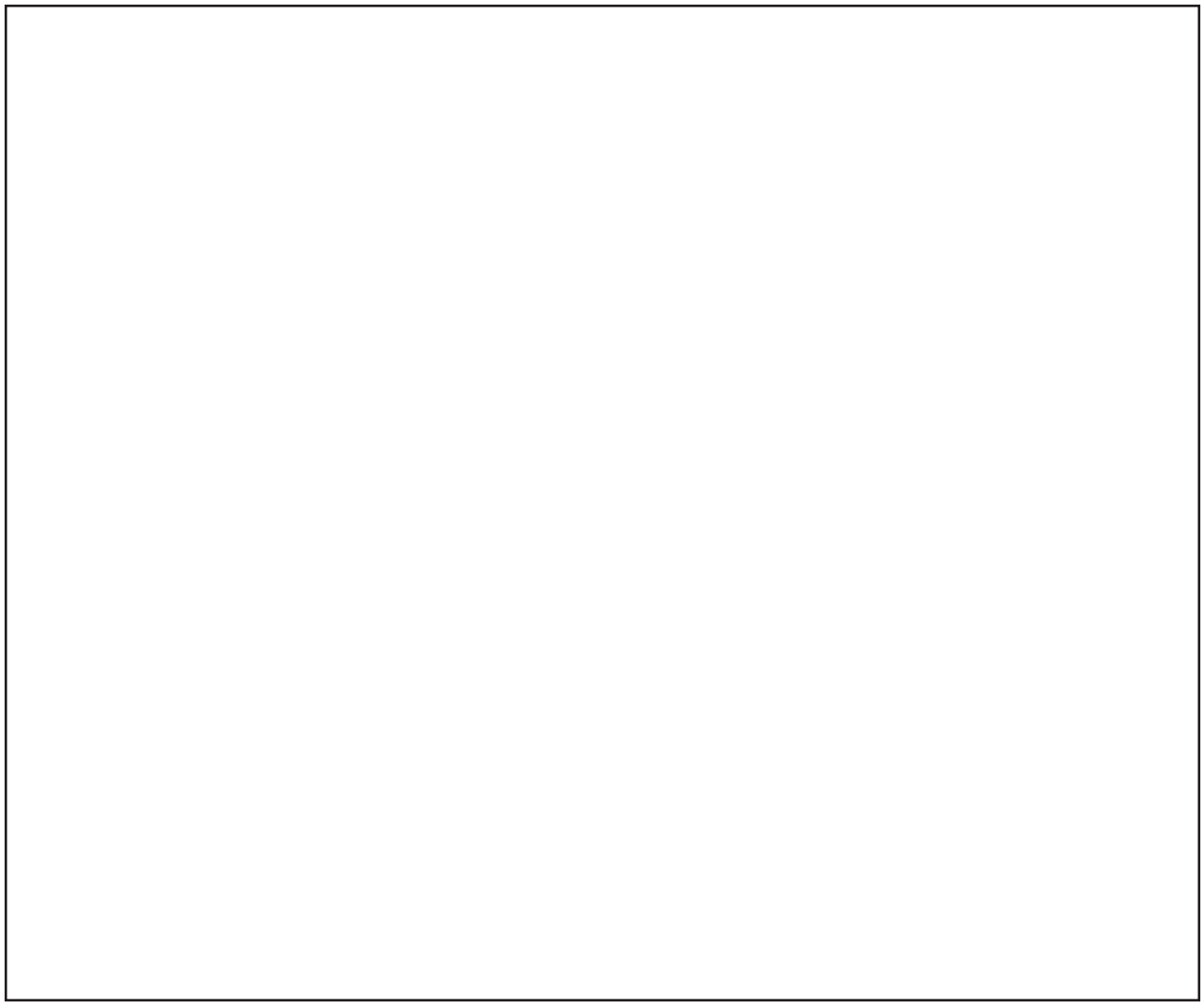
Service Instructions
126343E Rev. C
November 2012

G01F Through G13F Series

Hydraulic Actuators with Power Module Flange 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 G01X0XF, G2X0XF, G3X0XF, G4X0XF, G5X0XF, G7X0XF, G8X0XF, G10X0XF and G13X0XF Double Acting and Spring Return Series Actuators with one single Hydraulic Power Module - power module utilizing flange construction.

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 pneumatic 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: FOLLOW MANUFACTURER'S INSTRUCTIONS

Apply the thread sealant per the manufacturer’s instructions.

1.1.11 Bettis recommends that disassembly of the actuator components should be done in a clean area on a workbench.

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.

NOTE:

This product is only intended for use in large-scale fixed installations excluded from the scope of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS 2).

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: READ WARNING MESSAGES CAREFULLY

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: FOLLOW PLANT SAFETY PROCEDURES

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

1.4 Bettis Reference Materials

1.4.1 Assembly Drawing for GXXXXF Double Acting Hydraulic Series Actuators use part number 119576.

1.4.2 Assembly Drawing for GXXXXF Spring Return Hydraulic Series Actuators use part number 116740.

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.

Table 1. G Series Models

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 LUBRICANT REQUIREMENTS: For use in the housing (drive module) and the SR cartridge. 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 Automatic Transmission Fluid.

1.7.1.2 High temperature service (0°F to +350°F)/(-17°C to +176.6°C) use Dexron Automatic Transmission Fluid.

1.7.1.3 Low temperature service (-40°F to +150°F}/(-40°C to +65.6°C) use Exxon Univis J13 Hydraulic Fluid.

1.8 General Tool Information

1.8.1 Tools: All tools/Hexagons are American Standard inch (Imperial). 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 / 2169 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: DANGEROUS GAS AND/OR LIQUIDS

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 If the actuator has a Spring Module and the Spring Module is to be removed it should be removed from the Drive Module prior to the Hydraulic Power Module removal or disassembly. See Section 5 step 5.1.

2.1.3 This procedure is written with the Power Module removed from the Drive module prior to Power Module disassembly. Remove Power Module per Section 5 step 5.3. The Hydraulic Power Module can be disassembled while still attached to the Drive Module.

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, etc.

2.1.4 To ensure correct reassembly; 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:

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

⚠ WARNING: DISCONNECT OPERATING PRESSURE

If not already removed disconnect all operating pressure from actuator power cylinders.

⚠ WARNING: VERIFY SPRING POSITIONS

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 inner end cap (3-20).

2.2.2 Remove four pipe plugs (3-80) from cylinder assembly (3-10) and drain hydraulic fluid from cylinder assembly (hydraulic fluid may have been drained if all piping to pressure ports have previously been removed).

2.2.3 Remove 12 point cap screws (1-130), with lockwashers (3-110), from the flange of cylinder assembly (3-10).

2.2.4 Remove cylinder (3-10) from inner end cap (3-20), piston (3-30) and piston rod (3-40).

NOTE:

Refer to assembly drawing page 2 of 2 Detail "D" for steps 2.2.5 through 2.2.9.

2.2.5 Remove two split ring halves (3-50) and one retainer ring (3-60) from outboard side of piston (3-30) and piston rod (3-40).

2.2.6 Remove piston (3-30) from piston rod (3-40).

2.2.7 Remove o-ring seal (4-70) from piston rod (3-40).

2.2.8 Remove two split ring halves (3-50) and one retainer ring (3-60) from piston rod (3-40).

2.2.9 Remove stop tube (3-70) from piston rod (3-40).

NOTE:

Not all Power Modules will be equipped with a stop tube (3-70).

2.2.10 Remove hex cap screws (3-100) with lockwashers (3-110) from inner end cap (3-20) and housing (1-10).

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 the 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 “F”.

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 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 the 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 three 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) and extension rod assembly (1-50), by lifting yoke up and out of the housing (1-10). On spring return actuators also remove yoke (1-70) with extension rod assembly (9-50).

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 (2-20), two yoke bearings (2-40), yoke pin bearing (2-25), 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: CHECK SHELF LIFE OF SEALS

Only new seals, which are still within the seal's expectant shelf life, should be installed into the 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, tie bars and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

⚠ CAUTION: INSPECT PARTS BEFORE USE

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 drive 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. 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 ±5° degrees of the top or bottom centerline as shown in section A-A. 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° ±5° 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, Locktite 242, to threads of hex cap screws (1-110). Reference assembly drawing note no. 1.

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.

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.

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

Table 2. Housing Cover Screw Quantity and Torque

Model	QTY	TORQUE (±5%)		Model	QTY	TORQUE (±5%)	
		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.

3.2.31 On G5 through G13 models

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

NOTE:

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

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

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

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

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

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

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

3.2.37 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).

3.2.38 Place lockwashers (1-170) onto hex cap screws (1-160).

3.2.39 Install and tighten hex cap screws (1-160) with lockwashers through yoke cover (1-150) and into housing cover (1-20).

3.2.40 Vent check assembly installation as follows:

3.2.40.1 G01, G2 and G3 housing (1-10) using pipe sealant install one vent check assembly (13) into the front of housing (1-10).

3.2.40.2 G2 and G3 housing (1-10) using pipe sealant install one vent check assembly (13) into the top area of housing cover (1-20).

3.2.40.3 G4 through G13 housing (1-10) using pipe sealant install two vent check assemblies (13) into the front of housing (1-10).

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).

3.2.41 STOP SCREW (1-180) ASSEMBLY AND INSTALLATION. For Standard stop screw assembly and installation start at step 3.2.43.1.1 and go through step 3.2.43.1.6. For Submerged stop screw assembly with stop screw cover (1-195) start at step 3.2.43.2

3.2.41.1 STANDARD STOP SCREW ASSEMBLY AND INSTALLATION:

3.2.41.1.1 Install stop screw nuts (1-190) onto stop screws (1-180).

3.2.41.1.2 Install o-ring (2-90) onto stop screws (1-180) and up against the side of stop screw nut (1-190) that will install against housing (1-10).

3.2.41.1.3 Install two stop screws (1-180), with stop screw nut (1-180) and o-ring seal (2-90) into two stop screw holes on the front of housing (1-10).

3.2.41.1.4 Install two submerged stop screws (1-180) into two stop screw holes on the front of housing (1-10).

3.2.41.1.5 Adjust both stop screws (1-180) back to settings recorded earlier in Section 2 at step 2.3.2.

3.2.41.1.6 Tighten both stop screw nuts (1-190) securely.

3.2.41.2 SUBMERGED STOP SCREW ASSEMBLY AND INSTALLATION:

3.2.41.2.1 Install two submerged stop screws (1-180) into the housing (1-10).

3.2.41.2.2 Install o-ring seals (2-90) onto the two installed submerged stop screws (1-180) and up against the housing (1-10).

3.2.41.2.3 Adjust both submerged stop screws (1-180) back to settings recorded earlier in Section 2 at step 2.3.2.

3.2.41.2.4 Hold each of two submerged stop screw (1-180) in place and install and tighten submerged stop screw covers (1-195) onto submerged stop screws (1-180).

3.2.41.2.5 Using pipe dope install pipe plugs (1-260) into two submerged stop covers (1-195).

3.3 Hydraulic Power Module Resassembly

NOTE:

Review section 3.1 General Reassembly before proceeding with Hydraulic Power Module Reassembly.
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 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 (3-20).

⚠ CAUTION: INSTALL POLYPAK SEAL CORRECTLY

Install the Polypak seal with energizer ring facing piston side of inner end cap (3-20).

3.3.3 Install rod bushing (4-20) into inner end cap (3-20).

3.3.4 Install rod wiper (4-10) into inner end cap (3-20).

NOTE:

The pressure inlet ports of the inner end cap should be positioned in the same position as recorded in Section 2 step 2.2.1.

3.3.5 Install inner end cap (3-20) onto piston rod (3-40).

3.3.6 Refer to assembly drawing page 2 of 2 Detail "C". Install lock washers (3-110) onto hex cap screws (3-100).

3.3.7 Install hex cap screws (3-100), with lockwashers (3-110), through inner end cap (3-20) and housing (1-10).

3.3.8 Install hex nuts (3-120) onto hex cap screws (3-100).

3.3.9 Refer to assembly drawing page 2 of 2 Detail "D". Install o-ring seal (4-70) into the seal groove in piston rod (3-40).

NOTE:

Not all Power Modules will be equipped with an o-ring (4-100) and a stop tube (3-70).

3.3.10 Coat o-ring seal (4-100) with fluid and install into the internal seal groove of stop tube (3-70).

3.3.11 Install the stop tube (3-70) onto piston rod (3-40). Position the stop tube on the piston rod on the inboard side of the two split ring grooves.

3.3.12 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).

3.3.13 Install piston (3-30) onto piston rod (3-40) and up against split rings install in step 3.3.11.

3.3.14 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).

3.3.15 Apply fluid to the bore of cylinder assembly (3-10).

3.3.16 Coat piston bearing (4-50) with fluid and install into the piston external seal groove.

⚠ CAUTION: INSTALL PISTON SEALS CORRECTLY

Install the piston seals (4-60) with energizer ring facing outside edges of piston (3-30).

3.3.17 Coat two piston seals (4-60) with fluid and install into the piston external seal groove.

3.3.18 Install cylinder assembly (3-10) over piston (3-30) and up against inner end cap (3-20).

3.3.19 Install lock washers (3-110) onto hex cap screws (3-90).

3.3.20 Install hex cap screws (3-90), with lockwashers (3-110), through inner end cap (3-20) and screw into housing (1-10).

3.3.21 Torque tighten hex cap screws (3-100) and (3-90), alternately in 50 foot-pound increments, until a final lubricated torque, as listed in the following table, has been achieved.

Table 3. Hex Cap Screws

Housing Model	TORQUE (±5%)		Housing Model	TORQUE (±5%)	
	FT-lb.	N-m		FT-lb.	N-m
G01	15	20	G7	135	183
G2	15	20	G8	214	290
G3	15	20	G10	372	504
G4	32	43	G13	521	706
G5	71	96			

3.3.22 Using a male square drive extension, go through outer end cap (3-80) and torque tighten piston rod (3-40) to the lubricated torque as listed in the following table.

Table 4. Piston Rod Torque Information

Housing Model	TORQUE (±5%)		Housing Model	TORQUE (±5%)	
	FT-lb.	N-m		FT-lb.	N-m
G01	90	122	G7	240	325
G2	90	122	G8	240	325
G3	90	122	G10	240	325
G4	240	325	G13	240	325
G5	240	325			

⚠ WARNING: DO NOT CROSS-THREAD PISTON ROD

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.

3.3.23 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 Using Section 5.2 re-install the Spring Module onto the opposite end of housing (1-10) as it was previously located.

4.1.4 Using Section 5.4 re-install the Power Module onto the opposite end of housing (1-10) as it was previously located.

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.

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: CHECK IF SPRING IS COMPRESSED

DO NOT REMOVE SPRING MODULE WHILE SPRING IS COMPRESSED

⚠ WARNING: READ WARNINGS ON SPRING CARTRIDGE

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: CHECK IF SPRING IS COMPRESSED

DO NOT REMOVE SPRING MODULE WHILE SPRING IS COMPRESSED

NOTE:
Review section 2.1 General Disassembly before proceeding with Spring Module Disassembly.
The setting of stop screws (1-180) should be checked and setting recorded before stop screws are loosened or removed.
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: REMOVE MOUNTED ASSY. CORRECTLY

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 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: USE HEAVY-DUTY SUPPORT EQUIPMENT

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: DO NOT EXCEED MAXIMUM PRESSURE

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: DO NOT CUT SPRING CARTRIDGE ASSY.

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: USE HEAVY DUTY SUPPORT EQUIPMENT

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: ENSURE CORRECT OVERTRAVEL POSITION

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: FOLLOW STEPS CAREFULLY

COMPLETE STEP 5.2.5 TO AVOID SEVER 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: OBSERVE NUMBER OF TURNS

After initial thread engagement the tension rod must be rotated clockwise the minimum number of turns listed in the following table.

Table 5. Minimum Number of Turns

ACTUATOR MODEL	TORQUE UNITS	G01	G2	G3	G4	G5	G7	G8	G10	G13
MINIMUM NO OF TURNS	N/A	6	10	10	10	13	14	20	25	31

⚠ WARNING: DO NOT CROSS-THREAD ROD ASSY.

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.

Table 6. Spring Cartidge Tension Rod Torque

Housing Model	TORQUE (±5%)		Housing Model	TORQUE (±5%)	
	FT-lb.	N-m		FT-lb.	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.

Table 7. Hex Cap Screws (7-20) Torque

Housing Model	TORQUE (±5%)		Housing Model	TORQUE (±5%)	
	FT-lb.	N-m		FT-lb.	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 .031 diameter Monel wire as provided in the Module ordered. When replacing Monel wire use the following table for wire length requirements.

Table 8. Hex Cap Screws (7-20) Torque

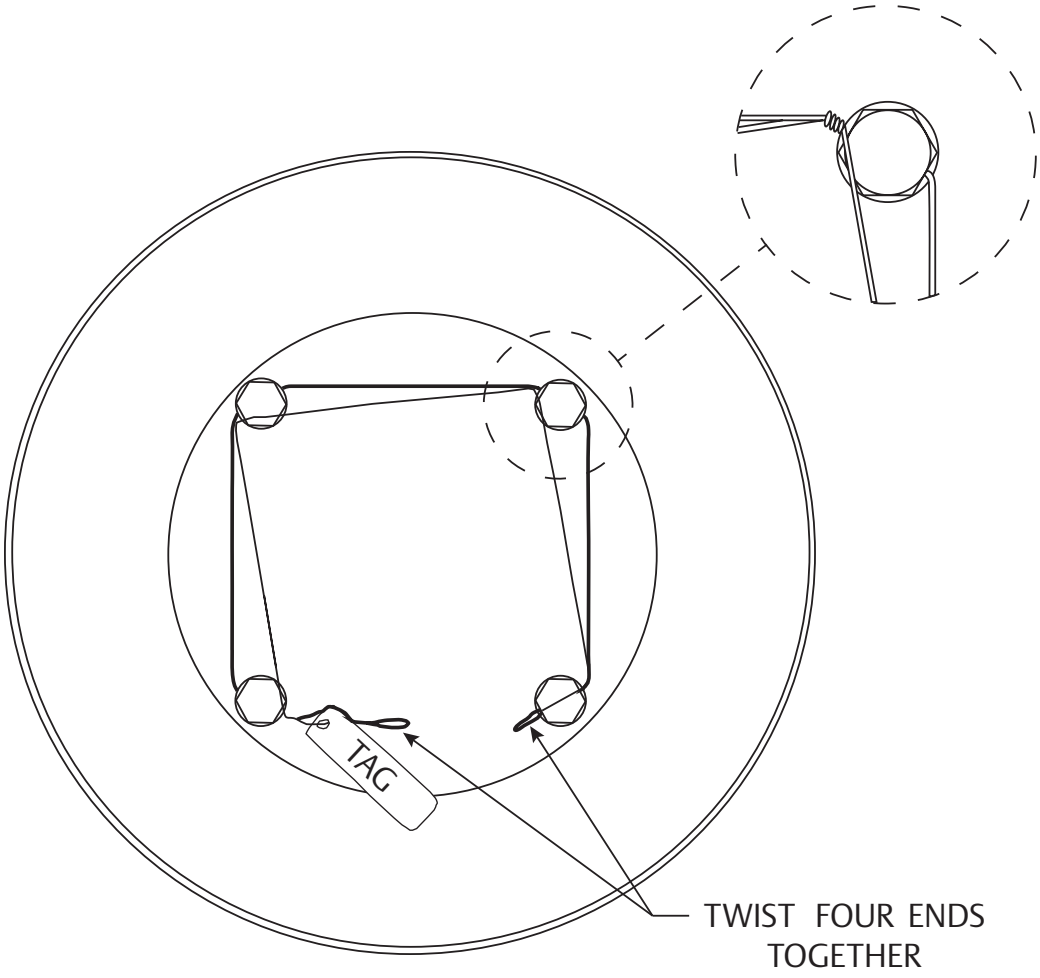
MODEL	LENGTH		MODEL	LENGTH	
	Inch	mm		Inch	mm
G01-SR	36	914.4	G5-SR	66	1676.4
G2-SR	44	1117.6	G7-SR	79	2006.6
G3-SR	48	1219.2	G8-SR	88	2235.2
G4-SR	55	1397.0	G10-SR	110	2794.0

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.

Figure 1 Tag Attachment Guide



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: CHECK SPRING POSITIONS

When the actuator has a spring return model 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.

⚠ WARNING: USE PROPER LIFTING EQUIPMENT

Use suitable lifting equipment to support the power module.

5.3.1 Remove seal plug (3-210) from outboard end of cylinder assembly (3-10).

5.3.2 Remove hex cap screws (3-90), with lockwashers (3-110), from inner end cap (3-20).

5.3.3 Refer to assembly drawing page 2 of 2 Detail "C". Remove hex nuts (3-120) from hex cap screws (3-100).

5.3.4 Standard Power Module continue at step 5.3.6 and power module with extended stop (ES) continue at step 5.3.5.

5.3.5 ES equipped power module:

5.3.5.1 Loosen ES nut (3-190).

5.3.5.2 Unscrew ES (3-180) and remove from outboard end of power module.

5.3.6 Using a male square drive extension, go through the inlet port in the outer end of power module as follows:

5.3.6.1 G2F through G13F power modules unscrew piston rod (3-40) from extension rod assembly (1-50).

5.3.6.2 G01F power modules unscrew piston rod assembly from guide block (1-30).

5.3.7 Remove Hydraulic Power Module from actuator Drive Module.

5.4 Hydraulic Power Module Installation

NOTE:

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

5.4.1 Install o-ring seal (4-90) in the seal groove located on the drive module side of inner end cap (3-20).

5.4.2 Using lifting equipment move the power module up to the drive module and align piston rod (3-40) as follows:

5.4.2.1 G2 through G13 models align piston rod (3-40) with power module extension rod assembly (1-50).

5.4.2.2 G01 models align piston rod (3-40) with the drive module guide block (1-30).

5.4.3 Using a male square drive extension, go through outer end of cylinder assembly (3-10) and install piston rod (3-40) as follows:

5.4.3.1 G2 through G13 screw piston rod (3-40) onto extension rod assembly (1-50).

5.4.3.2 G01 only screw piston rod (3-40) onto guide block (1-30).

⚠ CAUTION: DO NOT CROSS-THREAD ROD ASSY.

When screwing piston rod into the G2 through G13 extension rod assembly (1-50) or G01 guide block (1-30) make certain that the piston rod and extension rod assembly/ guide block threads do not cross-thread.

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

Table 9. Piston Rod (3-40) Torque

Housing Model	TORQUE (±5%)		Housing Model	TORQUE (±5%)	
	FT-lb.	N-m		FT-lb.	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			

5.4.5 Install lock washers (3-110) onto hex cap screws (3-90).

5.4.6 Install hex cap screws (3-90), with lockwashers (3-110), through inner end cap (3-20) and screw into housing (1-10).

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

5.4.8 Install hex cap screws (3-100), with lockwashers (3-110), through inner end cap (3-20) and housing (1-10).

5.4.9 Install hex nuts (3-120) onto hex cap screws (3-100).

5.4.10 Torque tighten hex cap screws (3-90) and (3-130) until a final lubricated torque, as listed in the following table, has been achieved.

Table 10. Piston Rod (3-40) Torque

Housing Model	TORQUE (±5%)		Housing Model	TORQUE (±5%)	
	FT-lb.	N-m		FT-lb.	N-m
G01	15	20	G7	135	183
G2	15	20	G8	214	290
G3	15	20	G10	372	504
G4	32	43	G13	521	706
G5	71	96			

5.4.11 Install seal plug (3-120) into outer end cap.

5.5 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: DO NOT DROP SPHERICAL WASHERS

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 Powr Swivl Module Installation

⚠ WARNING: CHECK OVERTRAVEL POSITION

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

Table 11. Module Weight by Item Number and Actuator Housing Size

ITEM NO.		G01F WT.	G2F WT.	G3F WT.	G4F WT.	G5F WT.	G7F WT.	G8F WT.	G10F WT.	G13F WT.	MODULE 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.	25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.5" Dia. Power Module
	Kg	11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
1	Lbs.	(1)	(1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.7" Dia. Power Module
	Kg	(1)	(1)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
3	Lbs.	(1)	(1)	(1)	N/A	N/A	N/A	N/A	N/A	N/A	2.0" Dia. Power Module
	Kg	(1)	(1)	(1)	N/A	N/A	N/A	N/A	N/A	N/A	
3	Lbs.	(1)	(1)	(1)	N/A	N/A	N/A	N/A	N/A	N/A	2.2" Dia. Power Module
	Kg	(1)	(1)	(1)	N/A	N/A	N/A	N/A	N/A	N/A	
3	Lbs.	(1)	(1)	(1)	58.4	N/A	N/A	N/A	N/A	N/A	2.5" Dia. Power Module
	Kg	(1)	(1)	(1)	26.4	N/A	N/A	N/A	N/A	N/A	
3	Lbs.	(1)	(1)	(1)	(1)	N/A	N/A	N/A	N/A	N/A	3.0" Dia. Power Module
	Kg	(1)	(1)	(1)	(1)	N/A	N/A	N/A	N/A	N/A	
3	Lbs.	(1)	(1)	(1)	70	(1)	N/A	N/A	N/A	N/A	3.5" Dia. Power Module
	Kg	(1)	(1)	(1)	31.7	(1)	N/A	N/A	N/A	N/A	
3	Lbs.	N/A	(1)	(1)	70	(1)	(1)	N/A	N/A	N/A	4.0" Dia. Power Module
	Kg	N/A	(1)	(1)	31.7	(1)	(1)	N/A	N/A	N/A	
3	Lbs.	N/A	N/A	(1)	(1)	257.5	(1)	N/A	N/A	N/A	4.5" Dia. Power Module
	Kg	N/A	N/A	(1)	(1)	116.8	(1)	N/A	N/A	N/A	
3	Lbs.	N/A	N/A	N/A	(1)	(1)	271	(1)	N/A	N/A	5.0" Dia. Power Module
	Kg	N/A	N/A	N/A	41.7	(1)	122.9	(1)	N/A	N/A	
3	Lbs.	N/A	N/A	N/A	106	(1)	257.5	(1)	(1)	N/A	6.0" Dia. Power Module
	Kg	N/A	N/A	N/A	49	(1)	116.8	(1)	(1)	N/A	
3	Lbs.	N/A	N/A	N/A	N/A	(1)	279	421	(1)	N/A	7.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	(1)	126.6	190.9	(1)	N/A	
3	Lbs.	N/A	N/A	N/A	N/A	(1)	(1)	(1)	(1)	(1)	8.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	(1)	(1)	(1)	(1)	(1)	
3	Lbs.	N/A	N/A	N/A	N/A	N/A	(1)	(1)	680	(1)	9.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	N/A	(1)	(1)	308.5	(1)	
3	Lbs.	N/A	N/A	N/A	N/A	N/A	(1)	(1)	(1)	1156	10.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	N/A	(1)	(1)	(1)	525	
3	Lbs.	N/A	N/A	N/A	N/A	N/A	N/A	(1)	(1)	(1)	12.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	N/A	N/A	(1)	(1)	(1)	

Table 11 (continued).....

ITEM NO.		G01F WT.	G2F WT.	G3F WT.	G4F WT.	G5F WT.	G7F WT.	G8F WT.	G10F WT.	G13F WT.	MODULE DESCRIPTION
3	Lbs.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	(1)	(1)	14.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	(1)	(1)	
3	Lbs.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	(1)	16.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	(1)	
3	Lbs.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	(1)	18.0" Dia. Power Module
	Kg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	(1)	
5	Lbs.	160	225	320	564	975	2740	3545	4975	10010	SR1 Spring Module
	Kg	73	102	145	256	442	1243	1608	2257	4541	
5	Lbs.	158	215	310	549	980	2630	2345	4515	9275	SR2 Spring Module
	Kg	72	98	141	249	445	1193	1064	2048	4207	
5	Lbs.	N/A	200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	SRA5 Spring Module
	Kg	N/A	91	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	180	N/A	N/A	N/A	N/A	N/A	N/A	N/A	SRA6 Spring Module
	Kg	N/A	82	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	220	310	N/A	N/A	N/A	N/A	N/A	N/A	SRF1 Spring Module
	Kg	N/A	100	141	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	210	300	N/A	N/A	N/A	N/A	N/A	N/A	SRF2 Spring Module
	Kg	N/A	95	136	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	210	285	N/A	N/A	N/A	N/A	N/A	N/A	SRF3 Spring Module
	Kg	N/A	95	129	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	195	270	N/A	N/A	N/A	N/A	N/A	N/A	SRF4 Spring Module
	Kg	N/A	88	122	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	205	N/A	N/A	N/A	N/A	N/A	N/A	N/A	SRF5 Spring Module
	Kg	N/A	93	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
5	Lbs.	N/A	185	N/A	N/A	N/A	N/A	N/A	N/A	N/A	SRF6 Spring Module
	Kg	N/A	84	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

NOTE:
(1) Weight not available at time of this procedure release. Contact Bettis factory for weights.

6.2 G01F Tool Style and Wrench Size

Table 12. G01F 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
3-80	9/32” Sq.	4	Pipe Plug	Open End or Adjustable
3-90	3/8”	4	12 Point Cap Screw	12 Point Socket
3-100	3/8”	4	12 Point Cap Screw	12 Point Socket
3-120	9/16”	4	Hex Nut	Socket
3-130	3/8”	8	12 Point Cap Screw	12 Point Socket
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	Tension Rod	Male Drive

6.3 G2F Tool Style and Wrench Size

Table 13. G2F 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
3-80	N/A	N/A	Pipe Plug	Open End or Adjustable
3-90	N/A	N/A	12 Point Cap Screw	12 Point Socket
3-100	N/A	N/A	12 Point Cap Screw	12 Point Socket
3-120	N/A	N/A	Hex Nut	Socket
3-130	N/A	N/A	12 Point Cap Screw	12 Point Socket
5-20	9/16”	6	Hex Cap Screws	Socket
7-20	9/16”	4	Hex Cap Screws	Socket
13	3/4”	2	Vent Check Assembly	Open End
-	3/8”	1	Tension Rod	Male Drive

6.4 G3F Tool Style and Wrench Size

Table 14. G3F 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
3-80	N/A	N/A	Pipe Plug	Open End or Adjustable
3-90	N/A	N/A	12 Point Cap Screw	12 Point Socket
3-100	N/A	N/A	12 Point Cap Screw	12 Point Cap Screw
3-120	N/A	N/A	Hex Nut	Socket
3-130	N/A	N/A	12 Point Cap Screw	12 Point Socket
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	Tension Rod	Male Drive

6.5 G4F Tool Style and Wrench Size

Table 15. G4F 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
3-80	9/32” Sq.	4	Pipe Plug, 1/8 NPT	Open End or Adjustable
3-90	1/2”	4	12 Point Cap Screw	12 Point Socket
3-100	1/2”	4	12 Point Cap Screw	12 Point Socket
3-120	3/4”	4	Hex Cap Screws	Socket
3-130	1/2”	8	12 Point Cap Screw	12 Point Socket
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
-	1/2”	1	Tension Rod	Male Drive

6.6 G5F Tool Style and Wrench Size

Table 16. G5F 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
3-80	9/32” Sq.	4	Pipe Plug	Open End or Adjustable
3-90	1/2”	4	12 Point Cap Screw	12 Point Socket
3-100	1/2”	4	12 Point Cap Screw	12 Point Socket
3-120	3/4”	4	Hex Cap Screws	Socket
3-130	5/8”	8	12 Point Cap Screw	12 Point Socket
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
-	1/2”	1	Tension Rod	Male Drive

6.7 G7F Tool Style and Wrench Size

Table 17. G7F 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
3-80	9/32” Sq.	4	Pipe Plug	Open End or Adjustable
3-90	15/16”	8	Hex Cap Screw	Socket
3-100	15/16”	8	Hex Cap Screw	Socket
3-120	15/16”	8	Hex Cap Screws	Socket
3-130	3/4”	8	12 Point Cap Screw	12 Point Socket
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	Tension Rod	Male Drive

6.8 G8F Tool Style and Wrench Size

Table 18. G8F 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
3-80	9/32” Sq.	4	Pipe Plug	Open End or Adjustable
3-90	3/4”	8	12 Point Cap Screw	12 Point Socket
3-100	3/4”	8	12 Point Cap Screw	12 Point Socket
3-120	1-1/8”	8	Hex Cap Screws	Socket
3-130	7/8”	8	12 Point Cap Screw	12 Point Socket
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	Tension Rod	Male Drive

6.9 G10F Tool Style and Wrench Size

Table 19. G10F 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
3-80	9/32” Sq.	4	Pipe Plug	Open End or Adjustable
3-90	1-5/16”	8	Hex Cap Screw	Socket
3-100	1-5/16”	8	Hex Cap Screw	Socket
3-120	1-5/16”	8	Hex Cap Screws	Socket
3-130	1”	8	12 Point Cap Screw	12 Point Socket
5-20	1”	8	Hex Cap Screws	Socket
7-20	1-15/16”	8	Hex Cap Screws	Socket
13	3/4”	2	Vent Check Assembly	Open End
-	3/4”	1	Tension Rod	Male Drive

6.10 G13F Tool Style and Wrench Size

Table 20. G13F 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
3-80	9/32” Sq.	4	Pipe Plug	Open End or Adjustable
3-90	1-11/16”	8	Hex Cap Screws	Socket
3-100	1-11/16”	8	Hex Cap Screws	Socket
3-120	1-11/16”	8	Hex Cap Screws	Socket
3-130	1-1/8”	10	12 Point Cap Screw	12 Point Socket
5-20	1-13/16”	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	Tension Rod	Male Drive

Section 7: Document Revision

Table 21. Revision Overview

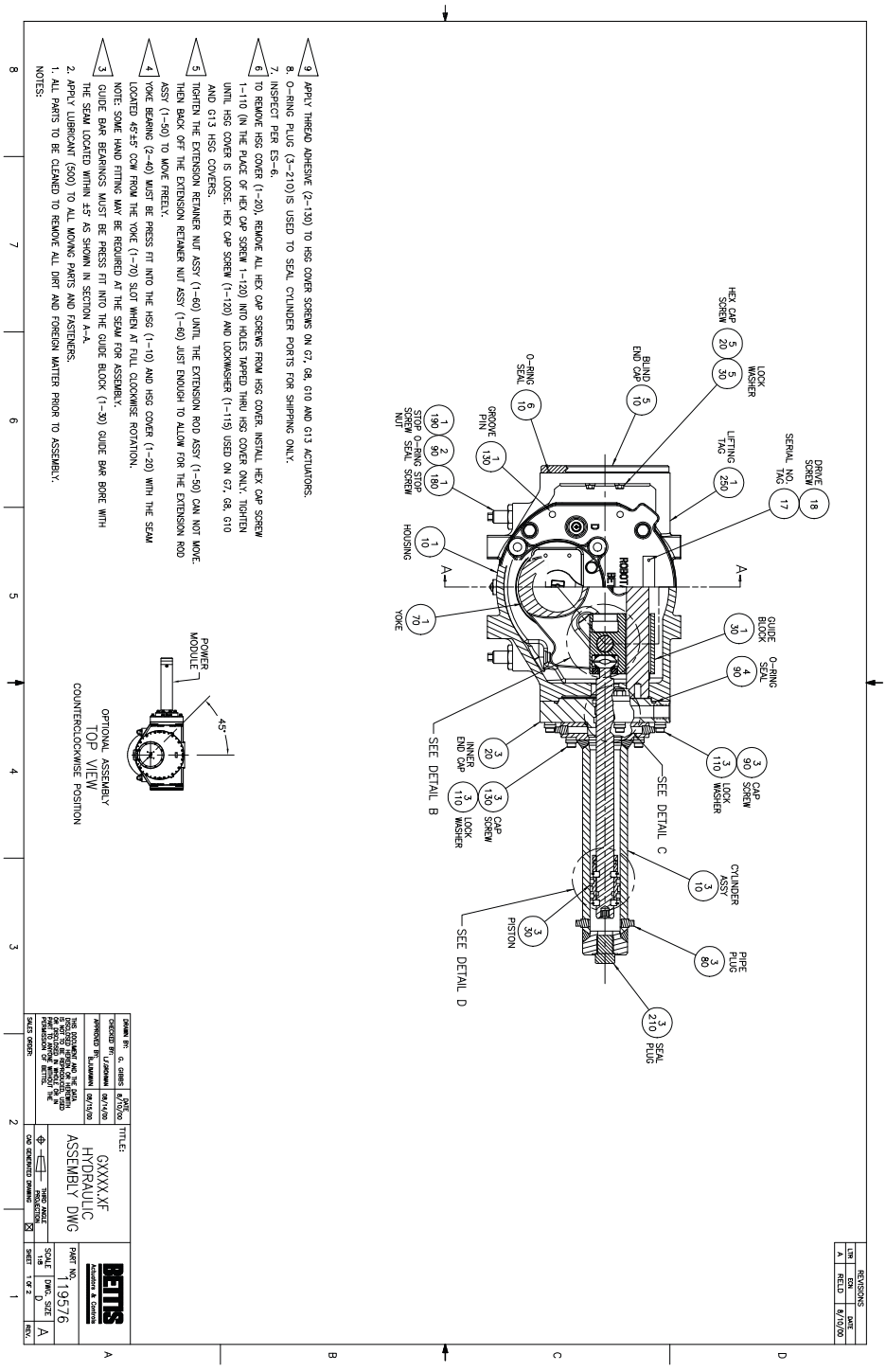
ECN	DATE	REV		BY *	DATE
Released	November 2012	C	COMPILED	C. Rico	November 2012
Reviewed			CHECKED	A. Cruz	November 2012
Approved			APPROVED	K. Chin	November 2012

* Signatures on file Bettis Actuator & Controls, Waller, List of Tables

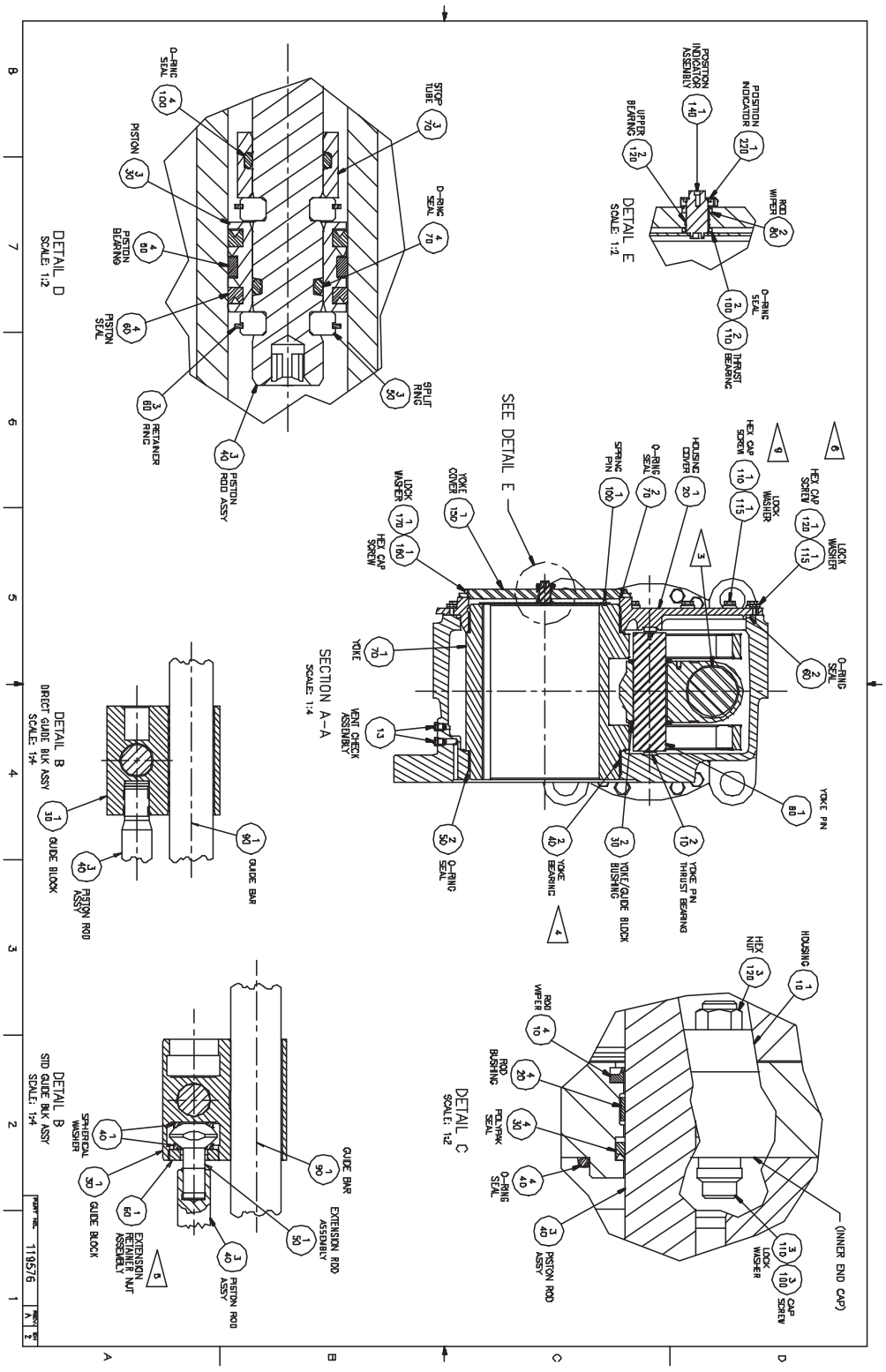
Appendix A: List of Tables

Appendix B: List of Drawings

B.1 Part No. 119576, GXXXX.XF Hydraulic Assy Dwg, Sheet 1 of 2



B.2 Part No. 119576, GXXXX.XF Hydraulic Assy Dwg, Sheet 2 of 2



B.3 Part No. 116740, GXXXXF Hydraulic Assy Dwg, Sheet X of X

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