

BETTIS

SERVICE INSTRUCTIONS

FOR MODELS

GTD SERIES

ACTUATORS

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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 GTD01X0X, GTD2X0X, GTD3X0X, GTD4X0X, GTD5X0X, and GTD7X0X Double Acting Series Actuators. These actuators will have one single GTD gas cylinder (Gas) utilizing tie bar construction and one single GTO oil cylinder (Hydraulic) utilizing tie bar construction.

1.1.2 Normal recommended service interval for this actuator series is five years to maximum total life cycle.

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 gas pressure has been removed from the actuator.

1.1.4 Remove all piping and mounted accessories that will interfere with the actuator assemblies(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 plug 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 Cylinder/Module weights are listed in Section 5 Table 5.1.

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 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 an authorized Bettis representative.

1.4 BETTIS REFERENCE MATERIALS

1.4.1 Assembly Drawing for GTD01 through GTD7 Series Actuators use part number 133202.

1.5 SERVICE SUPPORT ITEMS

1.5.1 Bettis Service Kits.

1.5.2 Non-hardening thread sealant.

1.6 LUBRICATION REQUIREMENTS

1.6.1 Bettis ESL-4, 5 & 10 lubricant. This lubricant is to be used in the Drive Module and GTD Gas Cylinder. NOTE: Bettis ESL-4, 5 & 10 lubricant tube(s) are contained in the Bettis Service Kits.

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

1.7 FLUID REQUIREMENTS

1.7.1 For use in the GTO Oil Cylinder use Dexron Automatic Transmission Fluid, or as specified.

1.7.2 This fluid is the recommended fluid only and does not limit the use of other hydraulic fluids compatible with supplied seals and coatings.

1.8 GENERAL TOOL INFORMATION

- 1.8.1 Tools: All tools are American Standard inch. Large adjustable wrench, two (2) large screwdrivers, Allen wrench set, set of open/box-end wrenches, rubber or leather mallet, torque wrench (up to 5,000 inch pounds), breaker bar, and a 1/2" drive socket set. For recommended tool and wrench sizes refer to Section 5 Tables 5.2 through 5.7

SECTION 2 - ACTUATOR DISASSEMBLY

2.1 GENERAL DISASSEMBLY

WARNING: It is very possible, that the actuator may contain a dangerous gas such as (Sour gas/H₂S, Oxygen, Nitrogen, etc.) and/or liquids such as (Condense, Descalers, Petroleum bases, etc.). Ensure that all proper measures have been taken to prevent dangerous exposure or release of these types of residues 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 actuator assemblies as needed (i.e., GTD Gas Cylinder, Drive Module or GTO Oil Cylinder).

2.1.2 The GTD gas cylinder is to be disassembled while still attached to the Drive Module.

2.1.3 The GTO oil cylinder can be disassembled while still attached to the Drive Module or it can be removed from the Drive Module and disassembled separate to the actuator (refer to Section 5 – Module, Cylinder Removal And Installation).

CAUTION: Using some means to contain hydraulic fluid as the tubing (piping) is disconnect from the GTO outer end cap (7-80) and inner end cap (7-10).

2.1.4 Disconnect all hydraulic fluid lines to GTO oil cylinder outer end cap (7-80) and inner end cap (7-10). Drain as much of the hydraulic fluid as possible.

2.1.5 To ensure correct re-assembly; that is, with GTO oil cylinder or GTD gas cylinder on same end of Drive Module as was, mark or tag right (or left) and mark mating surfaces.

2.2 GTD GAS CYLINDER DISASSEMBLY

NOTE: 1. Review Section 2 notes and steps 2.1.1 through 2.1.5 General Disassembly before proceeding with GTD gas cylinder disassembly.

WARNING: If not already removed disconnect all operating pressure from actuator GTD gas cylinder .

- 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 The setting of stop screw (3-180) should be checked and setting recorded before loosened or removed. NOTE: The stop screw will be removed later in this procedure.
- 2.2.3 Remove the jam nut (3-190) and o-ring seal (4-100) from stop screw (3-180).
- 2.2.4 Remove hex nuts (3-90), with lockwashers (3-95), from tie bars (3-20).
- 2.2.5 Remove outer end cap (3-80) from cylinder (3-70). and tie bars (3-20).
- 2.2.6 Remove stop screw assembly (3-180) from the inboard side of outer end cap (3-80).
- 2.2.7 Unscrew and remove tie bars (3-20) from inner end cap (3-10).
- 2.2.8 Remove cylinder (3-70) from piston (3-30) and inner end cap (3-10).
- 2.2.9 Refer to assembly drawing page 2 of 2 Detail "C". Remove two split ring halves (3-50) and one retainer ring (3-60) from outboard end of piston rod assembly (3-40).
- 2.2.10 Remove the piston (3-30) from piston rod assembly (3-40).
- 2.2.11 On model GTD4008.0 remove the end cap/cylinder adapter (3-260) from inner end cap (3-10).
- 2.2.12 Remove o-ring seal (4-70) from piston rod assembly (3-40).
- 2.2.13 Remove the remaining two split ring halves (3-50) and one retainer ring (3-60) from piston rod assembly (3-40).
- 2.2.14 Remove socket cap screws (3-115) with lockwashers (3-110) from inner end cap (3-10).
- 2.2.15 Refer to assembly drawing page 2 of 2 Detail "B". Remove hex nuts (3-105) from socket cap screws (3-100).
- 2.2.16 Remove socket cap screws (3-100) with lockwashers (3-110) from inner end cap (3-10).
- 2.2.17 Remove inner end cap (3-10) off of piston rod assembly (3-40).
- 2.2.18 Unscrew and remove piston rod assembly (3-40) from drive module.
- 2.2.19 It is not necessary to remove pipe plugs (3-210) from inner end cap (3-10) and outer end cap (3-80) for normal or routine actuator service.

2.3 GTO OIL CYLINDER DISASSEMBLY

NOTE: Review Section 2 notes and steps 2.1.1 through 2.1.4 General Disassembly before proceeding with GTO oil cylinder disassembly.

NOTE: The GTO oil cylinder can either be disassembled piece by piece or removed per Section 4.1 and disassembled on a work bench per the following steps.

- 2.3.1 Mark and record location of the ports on outer end cap (7-80) and inner end cap (7-10).
- 2.3.2 The setting of stop screw (7-180) should be checked and setting recorded before loosened or removed. NOTE: The stop screw will be removed later in this procedure.
- 2.3.3 Remove the jam nut (7-190) from stop screw (7-180).
- 2.3.4 Remove stop screw (7-180) from outer end cap (7-80).
- 2.3.5 Remove hex nuts (7-90), with lockwashers (7-95), from tie bars (7-20).
- 2.3.6 Remove outer end cap (7-80) from cylinder (7-70) and tie bars (7-20).
- 2.3.7 Unscrew and remove tie bars (7-20) from inner end cap (7-10).
- 2.3.8 Remove the cylinder (7-70) from piston (7-30) and inner end cap (7-10).
- 2.3.9 Refer to assembly drawing page 2 of 2 Detail "E". Remove two split ring halves (7-50) and one retainer ring (7-60) from outboard end of piston rod assembly (7-40).
- 2.3.10 Remove the piston (7-30) from piston rod assembly (7-40).
- 2.3.11 Remove the o-ring seal (8-70) from piston rod assembly (7-40).
- 2.3.12 Remove the remaining two split ring halves (7-50) and one retainer ring (7-60) from piston rod assembly (7-40).
- 2.3.13 Remove socket cap screws (7-115) with lockwashers (7-110) from inner end cap (7-10).
- 2.3.14 Refer to assembly drawing page 2 of 2 Detail "D". Remove hex nuts (7-105) from socket cap screws (7-100).
- 2.3.15 Remove socket cap screws (7-100) with lockwashers (7-110) from inner end cap (7-10).
- 2.3.16 Remove inner end cap (7-10) off of piston rod assembly (7-40).
- 2.3.17 Unscrew and remove piston rod assembly (7-40) from drive module.
- 2.3.18 It is not necessary to remove pipe plugs (7-210) from inner end cap (7-10) and outer end cap (7-80) for normal or routine actuator service.

2.4 DRIVE MODULE DISASSEMBLY

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

- 2.4.1 If not already removed remove piston rod assemblies (3-40) and (7-40) from drive module (1-10).

NOTE: For steps 2.4.2 through 2.4.9 refer to assembly drawing page 2 of 2 Section A-A and Detail "A".

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

NOTE: Step 2.4.3 is used only on GTD01, GTD2 and GTD3 Drive Modules. Drive Modules GTD4 and GTD5 will skip steps 2.4.3 and continue with step 2.4.4.

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

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

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

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

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

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

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

NOTE: Steps 2.4.10 and 2.4.11 are used only on GTD7 drive module (refer to assembly drawing note number five). Drive modules GTD01, GTD2, GTD3, GTD4 and GTD5 will skip steps 2.4.10 and 2.4.11 and continue with step 2.4.12.

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

2.4.11 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 groove pins (1-130).

NOTE: GTD01, GTD2, GTD3 and GTD4 model housing cover (1-20) will have cast tabs for placing prying tools to aid in cover removal.

2.4.12 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.

2.4.13 Remove guide bar (1-90) from housing (1-10).

2.4.14 Rotate the arms of yoke (1-70) to the center position of housing (1-10).

2.4.15 Remove yoke (1-70) with yoke pin (1-80), guide block assembly (1-30) and two yoke/guide block bushings (2-30) by lifting yoke up and out of the housing (1-10).

2.4.16 Remove yoke pin (1-80) by inserting 3/8"-16 UNC screw into top of the yoke pin and pull straight up and out.

- 2.4.17 Remove the guide block assembly (1-30) from between the arms of yoke (1-70).
- 2.4.18 Remove the yoke/guide block bushing (2-30) from top of guide block assembly (1-30).
- 2.4.19 Remove the yoke/guide block bushing (2-30) from the top of the lower yoke arm of yoke (1-70).
- 2.4.20 Unscrew and remove two stop screw plugs (1-180) from housing (1-10).
- 2.4.21 Housing (1-10) vent check assembly removal as follows:
 - 2.4.21.1 GTD01, GTD2 and GTD3 housing (1-10) unscrew and remove one vent check assembly (13) from the front of housing (1-10).
 - 2.4.21.2 GTD4 through GTD7 housing (1-10) unscrew and remove two vent check assemblies (13) from the front of housing (1-10).
- 2.4.22 The following items do not need to be removed from their assembled locations unless being replaced by new items: Two yoke bearings (2-40), yoke pin bearing and yoke pin thrust bearing (2-10).

SECTION 3 - ACTUATOR REASSEMBLY

3.1 GENERAL REASSEMBLY

CAUTION: Only new seals, that are still within the seals expectant shelf life, should be installed 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 assembly 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 drive module and GTD gas cylinder will be assembled using lubricant as identified in Section 1 step 1.6.1. The parts and seals used in the actuator GTO oil cylinder will be assembled using lubricant as identified in Section 1 step 1.7.1.

3.2 DRIVE MODULE REASSEMBLY

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

3.2.1 If the guide bar bearings are being replaced install new bearings into guide block assembly (1-30).

NOTE: The guide bar bearing 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.

3.2.2 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.

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

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

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

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

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

3.2.8 Align hole in guide block assembly (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).

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

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

- 3.2.11 Refer to assembly drawing page 2 of 2 Section A-A. Install spring pin (1-100) into the top of yoke (1-70).
- 3.2.12 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 2.4.6 for correct installation position.
- 3.2.13 Install o-ring (2-50) into housing cover (1-20).
- 3.2.14 Install housing cover o-ring (2-60) into housing cover (1-20).
- 3.2.15 Install the housing cover (1-20), being careful not to damage o-ring seals (2-50) and (2-60).
- 3.2.16 Place lockwashers (1-115) onto hex cap screws (1-110).
- NOTE: On GTD7 model actuators apply thread adhesive, Loctite 242, to threads of hex cap screws (1-110). Reference assembly drawing note number seven.
- 3.2.17 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.
- 3.2.18 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.
- 3.2.19 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							
MODE	QTY	TORQUE		MODEL	QTY	TORQUE	
		(± 5 % Percent)				(± 5 % Percent)	
		FT-lb	N-m			FT-lb	N-m
GTD01	4	40	54	GTD7	8	100	136
GTD2	6	40	54	GTD8	12	100	136
GTD3	8	40	54	GTD10	16	100	136
GTD4	8	40	54	GTD13	20	340	461
GTD5	8	100	136				

NOTE: Complete step 3.2.20 on GTD5, through GTD7 model actuators. For GTD01 through GTD4 model actuators skip step 3.2.20 and proceed to step 3.2.21.

- 3.2.20 On GTD5 through GTD7 models (refer to assembly drawing note number five).

3.2.20.1 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.

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

NOTE: For steps 3.2.21 through 3.2.25 refer to assembly drawing page 2 of 2 Section A-A and Detail "A".

- 3.2.21 Install thrust bearing (2-110) onto position indicator (1-140).
- 3.2.22 Install o-ring seal (2-100) onto position indicator (1-140).
- 3.2.23 Install upper bearing (2-120) into yoke cover (1-150).
- 3.2.24 Install rod wiper (2-80) into yoke cover (1-150).
- 3.2.25 Install o-ring seal (2-70) into yoke cover (1-150).
- 3.2.26 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).
- 3.2.27 Place lockwashers (1-170) onto hex cap screws (1-160).
- 3.2.28 Install and tighten hex cap screws (1-160) with lockwashers through yoke cover (1-150) and into housing cover (1-20).
- 3.2.29 Vent check assembly installation as follows:
 - 3.2.29.1 GTD01, GTD2 and GTD3 housing (1-10) using pipe sealant install one vent check assembly (13) into the front of housing (1-10).
 - 3.2.29.2 GTD01, GTD2 and GTD3 housing (1-10) using pipe sealant install one vent check assembly (13) into the top area of housing cover (1-20).
 - 3.2.29.3 GTD4 through GTD7 housing (1-10) using pipe sealant install two vent check assemblies (13) into the front of housing (1-10).
- 3.2.30 NOTE: Refer to Section 2 step 2.4.2 for correct position indicator placement. Install position indicator (1-220) over the exposed shaft of position indicator assembly (1-140).
- 3.2.31 Install o-ring seals (2-90) onto stop screw plugs (1-180).
- 3.2.32 Install and tighten two stop screw plugs (1-180) into two stop screw plug holes on the front of housing (1-10).

3.3 GTD GAS CYLINDER REASSEMBLY

NOTE: Review Section 3.1 General Reassembly before proceeding with GTD gas cylinder reassembly.

NOTE: Reassemble the GTD gas cylinder on a work bench per the following steps and then install on the Drive Module per this section.

NOTE: In Section 3.3 where the step indicates to "lubricate or coat with lubricant", use lubricant as listed in Section 1.6 for lubricating of the part being installed.

NOTE: For steps 3.3.2 through 3.3.5 refer to assembly drawing page 2 of 2 Detail "C".

- 3.3.1 Lubricate piston rod assembly (3-40) with lubricant.
- 3.3.2 Install o-ring seal (4-70) into the seal groove in piston rod assembly (3-40).
- 3.3.3 Install two split ring halves (3-50) into the inner most groove in piston rod assembly (3-40) and retain with one retainer ring (3-60).
- 3.3.4 Install piston (3-30) onto piston rod assembly (3-40) and up against split rings installed in step 3.3.3.
- 3.3.5 Install two split ring halves (3-50) into the outer most groove in piston rod assembly (3-40) and retain with one retainer ring (3-60).
- 3.3.6 Apply lubricant to the bore of cylinder (3-70).
- 3.3.7 Coat one piston bearing (4-45) with lubricant and install into the piston external bearing groove.
- 3.3.8 Install piston (3-30), with piston rod assembly (3-40), into cylinder (3-70) leave the inner most piston seal groove exposed outside of the cylinder.
- 3.3.9 Coat one piston seal (4-60) with lubricant and install into the exposed 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 lubricant and install into the piston external seal groove.

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

NOTE: Step 3.3.12 is used only on GTD4008.0 actuator Models. All other actuator models will skip steps 3.3.12 and continue with step 3.3.13.

- 3.3.12 GTD4008.0 actuator Models.

- 3.3.12.1 Install o-ring seal (4-40) onto outboard side of end cap/cylinder adapter (3-260).
- 3.3.12.2 Refer to assembly drawing page 1 of 2 Detail "F". Install o-ring seal (4-35) onto inboard face of end cap/cylinder adapter (3-260).
- 3.3.12.3 Install end cap/cylinder adapter (3-260) over piston rod assembly (3-40) and into inboard end of cylinder (3-70).

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

CAUTION: Install Polypak seal with energizer ring facing piston side of inner end cap.

3.3.14 Install rod bushing (4-20) into inner end cap (3-10).

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

3.3.16 Install one o-ring seal (4-90) into inboard face of inner end cap (3-10).

3.3.17 Install one o-ring seal (4-40) into outboard face of inner end cap (3-10).

3.3.18 Install inner end cap (3-10) onto piston rod assembly (3-40) and into inboard end of cylinder (3-70).

3.3.19 Install 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 (3-10) per instructions given in note number eight located on the assembly drawing page 1 of 2.

3.3.20 Temporarily install outer end cap (3-80) into open end of cylinder (3-70).

3.3.21 Install the hex nuts (3-90) onto tie bars (3-20) and temporarily tighten against outer end cap (3-80).

3.3.22 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).

3.3.23 Using lifting equipment move the power module up to housing (1-10) and align piston rod assembly (3-40) with guide block assembly (1-30).

3.3.24 Using a male square drive extension, go through outer end cap (3-80) and screw piston rod assembly (3-40) into guide block assembly (1-30).

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

3.3.25 Torque tighten piston rod assembly (3-40) until a final lubricated torque, as listed in the following table, has been achieved.

PISTON ROD ASSEMBLY TORQUE INFORMATION					
HOUSING MODEL	TORQUE (±5 % Percent)		HOUSING MODEL	TORQUE (±5 % Percent)	
	FT-lb	N-m		FT-lb	N-m
GTD01	131	178	GTD7	240	325
GTD2	196	266	GTD8	240	325
GTD3	240	325	GTD10	240	325
GTD4	240	325	GTD13	240	325
GTD5	240	325			

- 3.3.26 Install lock washers (3-110) onto socket cap screws (3-115).
- 3.3.27 Install socket cap screws (3-115), with lockwashers (3-110), through inner end cap (3-10) and screw into housing (1-10).
- 3.3.28 Refer to assembly drawing page 2 of 2 Detail "B". Install lock washers (3-110) onto socket cap screws (3-100).
- 3.3.29 Install socket cap screws (3-100), with lockwashers (3-110), through inner end cap (3-10) and housing (1-10).
- 3.3.30 Install hex nuts (3-105) onto socket cap screws (3-100).
- 3.3.31 Remove hex nuts (3-90) from tie bars (3-20).
- 3.3.32 Remove outer end cap (3-80) from cylinder (3-70), and tie bars (3-20).
- 3.3.33 Lubricate stop screw (3-180) and install into the outer end cap (3-80). NOTE: The stop screw is installed from the inboard side or cylinder side of the outer end cap (3-80).
- 3.3.34 Install o-ring seal (4-100) onto the out board side of the stop screw (3-180).
- 3.3.35 Install jam nut (3-190) onto the out board side of the stop screw (3-180).
- 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.
- 3.3.36 Install outer end cap (3-80) over tie bars (3-20) and into open end of cylinder (3-70).
- 3.3.37 Install lockwashers (3-95) onto tie bars (3-20) and up against outer end cap (3-80).
- 3.3.38 Install hex nuts (3-90) onto tie bars (3-20) and up against lockwashers (3-95).
- 3.3.39 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
GTD01	70	95	GTD7	466	632
GTD2	70	95	GTD8	680	922
GTD3	125	169	GTD10	875	1186
GTD4	190	258	GTD13	1367	1854
GTD5	330	447			

- 3.3.40 Adjust stop screw (3-180) back to settings recorded earlier in Section 2 at step 2.2.2.
- 3.3.41 Tighten jam nut (3-190) securely.

3.3.42 If removed apply thread sealant to two pipe plugs (3-210) and install into the ports of outer end cap (3-10) and inner end cap (3-80).

3.4 GTO OIL CYLINDER REASSEMBLY

NOTE: Review section 3.1 General Reassembly before proceeding with GTO oil cylinder reassembly.

NOTE: Reassemble the GTO oil cylinder on a work bench per the following steps and then install on the Drive Module per Section 4.

NOTE: In section 3.4 where the step indicates to "lubricate, coat or apply fluid", use hydraulic fluid for lubricating the part being installed.

3.4.1 Lubricate piston rod assembly (7-40) with fluid.

NOTE: For steps 3.4.2 through 3.4.7 refer to assembly drawing page 2 of 2 Detail "E".

3.4.2 Install o-ring seal (8-70) into the seal groove in piston rod assembly (7-40).

3.4.3 Install two split ring halves (7-50) into the inner most groove in piston rod assembly (7-40) and retain with one retainer ring (7-60).

3.4.4 Install piston (7-30) onto piston rod assembly (7-40) and up against split rings installed in step 3.4.3.

3.4.5 Install two split ring halves (7-50) into the outer most groove in piston rod assembly (7-40) and retain with one retainer ring (7-60).

3.4.6 Apply fluid to the bore of cylinder (7-70).

3.4.7 Coat one piston bearing (8-45) with fluid and install into the piston external seal groove.

3.4.8 Install piston (7-30), with piston rod assembly (7-40), into cylinder (7-70) leave the inner most piston seal groove exposed out side of the cylinder.

3.4.9 Coat one piston seal (8-60) with fluid and install into the exposed piston external seal groove.

CAUTION: Install the piston seal with energizer ring facing outside edge of piston (7-30).

3.4.10 Push the piston through the cylinder (7-70) until the outboard piston seal groove is exposed.

NOTE: To move the piston (7-30) through the bore of cylinder (7-70) may require mechanical assistance.

3.4.11 Coat one piston seal (8-60) with fluid and install into the exposed piston external seal groove.

CAUTION: Install the piston seal with energizer ring facing outside edge of piston (7-30).

3.4.12 Refer to assembly drawing page 2 of 2 Detail "D". Coat Polypak seal (8-30) with hydraulic fluid and install, lip first, into inner end cap (7-10).

CAUTION: Install the Polypak seal with energizer ring facing piston side of inner end cap (7-10).

3.4.13 Install rod bushing (8-20) into inner end cap (7-10).

3.4.14 Install rod wiper (8-10) into inner end cap (7-10).

3.4.15 Install one o-ring seal (8-90) into inboard face of inner end cap (7-10).

3.4.16 Install one o-ring seal (8-40) into outboard face of inner end cap (3-10).

3.4.17 Install inner end cap (7-10) onto piston rod assembly (7-40) and into inboard end of cylinder (7-70).

3.4.18 Install two tie bars (7-20) into inner end cap (7-10). NOTE: the tie bars should be installed across from each other.

3.4.19 Install one o-ring seal (8-40) into inboard face of outer end cap (7-80).

3.4.20 Install outer end cap (7-80) into open end of cylinder (7-70).

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 2.2.3.

3.4.21 Install the remaining tie bars (7-20) through outer end cap (7-80) and into inner end cap (7-10). Screw all tie bars (7-20) into inner end cap (7-10) per instructions given in note number eight located on the assembly drawing page 1 of 2.

3.4.22 Install lockwashers (7-95) onto tie bars (7-20) and up against outer end cap (7-80).

3.4.23 Install hex nuts (7-90) onto tie bars (7-20) and up against lockwashers (7-95).

3.4.24 Torque tighten hex nuts (7-90) until a final lubricated torque, as listed in the following table, has been achieved.

TIE BAR NUTS (7-90) TORQUE TABLE					
HOUSING MODEL	TORQUE (±5 % Percent)		HOUSING MODEL	TORQUE (±5 % Percent)	
	FT-lb	N-m		FT-lb	N-m
GTD01	70	95	GTD7	466	632
GTD2	70	95	GTD8	680	922
GTD3	125	169	GTD10	875	1186
GTD4	190	258	GTD13	1367	1854
GTD5	330	447			

3.4.25 Lubricate stop screw (7-180) and install into the outer end cap (7-80). NOTE: The stop screw is installed from the outboard side of the outer end cap (7-80).

- 3.4.26 Install o-ring seal (8-100) onto the out board side of the stop screw (7-180).
- 3.4.27 Install jam nut (7-190) onto the out board side of the stop screw (7-180).
- 3.4.28 Adjust stop screw (7-180) back to settings recorded earlier in Section 2 at step 2.3.2.
- 3.4.29 Tighten jam nut (7-190) securely.
- 3.4.30 If removed apply thread sealant to two pipe plugs (7-210) and install into the ports of outer end cap (7-10) and inner end cap (7-80).
- 3.4.31 For installation of the GTO oil cylinder onto Drive Module (housing) refer to Section 4 step 4.2 for GTO oil cylinder installation instructions.

3.5 ACTUATOR TESTING

- 3.5.1 Leakage Test - All sources of leakage to atmosphere and across pistons are to be checked, using pneumatic pressure.
 - 3.5.2 Cycle the actuator five time at 10 % percent of the operating pressure, as listed on the actuator name tag under max. pressure or use a minimum 80 to 100 psig 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.

SECTION 4 - MODULE, CYLINDER REMOVAL AND INSTALLATION

NOTE: The GTO oil cylinder is the only GTD actuator component that can be remove as a module.

4.1 GTO OIL CYLINDER REMOVAL

CAUTION: Using some means to contain hydraulic fluid as the tubing (piping) is disconnect from the GTO outer end cap (7-80) and inner end cap (7-10).

- 4.1.1 Disconnect all hydraulic fluid lines to GTO oil cylinder outer end cap (7-80) and inner end cap (7-10). Drain as much of the hydraulic fluid as possible.

- 4.1.2 The setting of stop screw (7-180) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screws will be removed later in this procedure.
- 4.1.3 Loosen and back off jam nut (7-190) at least two rotations.
- 4.1.4 Remove stop screw (7-180) from outer end cap (7-80).
- 4.1.5 Using a male square drive extension, go through outer end cap (7-80), unscrew piston rod assembly (7-40) from guide block assembly (1-30).

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

- 4.1.6 Remove socket cap screws (7-115), with lockwashers (7-110), from inner end cap (7-10).
- 4.1.7 Remove hex nuts (7-105) from socket cap screws (7-100).
- 4.1.8 Remove GTO oil cylinder from actuator housing (1-10).

4.2 GTO OIL CYLINDER INSTALLATION

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

- 4.2.1 The setting of stop screw (7-180) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screw (7-180) will be removed later in this procedure.
- 4.2.2 Loosen or remove the jam nut (7-190) from stop screw (7-180).
- 4.2.3 Remove stop screw (7-180) from outer end cap (7-80).
- 4.2.4 Check to verify that o-ring seal (8-90) is properly seated in its seal groove located on the housing side of inner end cap (7-10).
- 4.2.5 Using lifting equipment move the oil cylinder up to housing (1-10) and align piston rod assembly (7-40) with guide block assembly (1-30).
- 4.2.6 Using a male square drive extension, go through the vacant stop screw hole located in outer end cap (7-80) and screw piston rod assembly (7-40) into guide block assembly (1-30).

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

- 4.2.7 Torque tighten piston rod assembly (7-40) until a final lubricated torque, as listed in the following table, has been achieved.

PISTON ROD ASSEMBLY TORQUE INFORMATION					
HOUSING MODEL	TORQUE (±5 % Percent)		HOUSING MODEL	TORQUE (±5 % Percent)	
	FT-lb	N-m		FT-lb	N-m
GTD01	131	178	GTD7	240	325
GTD2	196	266	GTD8	240	325
GTD3	240	325	GTD10	240	325
GTD4	240	325	GTD13	240	325
GTD5	240	325			

- 4.2.8 Install lock washers (7-110) onto socket cap screws (7-115).
- 4.2.9 Install socket cap screws (7-115), with lockwashers (7-110), through inner end cap (7-10) and screw into housing (1-10).
- 4.2.10 Install lock washers (7-110) onto socket cap screws (7-100).
- 4.2.11 Install socket cap screws (7-100), with lockwashers (7-110), through inner end cap (7-10) and housing (1-10).
- 4.2.12 Install and tighten hex nuts (7-105) onto socket cap screws (7-100).
- 4.2.13 Lubricate stop screw (7-180) and install into the outer end cap (7-80). NOTE: The stop screw is installed from the outboard side of the outer end cap (7-80).
- 4.2.14 Verify that o-ring seal (8-100) is installed on the stop screw (7-180).
- 4.2.15 Install jam nut (7-190) onto the out board side of the stop screw (7-180).
- 4.2.16 Adjust stop screw (7-180) per step 4.2.16.1 or 4.2.16.2.
- 4.2.16.1 Adjust stop screw (7-180) back to settings recorded earlier in either step 2.3.2 or 4.2.1.
- 4.2.16.2 Adjust stop screw (7-180) to setting as instructed by the valve manufactures procedures for actuator stop requirements.
- 4.2.17 Tighten jam nut (7-190) securely.

5.2 GTD01 TOOL STYLE AND WRENCH SIZE

ITEM NO.	WRENCH SIZE	ITEM QTY	LOCATION OR DESCRIPTION	RECOMMENDED TOOL STYLE
1-110	9/16"	4	Hex Cap Screws	Socket
1-160	1/2"	4	Hex Cap Screws	Socket
1-180	1-1/16"	2	Hex Cap Screws	Open End or Adjustable
3-40	3/8" Sq.	1	Piston Rod Assembly	Male Drive
3-90	15/16"	4	Standard Hex Nuts	Socket
3-100	5/16"	4	Socket Cap Screws	Allen
3-105	9/16"	4	Standard Hex Nuts	Open End Or Box end
3-115	5/16"	4	Socket Cap Screws	Allen
3-180	3/4" Sq.	1	Stop Screw Assembly	Open End or Adjustable
3-190	1-13/16"	1	Heavy Hex Jam Nut	Open End or Adjustable
3-210	7/16" Sq.	2	Pipe Plug	Open End or Adjustable
7-40	3/8" Sq.	1	Piston Rod Assembly	Male Drive
7-90	15/16"	4	Standard Hex Nuts	Socket
7-100	5/16"	4	Socket Cap Screws	Allen
7-105	9/16"	4	Standard Hex Nuts	Socket
7-115	9/16"	4	Socket Cap Screws	Allen
7-180	3/4"	1	Stop Screw Assembly	Open End or Adjustable
7-190	1-13/16"	1	Heavy Hex Jam Nut	Open End or Adjustable
7-210	7/16" Sq.	2	Pipe Plug	Open End or Adjustable
13	3/4"	2	Vent Check Assembly	Open End

5.3 GTD2 TOOL STYLE AND WRENCH SIZE

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

5.4 GTD3 TOOL STYLE AND WRENCH SIZE

ITEM NO.	WRENCH SIZE	ITEM QTY	LOCATION OR DESCRIPTION	RECOMMENDED TOOL STYLE
1-110	9/16"	8	Hex Cap Screw	Socket
1-160	9/16"	4	Hex Cap Screw	Socket
1-180	1-5/16"	2	Hex Cap Screw	Open End or Adjustable
3-40	3/8" Sq.	1	Piston Rod Assembly	Male Drive
3-90	1-1/8"	6	Standard Hex Nuts	Socket
3-100	5/16"	4	Socket Cap Screws	Allen
3-105	9/16"	4	Standard Hex Nuts	Open End Or Box end
3-115	5/16"	4	Socket Cap Screws	Allen
3-180	3/4"	1	Stop Screw Assembly	Open End or Adjustable
3-190	1-13/16"	1	Heavy Hex Jam Nut	Open End or Adjustable
3-210	7/16" Sq.	2	Pipe Plug	Open End or Adjustable
7-40	3/8" Sq.	1	Piston Rod Assembly	Male Drive
7-90	1-1/8"	6	Standard Hex Nuts	Socket
7-100	5/16"	4	Socket Cap Screws	Allen
7-105	9/16"	4	Standard Hex Nuts	Socket
7-115	5/16"	4	Socket Cap Screws	Allen
7-180	3/4"	1	Stop Screw Assembly	Open End or Adjustable
7-190	1-13/16"	1	Heavy Hex Jam Nut	Open End or Adjustable
7-210	7/16" Sq.	2	Pipe Plug	Open End or Adjustable
13	3/4"	2	Vent Check Assembly	Open End

5.5 GTD4 TOOL STYLE AND WRENCH SIZE

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

5.6 GTD5 TOOL STYLE AND WRENCH SIZE

ITEM NO.	WRENCH SIZE	ITEM QTY	LOCATION OR DESCRIPTION	RECOMMENDED TOOL STYLE
1-110	3/4"	8	Hex Cap Screw	Socket
1-120	3/4"	4	Hex Cap Screw	Socket
1-160	9/16"	6	Hex Cap Screws	Socket
1-180	2-3/8"	2	Hex Cap Screw	Open End or Adjustable
3-40	3/4Sq.	1	Piston Rod Assembly	Male Drive
3-90	1-1/2"	6	Standard Hex Nuts	Socket
3-100	3/8"	8	Socket Cap Screws	Allen
3-105	3/4"	4	Standard Hex Nuts	Open End Or Box end
3-115	3/8"	4	Socket Cap Screws	Allen
3-180	1-1/4"Sq.	1	Stop Screw Asswmbly,GTD5	Open End or Adjustable
3-210	9/16"Sq.	4	O-Ring Plug	Open End or Adjustable
7-40	3/4Sq.	1	Piston Rod Assembly	Male Drive
7-90	1-1/2"	6	Standard Hex Nuts	Socket
7-100	3/8"	8	Socket Cap Screws	Allen
7-105	3/4"	4	Standard Hex Nuts	Socket
7-115	3/8"	4	Socket Cap Screws	Allen
7-180	1-1/4"Sq.	1	Stop Screw Asswmbly,GTD5	Open End or Adjustable
7-210	9/16"Sq.	4	O-Ring Plug	Open End or Adjustable
13	3/4"	2	Vent Check Assembly	Open End

5.7 GTD7 TOOL STYLE AND WRENCH SIZE

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

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