPRING RETURN

4.2.1 Remove Blind End Cap Module per Section 2.4.

4.2.2 If Hydraulic Power Module needs to be relocated due to fail mode requirements (fail counter-clockwise) use Section 5.3 for removal and Section 5.4 for installation.

4.2.3 Install Powr Swivl Module per Section 5.6.

4.2.4 Install the Spring Module onto the end of housing (1-10) per Section 5.2.

4.3 CONVERTING SPRING RETURN ACTUATOR TO DOUBLE ACTING

4.3.1 Remove the Spring Cartridge per Section 5.1

- 4.3.2 If Hydraulic Power Module needs to be relocated due to fail mode requirements (fail counter-clockwise) use Section 5.3 for removal and Section 5.4 for installation.

NOTE: Skip step 4.3.3 when working on G01-SR models and continue at step 4.3.4.

- 4.3.3 Remove the Spring Cartridge Powr Swivl Module per Section 5.5.

- 4.3.4 Install the Blind End Cap Module per Section 3.4

SECTION 5 - MODULE REMOVAL AND INSTALLATION

NOTE: When the Spring Module is to be removed it should be removed from the drive Module prior to the Hydraulic Power Module removal or disassembly.

WARNING: DO NOT REMOVE SPRING MODULE WHILE SPRING IS COMPRESSED

WARNING: ACTUATORS EQUIPPED WITH A SPRING CARTRIDGE MOUNTED M3 JACKSCREW OR AN EXTENDED STOP (ES) READ WARNING TAG WIRED TO THE SPRING CARTRIDGE COVER PLATE

5.1 SPRING MODULE REMOVAL

WARNING: DO NOT REMOVE SPRING MODULE WHILE SPRING IS COMPRESSED

- NOTES:
1. Review section 2.1 General Disassembly before proceeding with Spring Module Disassembly.
 2. The setting of stop screws (1-180) should be checked and setting recorded before stop screws are loosened or removed.
 3. G2-SRF and G3-SRF use step 5.1.1. G01-SR, G2-SR, G3-SR through G13 skip step 5.1.1 and start at step 5.1.2.

- 5.1.1 G2-SRF and G3-SRF unscrew and remove pipe plug (7-10) from spring cartridge assembly (5-10). Skip steps 5.1.2, 5.1.3 and start at step 5.1.4.

WARNING: If an M3, M3HW jackscrew or extended stop (ES) is mounted in the spring module cover plate (7-10), the M3, M3HW or ES assembly (7-40) should not contact the end of the spring module tension rod.

- 5.1.2 Unscrew hex cap screws (7-20) with lockwashers (7-30) from cover plate (7-10) or if spring module has a ES or M3-SR adapter plate (7-10) remove safety wire from hex cap screws (7-20) and then remove hex cap screws (7-20).

- 5.1.3 Remove cover plate (7-10) from spring cartridge assembly (5-10).
- 5.1.4 Apply hydraulic pressure to the pressure inlet port of inner end cap (3-10) to compress the spring enough to move the yoke off the stop screw on the Spring Module side of the Drive Module.
- 5.1.5 Loosen the stop screw nut (1-190) located on the stop screw that is closest to or next to Spring Module.
- 5.1.6 Unscrew stop screw (1-180) that is closest to or next to spring cartridge module (unscrew or back out until the load is removed from the stop screw).
- 5.1.7 Remove hydraulic pressure from pressure inlet port of inner end cap (3-10).

CAUTION: Due to the weight and size of spring cartridge assembly (5-10), heavy-duty support equipment will be required when removing spring cartridge assembly from the actuator housing. Refer to section 6 for spring cartridge module weights.

- 5.1.8 The spring cartridge "pre-load" must be removed before spring cartridge (5-10) is removed from housing (1-10). Refer to steps 5.1.4 through 5.1.6 for spring cartridge "pre-load" removal.

CAUTION: The maximum pressure to be applied in step 5.1.9 is 25 PSIG.

- 5.1.9 Apply hydraulic pressure, not to exceed the maximum as indicated in the above "**CAUTION**", to the pressure inlet port of outer end cap (3-80) to move the spring cartridge tension rod hex nut out of it's cast hex seat.

NOTE: If hydraulic pressure is not available to apply to the pressure inlet port of outer end cap (3-80) then remove hex plug (3-120). Using a long rod go through the outer end cap vacant pipe plug port hole and push on the piston rod so as to move the spring cartridge tension rod hex nut out of it's cast hex seat.

- 5.1.10 Unscrew the spring cartridge tension rod from the Drive Module. The tension rod can be rotated for removal by going through the open end of spring cartridge assembly with a square male drive extension.
- 5.1.11 Remove hex cap screws (5-20) with lockwashers (5-30) from housing (1-10).
- 5.1.12 Remove spring cartridge assembly (5-10) from actuator housing (1-10).

WARNING: Under no circumstances should the spring cartridge assembly (5-10) be cut apart, as the spring is pre-loaded and the spring cartridge is a weld assembly.

5.2 SPRING MODULE INSTALLATION

CAUTION: Due to the weight and size of Spring Module, heavy duty support equipment will be required when installing spring cartridge module to the actuator housing. For the approximate weight of the spring cartridge refer to Section 6.

WARNING ACTUATOR MUST BE IN THE APPROPRIATE OVERTRAVEL POSITION (Refer to detail "A" on warning tag attached to Spring Module access hole cover or to Bettis drawing part number 130084 for G01 models or part number 123650 for G2 through G13 models). Confirm over-travel position by observing the guide block (1-30) is against the inner wall of housing (1-10).

NOTE: The setting of stop screws (1-180) should be checked and setting recorded before stop screws are loosened or removed.

5.2.1 On stop screw (1-180), that is located on the same side of the housing as spring cartridge (5-10), loosen stop screw nut (1-190).

5.2.2 Unscrew or back out stop screw (1-180) to achieve over-travel as illustrated in detail "A" on warning tag attached to Spring Module cover plate or to Bettis drawing part number 123650.

5.2.3 Install o-ring seal (6-20) into the o-ring groove in the inboard end of spring cartridge assembly (5-10).

5.2.4 Using lifting equipment move Spring Module up to housing (1-10) and align spring cartridge tension rod with extension rod assembly (9-50) for G2 through G13 models or G01 models align spring cartridge with tapped hole in guide block (1-30).

WARNING: COMPLETE STEP 5.2.5 TO AVOID SEVERE INJURY TO PERSONNEL OR INCUR MAJOR DAMAGE TO THE ACTUATOR.

5.2.5 SPRING CARTRIDGE TENSION ROD TO ROD EXTENSION INSTALLATION AS FOLLOWS:

5.2.5.1 Using a male square drive extension, go through the open end of Spring Module (5-10) and rotate the tension rod nut until initial thread engagement is achieved.

NOTE: Confirm initial thread engagement of rod extension (9-50) to tension rod.

5.2.5.2 After confirming initial thread engagement rotate tension rod into extension rod assembly (9-50) per the following table.

| WARNING: After initial thread engagement the tension rod must be rotated clockwise the minimum number of turns listed in the following table. | | | | | | | | | | |
|--|--------------|-----|----|----|----|----|----|----|-----|-----|
| ACTUATOR MODEL | TORQUE UNITS | G01 | G2 | G3 | G4 | G5 | G7 | G8 | G10 | G13 |
| MINIMUM NO TURNS | N/A | 6 | 10 | 10 | 10 | 13 | 14 | 20 | 25 | 31 |

WARNING: When screwing tension rod into extension rod assembly (9-50) make certain that the tension rod and extension rod assembly threads do not cross-thread.

5.2.6 Torque tighten the spring cartridge tension rod as listed in the following table.

| SPRING CARTRIDGE TENSION ROD TORQUE TABLE | | | | | |
|---|-----------------------------|-----|------------------|-----------------------------|-----|
| HOUSING MODEL | TORQUE (± 5 % Percent) | | HOUSING MODEL | TORQUE (± 5 % Percent) | |
| | Lbs. Ft | N.m | | Lbs. Ft | N.m |
| G01 | 50 | 68 | G7 | 240 | 325 |
| G2 | 90 | 122 | G8 | 240 | 325 |
| G3 | 90 | 122 | G10 | 240 | 325 |
| G4 | 240 | 325 | G13 | 240 | 325 |
| G5 | 240 | 325 | | | |

5.2.7 Install lock washers (5-30) onto hex cap screws (5-20).

5.2.8 Install hex cap screws (5-20) with lockwashers (5-30) through housing (1-10) and into spring cartridge assembly (5-10) and tighten.

5.2.9 Install o-ring seal (6-10) into the o-ring groove in the outboard end of spring cartridge assembly (5-10).

NOTE G2-SRF and G3-SRF use step 5.2.10. G01-SR, G2-SR, G3-SR through G13-SR skip step 5.2.10 and start at step 5.2.11.

5.2.10 Using pipe sealant on the threads install pipe plug (7-10) in the vacant hole in out board end of spring cartridge assembly (5-10). Skip steps 5.2.11 through 5.2.14 and start at step 5.2.15.

5.2.11 Install lockwashers (7-30) onto hex cap screws (7-20).

5.2.12 Install the cover plate (7-10) or install M3 adapter plate (7-10) onto the outboard end of spring cartridge assembly (5-10).

5.2.13 Install and tighten hex cap screws (7-20) with lockwashers (7-30) through cover plate (7-10) and into spring cartridge assembly (5-10).

5.2.14 Torque tighten hex cap screws (7-20) until a final lubricated torque, as listed in the following table, has been achieved.

| HEX CAP SCREWS (7-20) TORQUE TABLE | | | | | |
|------------------------------------|--------------------------|-----|------------------|--------------------------|-----|
| HOUSING MODEL | TORQUE ± 5 % Percent | | HOUSING MODEL | TORQUE ± 5 % Percent | |
| | Lbs. Ft | N-m | | Lbs. Ft | N-m |
| G01 | 30 | 41 | G7 | 135 | 183 |
| G2 | 30 | 41 | G8 | 240 | 325 |
| G3 | 30 | 41 | G10 | 285 | 386 |
| G4 | 65 | 88 | G13 | 340 | 461 |
| G5 | 65 | 88 | | | |

5.2.15 On M3, M3HW and ES models install Monel wire (6-130) through each hex cap screw (7-20) per the following steps:

NOTE: The following steps provides guidelines for wire locking hex cap screws to discourage screw loosening and removal in applications where screw removal could be hazardous.

5.2.15.1 Make sure hex cap screws are tightened to their specified torque.

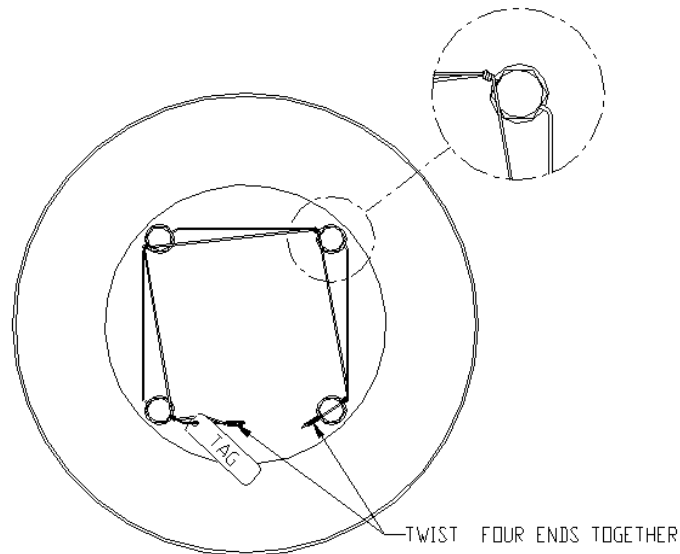
5.2.15.2 Using required lengths of .31 diameter Monel wire as provided in the Module ordered. When replacing Monel wire use the following table for wire length requirements.

| MODEL | LENGTH | | MODEL | LENGTH | |
|--------|--------|--------|--------|--------|--------|
| | Inch | mm | | Inch | Mm |
| G01-SR | 36 | 914.4 | G5-SR | 66 | 1676.4 |
| G2-SR | 44 | 1117.6 | G7-SR | 79 | 2006.6 |
| G3-SR | 48 | 1219.2 | G8-SR | 88 | 2235.2 |
| G4-SR | 55 | 1397.0 | G10-SR | 110 | 2794.0 |

5.2.15.3 Twist the end of both wires together and insert one through the drilled hole in the hex cap screw head, pass the second wire over the screw head and twist it three (3) times around the first wire at a location where the first wire exits the screw head.

5.2.15.4 Repeat the procedure until the second wire is twist tied to the screw head through wire of the last screw head.

5.2.15.5 Attach caution tag and twist tie the wires from the last screw head to the twisted wires of the first screw head. See following for illustration.



- 5.2.16 If removed install stop screw nuts (1-190) onto stop screws (1-180).
- 5.2.17 If removed install o-ring (2-90) onto stop screws (1-180).
- 5.2.18 If removed install two stop screws (1-180) into two stop screw holes on the front of housing (1-10).
- 5.2.19 Adjust both stop screws (1-180) back to settings recorded earlier in Section 5.
- 5.2.20 Tighten both stop screw nuts (1-190) securely.

5.3 **HYDRAULIC POWER MODULE REMOVAL**

WARNING: The spring cartridge must be checked to verify that the spring(s) are in their extended position before the power module is removed from the actuator.

NOTE: Review section 2.1 General Disassembly before proceeding with The Hydraulic Power Module Disassembly.

- 5.3.1 Remove o-ring plug (3-120) from outer end cap (3-80).
- 5.3.2 Using a male square drive extension, go through outer end cap (3-80), unscrew piston rod (3-40) from extension rod assembly (1-50).

WARNING: Use suitable lifting equipment to support the cylinder assembly.

- 5.3.3 Remove hex cap screws (3-115), with lockwashers (3-110), from inner end cap (3-10).
- 5.3.4 Remove hex nuts (3-105) from hex cap screws (3-100).
- 5.3.5 Remove Hydraulic Power Module from actuator housing (1-10).

5.4 **HYDRAULIC POWER MODULE INSTALLATION**

NOTE: Review section 3.1 General Reassembly before proceeding with Hydraulic Power Module Installation.

- 5.4.1 Check to verify that o-ring seal (4-90) is properly seated in its seal groove located on the housing side of inner end cap (3-10).
- 5.4.2 Using lifting equipment move the Power Module up to housing (1-10) and install as follows: Use step 5.4.3 for G01 and step 5.4.4 for G2 through G10 model actuators.

5.4.3 G01 MODEL ACTUATORS:

- 5.4.3.1 Align piston rod (3-40) with threads in the guide block (1-30).
- 5.4.3.2 Using a male square drive extension, go through outer end cap (3-80) and screw piston rod (3-40) into guide block (1-30).

WARNING: When screwing piston rod into guide block (1-30) make certain that the piston rod and guide block threads do not cross-thread.

5.4.4 G2 THROUGH G10 MODEL ACTUATORS:

5.4.4.1 Align piston rod (3-40) with extension rod assembly (1-50).

5.4.4.2 Using a male square drive extension, go through outer end cap (3-80) and screw piston rod (3-40) into extension rod assembly (1-50).

WARNING: When screwing piston rod into extension rod assembly (1-50) make certain that the piston rod and extension rod assembly threads do not cross-thread.

5.4.5 Torque tighten piston rod (3-40) per the following chart.

5.4.5.1 G01 model actuators torque to 50 foot pounds / 68 N-m lubricated.

5.4.5.2 G2 and G3 model actuators torque to 90 foot pounds / 122 N-m lubricated.

5.4.5.3 G4 through G13 model actuators torque to 240 foot pounds / 325 N-m lubricated.

5.4.6 Install lock washers (3-110) onto hex cap screws (3-115).

5.4.7 Install hex cap screws (3-115), with lockwashers (3-110), through inner end cap (3-10) and screw into housing (1-10).

5.4.8 Install lock washers (3-110) onto hex cap screws (3-100).

5.4.9 Install hex cap screws (3-100), with lockwashers (3-110), through inner end cap (3-10) and housing (1-10).

5.4.10 Install and tighten hex nuts (3-105) onto hex cap screws (3-100).

5.4.11 Using pipe dope, install standard NPT pipe plug (3-120) into outer end cap (3-80). If the actuator uses SAE threads install SAE o-ring plug (3-120) into outer end cap (3-80).

5.5 G2 THRU G13 POWR SWIVL REMOVAL

5.5.1 Push the guide block to the side of housing (1-10) that will expose the extension rod assembly (1-50). NOTE: The guide block can be moved by inserting a long non metallic rod through the hole where the blind end cap was removed and pushing on the guide block.

5.5.2 Refer to assembly drawing page 2 of 2 Detail "B". Use Bettis tool part number as listed in chart in section 1 step 1.2.1 to remove retainer nut assembly (1-60) from the guide block (1-30).

CAUTION: When removing rod extension assembly from guide block be careful not to drop one of the spherical washers inside the housing.

5.5.3 Remove rod extension assembly (1-50) from guide block (1-30).

NOTE: One spherical washer (1-40) will be removed from guide block (1-30) when extension rod assembly is removed.

5.5.4 Remove the remaining spherical washer (1-40) from guide block (1-30).

5.6 **G2 THRU G13 POWR SWIVL MODULE INSTALLATION**

WARNING: The actuator must be in the appropriate overtravel position. Confirm overtravel position by observing the guide block (1-30) is against the inner wall of housing (1-10).

5.6.1 Push the guide block to the required side of the housing (1-10). NOTE: The guide block can be moved by inserting a long rod through either end of the housing and pushing on the guide block.

5.6.2 Lubricate two spherical washers (1-40), and one extension rod assembly (1-50).

5.6.3 Install one spherical washer (1-40) into the side of guide block (1-30). NOTE: The spherical side of washer (1-40) will be facing to the outside of guide block (1-30).

5.6.4 Install second spherical washer (1-40) over threaded end of extension rod assembly (1-50). NOTE: The spherical side of the washer will go on the extension rod assembly facing the head of the extension rod assembly.

5.6.5 Install extension rod assembly (1-50) into right of guide block (1-30) and up against the first spherical washer (1-40).

5.6.6 Install extension retainer nut assembly (1-60) over extension rod assembly (1-50) and screw into guide block (1-30).

5.6.7 Tighten extension retainer nut assembly (1-60) until extension rod assembly (1-50) can not move. Back off the extension retainer nut assembly (1-60) just enough to allow for extension rod assembly (1-50) to move freely.

SECTION 6 - ACTUATOR SUPPORT INFORMATION

6.1 MODULE WEIGHTS BY ITEM NUMBER AND ACTUATOR HOUSING SIZE

| ITEM NO. | | G01 WT. | G2 WT. | G3 WT. | G4 WT. | G5 WT. | G7 WT. | G8 WT. | G10 WT. | G13 WT. | DESCRIPTION |
|----------|-----|---------|--------|--------|--------|--------|--------|--------|---------|---------|--------------|
| 1 | Lbs | 83 | 110 | 162 | 280 | 545 | 1025 | 1495 | 2550 | 4625 | Drive Module |
| | Kg | 38 | 50 | 73 | 127 | 247 | 465 | 678 | 1157 | 2098 | |
| 1 | Lbs | 26 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1.5" Dia. |
| | Kg | 12 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Power Module |
| 1 | Lbs | 25 | 30 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1.7" Dia. |
| | Kg | 11.4 | 13.6 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | Power Module |
| 3 | Lbs | 26 | 29 | 43 | N/A | N/A | N/A | N/A | N/A | N/A | 2.0" Dia. |
| | Kg | 11.7 | 13 | 19.5 | N/A | N/A | N/A | N/A | N/A | N/A | Power Module |
| 3 | Lbs | 27 | 30 | 45 | N/A | N/A | N/A | N/A | N/A | N/A | 2.2" Dia. |
| | Kg | 12.2 | 13.6 | 20.4 | N/A | N/A | N/A | N/A | N/A | N/A | Power Module |
| 3 | Lbs | 28 | 31 | 48 | 71 | N/A | N/A | N/A | N/A | N/A | 2.5" Dia. |
| | Kg | 12.7 | 14.1 | 21.7 | 32 | N/A | N/A | N/A | N/A | N/A | Power Module |
| 3 | Lbs | 29 | 35 | 48 | 84.5 | N/A | N/A | N/A | N/A | N/A | 3.0" Dia. |
| | Kg | 13 | 15.8 | 21.7 | 38 | N/A | N/A | N/A | N/A | N/A | Power Module |
| 3 | Lbs | 32 | 38 | 52 | 83 | 160 | N/A | N/A | N/A | N/A | 3.5" Dia. |
| | Kg | 14.5 | 17.2 | 23.5 | 37.6 | 73 | N/A | N/A | N/A | N/A | Power Module |
| 3 | Lbs | N/A | 42 | 57 | 84 | 170 | 287 | N/A | N/A | N/A | 4.0" Dia. |
| | Kg | N/A | 19 | 25.8 | 38 | 77 | 130 | N/A | N/A | N/A | Power Module |
| 3 | Lbs | N/A | N/A | 59 | 86 | 177.5 | 301 | N/A | N/A | N/A | 4.5" Dia. |
| | Kg | N/A | N/A | 26.7 | 39 | 80.5 | 136 | N/A | N/A | N/A | Power Module |
| 3 | Lbs | N/A | N/A | N/A | 92 | 173 | 317 | 411 | N/A | N/A | 5.0" Dia. |
| | Kg | N/A | N/A | N/A | 41.7 | 78 | 144 | 186 | N/A | N/A | Power Module |
| 3 | Lbs | N/A | N/A | N/A | 106 | 184 | 303 | 475 | 729 | N/A | 6.0" Dia. |
| | Kg | N/A | N/A | N/A | 49 | 83 | 137 | 215 | 331 | N/A | Power Module |
| 3 | Lbs | N/A | N/A | N/A | N/A | 194 | 331 | 485 | 783 | N/A | 7.0" Dia. |
| | Kg | N/A | N/A | N/A | N/A | 88 | 150 | 220 | 255 | N/A | Power Module |
| 3 | Lbs | N/A | N/A | N/A | N/A | 228 | 337 | 459 | 756 | - | 8.0" Dia. |
| | Kg | N/A | N/A | N/A | N/A | 103 | 153 | 208 | 343 | - | Power Module |
| 3 | Lbs | N/A | N/A | N/A | N/A | N/A | 394 | 495 | 808 | - | 9.0" Dia. |
| | Kg | N/A | N/A | N/A | N/A | N/A | 179 | 225 | 367 | - | Power Module |
| 3 | Lbs | N/A | N/A | N/A | N/A | N/A | 400 | 501 | 862 | - | 10.0" Dia. |
| | Kg | N/A | N/A | N/A | N/A | N/A | 181 | 227 | 400 | - | Power Module |
| 3 | Lbs | N/A | N/A | N/A | N/A | N/A | N/A | 599 | 959 | 1139 | 12.0" Dia. |
| | Kg | N/A | N/A | N/A | N/A | N/A | N/A | 254 | 435 | 517 | Power Module |
| 3 | Lbs | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1104 | - | 14.0" Dia. |
| | Kg | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 501 | - | Power Module |

6.2 G01 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 9/16" | 4 | Cover Screws | Socket |
| 1-160 | 1/2" | 4 | Yoke Cover Screws | Socket |
| 1-180 | 3/8" Sq. | 2 | Stop Screws | Open End or Adjustable |
| 1-190 | 15/16" | 2 | Hex Jam Nuts | Open End or Adjustable |
| 3-40 | 3/8" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 3/4 " | 4 | Standard Hex Nuts | Socket |
| 3-100 | 9/16" | 4 | Hex Cap Screws | Socket |
| 3-105 | 9/16" | 4 | Standard Hex Nuts | Socket |
| 3-115 | 9/16" | 4 | Hex Cap Screws | Socket |
| 3-120 | 9/16" Sq. | 1 | Pipe Plug, Square Head | Open End or Adjustable |
| 3-210 | 7/16" Sq. | 4 | Pipe Plug, Square Head | Open End or Adjustable |
| 5-20 | 9/16" | 4 | Hex Cap Screws | Socket |
| 7-20 | 9/16" | 4 | Hex Cap Screw | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/8" | 1 | Pull Rod | Male Drive |

6.3 G2 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 9/16" | 6 | Cover Screws | Socket |
| 1-160 | 9/16" | 4 | Yoke Cover Screws | Socket |
| 1-180 | 3/8" Sq. | 2 | Stop Screws | Open End or Adjustable |
| 1-190 | 1-1/8" | 2 | Hex Jam Nuts | Open End or Adjustable |
| 3-40 | 3/8" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 3/4" | 4 | Standard Hex Nuts | Socket |
| 3-100 | 9/16" | 4 | Hex Cap Screws | Socket |
| 3-105 | 9/16" | 4 | Standard Hex Nuts | Socket |
| 3-115 | 9/16" | 4 | Hex Cap Screws | Socket |
| 3-120 | 9/16" Sq. | 1 | Pipe Plug, Square Head | Open End or Adjustable |
| 3-210 | 7/16" Sq. | 4 | Pipe Plug, Square Head | Open End or Adjustable |
| 5-20 | 9/16" | 6 | Hex Cap Screws | Socket |
| 7-20 | 9/16" | 6 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/8" | 1 | Pull Rod | Male Drive |

6.4 G3 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 9/16" | 8 | Cover Screws | Socket |
| 1-160 | 9/16" | 4 | Yoke Cover Screws | Socket |
| 1-180 | 1/2" Sq. | 2 | Stop Screws | Open End or Adjustable |
| 1-190 | 1-5/16" | 2 | Hex Jam Nuts | Open End or Adjustable |
| 3-40 | 3/8" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 3/4" | 6 | Standard Hex Nuts | Socket |
| 3-100 | 9/16" | 4 | Hex Cap Screws | Socket |
| 3-105 | 9/16" | 4 | Standard Hex Nuts | Socket |
| 3-115 | 9/16" | 4 | Hex Cap Screws | Socket |
| 3-120 | 9/16" Sq. | 1 | Square Head Pipe Plug | Open End or Adjustable |
| 3-210 | 7/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 9/16" | 6 | Hex Cap Screws | Socket |
| 7-20 | 9/16" | 6 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/8" | 1 | Pull Rod | Male Drive |

6.5 G4 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 9/16" | 8 | Cover Screws | Socket |
| 1-160 | 9/16" | 4 | Yoke Cover Screws | Socket |
| 1-180 | 3/4" Sq. | 2 | Stop Screws | Open End or Adjustable |
| 1-190 | 1-13/16" | 2 | Hex Jam Nuts | Open End or Adjustable |
| 3-40 | 1/2" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 15/16" | 6 | Standard Hex Nuts | Socket |
| 3-100 | 3/4" | 4 | Hex Cap Screws | Socket |
| 3-105 | 3/4" | 4 | Standard Hex Nuts | Socket |
| 3-115 | 3/4" | 4 | Hex Cap Screws | Socket |
| 3-120 | 5/8" Sq. | 1 | Square Head Pipe Plug | Open End or Adjustable |
| 3-210 | 9/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 3/4" | 6 | Hex Cap Screws | Socket |
| 7-20 | 3/4" | 6 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/4" | 1 | Pull Rod | Male Drive |

6.6 G5 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 3/4" | 8 | Cover Screws | Socket |
| 1-120 | 3/4" | 4 | Yoke Cover Screws | Socket |
| 1-160 | 9/16" | 6 | Hex Cap Screws | Socket |
| 1-180 | 3/4" Sq. | 2 | Stop Screws | Open End or Adjustable |
| 1-190 | 2-3/8" | 2 | Heavy Hex Jam Nuts | Open End or Adjustable |
| 3-40 | 1/2" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 15/16" | 6 | Hex Nuts | Socket |
| 3-100 | 3/4" | 4 | Hex Cap Screws | Socket |
| 3-105 | 3/4" | 4 | Standard Hex Nuts | Socket |
| 3-115 | 3/4" | 4 | Hex Cap Screws | Socket |
| 3-120 | 5/8" Sq. | 1 | Square Head Pipe Plug | Open End or Adjustable |
| 3-210 | 9/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 3/4" | 8 | Hex Cap Screws | Socket |
| 7-20 | 3/4" | 8 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/4" | 1 | Pull Rod | Male Drive |

6.7 G7 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 3/4" | 8 | Cover Screws | Socket |
| 1-120 | 3/4" | 4 | Yoke Cover Screws | Socket |
| 1-160 | 9/16" | 8 | Hex Cap Screws | Socket |
| 1-180 | 1" | 2 | Stop Screws | Open End or Adjustable |
| 3-40 | 3/4" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 1-1/2" | 6 | Hex Nuts | Socket |
| 3-100 | 15/16" | 8 | Hex Cap Screws | Socket |
| 3-105 | 15/16" | 8 | Standard Hex Nuts | Socket |
| 3-115 | 15/16" | 8 | Hex Cap Screws | Socket |
| 3-120 | 15/16" | 1 | Hex Head Pipe Plug | Open End or Adjustable |
| 3-210 | 9/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 15/16" | 8 | Hex Cap Screws | Socket |
| 7-20 | 15/16" | 8 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/4" | 1 | Pull Rod | Male Drive |

6.8 G8 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 3/4" | 12 | Cover Screws | Socket |
| 1-120 | 3/4" | 4 | Yoke Cover Screws | Socket |
| 1-160 | 9/16" | 8 | Hex Cap Screws | Socket |
| 1-180 | 1-1/4" | 2 | Stop Screws | Open End or Adjustable |
| 3-40 | 3/4" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 1-1/2" | 8 | Hex Nuts | Socket |
| 3-100 | 1-1/8" | 8 | Hex Cap Screws | Socket |
| 3-105 | 1-1/8" | 8 | Standard Hex Nuts | Socket |
| 3-115 | 1-1/8" | 8 | Hex Cap Screws | Socket |
| 3-120 | 15/16" | 1 | Hex Head Pipe Plug | Open End or Adjustable |
| 3-210 | 9/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 1-1/8" | 8 | Hex Cap Screws | Socket |
| 7-20 | 1-1/8" | 8 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/4" | 1 | Pull Rod | Male Drive |

6.9 G10 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 3/4" | 16 | Cover Screws | Socket |
| 1-120 | 3/4" | 4 | Yoke Cover Screws | Socket |
| 1-160 | 9/16" | 8 | Hex Cap Screws | Socket |
| 1-180 | 1-1/2" | 2 | Stop Screws | Open End or Adjustable |
| 3-40 | 3/4" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 3-1/2" | 8 | Hex Nuts | Socket |
| 3-100 | 1-1/8" | 8 | Hex Cap Screws | Socket |
| 3-105 | 1-1/8" | 8 | Standard Hex Nuts | Socket |
| 3-115 | 1-1/8" | 8 | Hex Cap Screws | Socket |
| 3-120 | 15/16" | 1 | Hex Head Pipe Plug | Open End or Adjustable |
| 3-210 | 9/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 1-5/16" | 8 | Hex Cap Screws | Socket |
| 7-20 | 1-5/16" | 8 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/4" | 1 | Pull Rod | Male Drive |

6.10 G13 TOOL STYLE AND WRENCH SIZE

| ITEM NO. | WRENCH SIZE | ITEM QTY | LOCATION OR DESCRIPTION | RECOMMENDED TOOL STYLE |
|----------|-------------|----------|-------------------------|------------------------|
| 1-110 | 1-1/8" | 20 | Cover Screws | Socket |
| 1-120 | 1-1/8" | 4 | Yoke Cover Screws | Socket |
| 1-160 | 9/16" | 12 | Hex Cap Screws | Socket |
| 1-180 | 2" Sq. | 2 | Stop Screws | Open End or Adjustable |
| 3-40 | 7/8" Sq. | 1 | Piston Rod | Male Drive |
| 3-90 | 1-11/16" | 8 | Hex Nuts | Socket |
| 3-100 | 1-11/16" | 8 | Hex Cap Screws | Socket |
| 3-105 | 1-11/16" | 8 | Standard Hex Nuts | Socket |
| 3-115 | 1-11/16" | 8 | Hex Cap Screws | Socket |
| 3-120 | 15/16" Sq. | 1 | Square Head Pipe Plug | Open End or Adjustable |
| 3-210 | 13/16" Sq. | 4 | Square Head Pipe Plug | Open End or Adjustable |
| 5-20 | 1-13/16" | 8 | Hex Cap Screws | Socket |
| 7-20 | 1-13/16" | 8 | Hex Cap Screws | Socket |
| 13 | 3/4" | 2 | Vent Check Assembly | Open End |
| - | 3/4" | 1 | Pull Rod | Male Drive |

| ECN | DATE | REV | BY * | DATE |
|----------|------------------|-----|----------------------|------------|
| Released | 3 September 1998 | A | COMPILED COLBY | 22 JUNE 06 |
| 17787 | 17 December 2001 | B | CHECKED JOHN R | 6/22/06 |
| 19110 | 06 July 2006 | C | APPROVED DAVID MCGEE | 7/18/06 |

* Signatures on file Bettis, Waller, Texas