

BETTIS

SERVICE INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY

FOR MODEL

HD731

DOUBLE ACTING SERIES

PNEUMATIC ACTUATORS

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CONTENTS

	Page
<u>SECTION 1 - INTRODUCTION</u>	2
1.1 GENERAL SERVICE INFORMATION	2
1.2 DEFINITIONS:	3
1.3 GENERAL SAFETY INFORMATION.....	3
1.4 BETTIS REFERENCE MATERIALS	3
1.5 SUPPORT ITEMS AND TOOLS.....	3
1.6 LUBRICATION REQUIREMENTS	4
<u>SECTION 2 – ACTUATOR DISASSEMBLY</u>	4
2.1 GENERAL DISASSEMBLY	4
2.2 PRESSURE CYLINDER REMOVAL.....	5
2.3 ROD COVER DISASSEMBLY	5
2.4 HOUSING DISASSEMBLY.....	6
2.5 CYLINDER ASSEMBLY M3 JACKSCREW DISASSEMBLY	6
2.6 ROD COVER M3 JACKSCREW DISASSEMBLY	8
<u>SECTION 3 – ACTUATOR REASSEMBLY</u>	10
3.1 GENERAL REASSEMBLY	10
3.2 HOUSING REASSEMBLY	10
3.3 PRESSURE CYLINDER REASSEMBLY	12
3.4 M3 JACKSCREW REASSEMBLY TO ROD COVER.....	14
3.5 M3 JACKSCREW REASSEMBLY CYLINDER ASSEMBLY	16
3.6 ACTUATOR TESTING	18
3.7 RETURN TO SERVICE	19
<u>SECTION 4 – ACTUATOR SUPPORT INFORMATION</u>	20
4.1 ACTUATOR WEIGHT TABLE	20
4.2 TOOL TABLE	21
4.3 PRODUCR IMPROVEMENT AND REVISIONS	21

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, HD731, HD731-M3 and HD731-M3HW Double Acting Series Pneumatic Actuators (includes actuator models that have a -10 or -11 suffix at the end of the model number).

NOTE: When the model number has "-S" as a suffix then the actuator is special and may have some differences that are not included in this procedure.

1.1.2 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 Also, it is understood that the actuator has been removed from the valve as well as all piping and accessories that are mounted on the actuator have been removed.

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, exploded detail drawings and actuator parts list.

1.1.7 This procedure is written using the following Actuator references:

1.1.7.1 Stop screw side of housing (1-10) will be considered the front of the actuator.

1.1.7.2 Housing cover (1-20) will be the top of the actuator.

1.1.8 Some HD series actuator models are heavy and will require a means of assistance. For actuator approximate weight refer to Section 4 table 4.1.

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

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

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

1.1.11 Bettis recommends that disassembly of the actuator 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.

M3: Jackscrew or jackscrew assembly.

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 a well trained, equipped, prepared and competent technician.

WARNING: For the protection of personnel working on Bettis actuators, this procedure should be reviewed and implemented for safe disassembly and reassembly. Close attention should be noted to the WARNINGS, CAUTIONS and NOTES contained in this procedure.

WARNING: This procedure should not supersede or replace any 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 customers representative and an authorized Bettis representative.

1.4 **BETTIS REFERENCE MATERIALS**

1.4.1 Assembly drawing 036223 for model HD731 Series.

1.4.2 Exploded Detail drawing 063360* for model HD731 Series.

1.4.3 Exploded Detail drawing 068126* for models HD731-M3 and HD731-M3HW Series.

* Exploded Detail drawings are included in the standard Bettis Service Kit.

1.5 **SUPPORT ITEMS AND TOOLS**

1.5.1 Support Items - Service Kit, commercial leak testing solution, and non-hardening thread sealant.

1.5.2 Tools - All tools / Hexagons are American Standard inch (Imperial). Two each medium standard screwdrivers, small standard screwdriver with corners rounded, putty knife, rubber or leather mallet and a torque wrench (up to 2,000 inch pounds / 226 N-m). Refer to Section 4 table 4.2 for recommended tool style and size.

1.6 LUBRICATION REQUIREMENTS

1.6.1 The actuator should be re-lubricated at the beginning of each service interval using the following recommended lubricant.

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

1.6.2. 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 and the tube is marked ESL-4,5 & 10 lubricant.

SECTION 2 – ACTUATOR DISASSEMBLY

2.1 GENERAL DISASSEMBLY

NOTE: Review Section 1 General Service Information prior to starting Section 2.

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

2.1.1 **BASIC SERVICE INFORMATION:** Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.

CAUTION: Pressure applied to the actuator is not to exceed the maximum operating pressure rating listed on the actuator's name tag.

2.1.2 Before starting the general disassembly of the actuator, it is a good practice to operate the actuator with the pressure used by the customer to operate the actuator during normal operation. Note and record any abnormal symptoms such as jerky or erratic operation.

2.1.3 To help in correct re-assembly all mating parts should be marked or tagged for ease of reassembly, i.e. cylinder to cylinder adapter, cylinder adapter to housing, and right and left stop adjustment screws, etc.

2.1.4 If not already removed disconnect all operating pressure from pneumatic cylinder (3) or (3-10).

2.1.5 Actuators equipped with -M3HW jackscrew with handwheel option, remove hex nut (8-30), lock washer (8-20), and handwheel (8-10).

2.1.6 Mark or record the following:

2.1.6.1 Mark stop screws (1-60) left and right.

2.1.6.2 Measure and record the exposed length of the right and left stop screws (1-60).

NOTE: The stop screws will be removed later in this procedure.

2.1.6.3 Record the location of the pressure ports in the cylinder adapter (2-30).

2.2 PRESSURE CYLINDER REMOVAL

NOTE: Review all of Section 2 steps 2.1.1 through 2.1.6 General Disassembly before proceeding with Pressure Cylinder Disassembly.

2.2.1 Secure the chain wrench around cylinder (3) or (3-10) as close to the welded end cap as possible. Using a mallet, break the cylinder loose sufficiently so it can be removed.

2.2.2 Remove cylinder (3) or (3-10) from cylinder adapter (2-30) by rotating in a counter clockwise direction.

CAUTION: When removing and setting cylinder (3) or (3-10) aside, care should be taken to protect the cylinder's chamfered edge and external threads.

2.2.3 Unscrew and remove hex Lok nut (2-70) from piston rod (2-10).

2.2.4 Remove piston (2-20) from piston rod (2-10).

NOTE: Identify cylinder adapter (2-30) location and record it's inlet port locations.

2.2.5 Unscrew and remove four ferry cap screws (2-90) with gasket seals (6-80) from cylinder adapter (2-30). Refer to Section 4, step 4.3.9, for information when ferry cap screw are not used in this location.

2.2.6 Remove cylinder adapter (2-30), taking care not to scratch piston rod (2-10) or disengage rod bushing (2-40).

2.2.7 For actuators equipped with M3 or M3HW assembly, it is not necessary to disassemble the M3 Jackscrew from cylinder assembly -M3 (3-10). If the M3 stud or nut seal (3-30) needs replacement then refer to Section 2.5 for cylinder assembly M3 disassembly.

2.3 ROD COVER DISASSEMBLY

2.3.1 Unscrew and remove four ferry cap screws (2-100) with seal gaskets (6-80) from rod cover (2-60). Refer to Section 4, step 4.3.9, for information when ferry cap screw are not used in this location.

2.3.2 Remove rod cover (2-60) taking care not to scratch the piston rod (2-10).

- 2.3.3 For actuators equipped with M3 or M3HW jackscrew override, it is not necessary to disassemble the M3 Jackscrew from rod cover (2-60). If the M3 stud (2-120) or nut seal (2-130) needs replacement then refer to Section 2.6 for rod cover M3 disassembly.

2.4 HOUSING DISASSEMBLY

- 2.4.1 Remove snubber valve (1-130) from the top of housing (1-10).
- 2.4.2 Removed socket cap screws (1-120) from position indicator (1-110).
- 2.4.3 Remove position indicator (1-110) and yoke weather cover (6-110) from the top of yoke (1-140).
- 2.4.4 Remove four hex cap screws (1-30) and seal gaskets (6-80) from housing cover (1-20).
- 2.4.5 Remove housing cover (1-20) from the top housing (1-10).

NOTE: The housing cover has a tight fit and may require the use of two pry bars or screw drivers to assist in removal.

- 2.4.6 Rotate the arms of yoke (1-140) to the center position in the cavity of housing (1-10).
- 2.4.7 Remove upper yoke roller (1-50) from yoke pin (1-40).
- 2.4.8 Remove yoke pin (1-40) from slot in the arms of yoke (1-140).
- 2.4.9 Holding rod bushing (2-40) in place, remove piston rod (2-10) out through rod bushing (2-40).
- 2.4.10 Remove rod bushing (2-40) from housing (1-10).
- 2.4.11 Remove yoke (1-140) from housing (1-10).

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

- 2.4.12 Remove lower yoke roller (1-50) from the cavity of housing (1-10).
- 2.4.13 Unscrew and remove stop screws (1-60), jam nuts (1-70), and gasket seals (6-90).
- 2.4.14 It is not necessary to remove pipe plug (2-110) from cylinder adapter (2-30).

2.5 CYLINDER ASSEMBLY M3 JACKSCREW DISASSEMBLY

NOTE: Review all of Section 2 steps 2.1.1 through 2.1.6 General Disassembly before proceeding with M3 jackscrew disassembly.

NOTE: If the age of the actuator is unknown or if the M3 jackscrew has been replaced at some unknown point in time, then review all of Section 2.5 for a M3 jackscrew description that is installed on the actuator being disassembled.

- 2.5.1 Disassembly cylinder assembly M3 manufactured after December, 1990 (current M3 design).
 - 2.5.1.1 With cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.
 - 2.5.1.2 Using a small pin punch, drive out and remove the roll pin from the slotted nut located on outboard end of M3 jackscrew assembly (3-20).
 - 2.5.1.3 Remove the slotted nut from jackscrew assembly (3-20).
 - 2.5.1.4 Loosen and rotate seal nut (3-30) off of jackscrew assembly (3-20).
 - 2.5.1.5 Rotate jackscrew assembly (3-20) into cylinder (3-10) until it is disengaged from the cylinder end cap.
 - 2.5.1.6 Remove jackscrew assembly (3-20) from the open end of cylinder (3-10).
- 2.5.2 Disassembly cylinder assembly M3 manufactured March 1982 through December 1990.
 - 2.5.2.1 With cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.
 - 2.5.2.2 Loosen and rotate seal nut (3-30) all the way back to the welded nut.
 - 2.5.2.3 Rotate jackscrew assembly (3-20) into cylinder (3-10) until the pin and washer are exposed.
 - 2.5.2.4 Using a small pin punch, drive out and remove the pin.
 - 2.5.2.5 Remove the washer.
 - 2.5.2.6 Rotate jackscrew assembly (3-20) out and remove.
 - 2.5.2.7 Remove seal nut (3-30) from the M3 jackscrew stud.
- 2.5.3 Disassembly cylinder assembly M3 manufactured July 1978 through February 1982.
 - 2.5.3.1 With cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.
 - 2.5.3.2 Loosen and rotate seal nut (3-30) all the way back to the welded nut.
 - 2.5.3.3 Rotate jackscrew assembly (3-20) into cylinder (3-10) until the retaining screw is exposed.
 - 2.5.3.4 Remove the retaining screw from the M3.

2.5.3.5 Rotate the jackscrew assembly (3-20) out and remove.

2.5.3.6 Remove seal nut (3-30) from the M3 jackscrew stud.

2.5.4 Disassembly cylinder assembly M3 manufactured before July, 1978.

2.5.4.1 With the cylinder (3-10) on a workbench, lubricate jackscrew assembly (3-20) threads with lubricant.

2.5.4.2 Loosen seal nut (3-30).

2.5.4.3 Rotate the jackscrew assembly (3-20) out and remove.

2.5.4.4 Remove seal nut (3-30) from the M3 jackscrew stud.

2.6 ROD COVER M3 JACKSCREW DISASSEMBLY

NOTE: Review all of Section 2 steps 2.1.1 through 2.1.6 General Disassembly before proceeding with rod cover M3 jackscrew disassembly.

NOTE: If the age of the actuator is unknown or if the M3 has been replaced at some unknown point in time, then review all of Section 2.6 for a M3 description that is installed on the actuator being disassembled.

2.6.1 Disassembly Rod Cover M3 jackscrews manufactured after December, 1990 (current M3 design).

2.6.1.1 With the rod cover (2-60) on a workbench, lubricate M3 assembly (2-120) threads with lubricant.

2.6.1.2 Using a small pin punch, drive out and remove the roll pin from the slotted nut located on the outboard end of the M3 assembly (2-120).

2.6.1.3 Remove the slotted nut from the M3 assembly (2-120).

2.6.1.4 Loosen and rotate seal nut (2-130) off of the M3 assembly (2-120).

2.6.1.5 Rotate the M3 assembly (2-120) into rod cover (2-60) until it is disengaged from the rod cover.

2.6.1.6 Remove the M3 assembly (2-120) from the open end of the rod cover (2-60).

2.6.2 Disassembly Rod Cover M3 jackscrews manufactured March, 1982 through December, 1990.

2.6.2.1 With the rod cover (2-60) on a workbench, lubricate M3 assembly (2-120) threads with lubricant.

2.6.2.2 Loosen and rotate nut seal (2-130) all the way back to the welded nut.

- 2.6.2.3 Rotate the M3 assembly (2-120) into rod cover (2-60) until the pin and washer are exposed.
- 2.6.2.4 Using a small pin punch, drive out and remove the pin.
- 2.6.2.5 Remove the washer.
- 2.6.2.6 Rotate the M3 assembly (2-120) out and remove.
- 2.6.2.7 Remove seal nut (2-130) from the M3 stud.
- 2.6.3 Disassembly Rod Cover M3 jackscrews manufactured July, 1978 through February 1982.
 - 2.6.3.1 With the rod cover (2-60) on a workbench, lubricate M3 assembly (2-120) threads with lubricant.
 - 2.6.3.2 Loosen and rotate seal nut (2-130) all the way back to the welded nut.
 - 2.6.3.3 Rotate the M3 assembly (2-120) into rod cover (2-60) until the retaining screw is exposed.
 - 2.6.3.4 Remove the retaining screw from the M3.
 - 2.6.3.5 Rotate the M3 assembly (2-120) out and remove.
 - 2.6.3.6 Remove seal nut (2-130) from the M3 stud.
- 2.6.4 Disassembly Rod Cover M3 jackscrews manufactured before July, 1978.
 - 2.6.4.1 With the rod cover (2-60) on a workbench, lubricate M3 assembly (2-120) threads with lubricant.
 - 2.6.4.2 Loosen nut seal (2-130).
 - 2.6.4.3 Rotate the M3 assembly (2-120) out and remove.
 - 2.6.4.4 Remove seal nut (2-130) from the M3 stud.

SECTION 3 – ACTUATOR REASSEMBLY

3.1 GENERAL REASSEMBLY

NOTE: Review Section 1 General Service Information prior to starting Section 3.

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

3.1.1 Remove and discard all seals and gaskets.

3.1.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.

3.1.3 All parts should be thoroughly inspected for excessive wear, stress cracking, galling and pitting. Attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding or rotating motion. Sealing surfaces of the cylinder and piston rod must be free of deep scratches, pitting, corrosion and blistering or flaking coating.

CAUTION: Actuator parts that reflect any of the above listed characteristics must be replaced with new parts.

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

NOTE: The parts and seals used in the actuator housing assembly and power cylinder will be assembled using lubricant as identified in Section 1.6.

3.1.5 The torque requirements for critical fasteners are specified at the appropriate step of the assembly procedure.

3.2 HOUSING REASSEMBLY

NOTE: Review Section 3 steps 3.1.1 thru 3.1.5 General Reassembly before proceeding with housing reassembly.

NOTE: The parts and seals used in the actuator housing (1-10) will be assembled using lubricant as identified in Section 1.6

3.2.1 If removed, install pipe plug (1-100) into the drain port of housing (1-10). Refer to Section 4 step 4.3.10 for housing pipe plug information.

3.2.2 In the bottom area of housing (1-10) apply lubricant to the yoke bore and the cast raised ribs. Arrange the housing so that the yoke bore is nearest to you.

3.2.3 Coat one o-ring seal (6-20) with lubricant and install into the seal groove located in the yoke bore in the bottom area of housing (1-10). Refer to Section 4, step 4.3.1, for "B" model yoke o-ring information.

NOTE: The Bettis Service Kit will contain two sets of o-ring seals for item (6-20). One set will fit the current model HD Series actuators while the larger outer diameter o-ring seal set will fit the early model HD Series actuators.

3.2.4 Lubricate the yoke (1-140) with a generous amount of lubricant to all bearing surfaces and the slot in the upper and lower arms.

NOTE: The wide arm of yoke (1-140) should be installed toward the top of housing (1-10).

3.2.5 Install yoke (1-140) into the bore located in the bottom area of housing (1-10).

3.2.6 Coat one yoke roller (1-50) with lubricant and place into the lower yoke arm slot nearest the cylindrical portion of yoke (1-140).

3.2.7 Apply a coat of lubricant to rod bushing (2-40) and piston rod (2-10).

3.2.8 Install rod bushing (2-40) on to piston rod (2-10).

NOTE: Standard constructed actuators will have the threaded end of piston rod (2-10) and rod bushing (2-40) will be on the right side of housing (1-10).

3.2.9 Install piston rod (2-10), with rod bushing (2-40), into housing (1-10).

3.2.10 Slide rod bushing (2-40) along piston rod (2-10) and into side of housing (1-10).

3.2.11 Install cylinder gasket (6-70) onto the left side of housing (1-10).

NOTE: If the actuator rod cover is equipped with a M3 or M3HW assembly and it was removed then reassemble per appropriate steps in Section 3.4.

3.2.12 Install rod cover (2-60) over left end of piston rod.

3.2.13 Install gasket seals (6-80) onto ferry cap screws (2-100).

3.2.14 Install and tighten ferry cap screws (2-100) into rod cover (2-60).

3.2.15 Coat yoke pin (1-40) with lubricant and install through piston rod (2-10) into lower yoke roller (1-50).

3.2.16 Coat remaining yoke roller (1-50) with lubricant and install over yoke pin (1-40) and into the slot in the upper yoke arm of yoke (1-140).

3.2.17 Install jam nuts (1-70) and gasket seals (6-90) onto stop screws (1-60). Refer to Section 4, step 4.3.4, for information concerning early model actuator stop screw gasket seals.

3.2.18 Install stop screws (1-60), with gasket seals (6-90) and stop screw jam nuts (1-70), into housing (1-10) in the position as recorded in Section 2 step 2.1.6.

3.2.19 Coat the yoke bore in cover (1-20) with lubricant.

- 3.2.20 Coat remaining o-ring seal (6-20) with lubricant and install into housing cover (1-20). Refer to Section 4, step 4.3.1, for information concerning HD "B" series yoke o-rings.
- 3.2.21 Install cover gasket (6-60) onto top area of housing (1-10).
- 3.2.22 Install housing cover (1-20) over cover gasket (6-60) and onto top area of housing (1-10).
- 3.2.23 Install four gasket seals (6-80) onto hex cap screws (1-30). Refer to Section 4, step 4.3.5, for information when gasket seals have not been in prior use for this location.
- 3.2.24 Install four hex cap screws (1-30) with gasket seals through housing cover (1-20) and into housing (1-10).

3.3 PRESSURE CYLINDER REASSEMBLY

NOTE: Review Section 3 steps 3.1.1 thru 3.1.5 General Reassembly before proceeding with pressure cylinder reassembly.

- 3.3.1 If the actuator cylinder is equipped with a M3 or M3HW assembly and it was removed then reassemble per appropriate steps in Section 3.5.
- 3.3.2 Coat rod seal (6-30) with lubricant and install, lip first, into cylinder adapter (2-30). Refer to Section 4, step 4.3.2, for information pertaining to different rod seal configurations.

CAUTION: Energizer ring (O-ring) of rod seal (6-30) must face into cylinder adapter (2-30) or when cylinder is installed on the actuator the rod seal o-ring will be facing towards piston (2-20).

- 3.3.3 Install adapter gasket (6-70) over piston rod (2-10), rod bushing (2-40) and up against housing (1-10).
- 3.3.4 Install gasket seals (6-80) onto ferry cap screws (2-100). Refer to Section 4, step 4.3.6, for information pertaining to the past use of lock washers in this location.

CAUTION: Care should be taken to not scratch or damage the piston rod when installing the cylinder adapter.

- 3.3.5 Install cylinder adapter (2-30) over the end of piston rod (2-10).
- 3.3.6 Arrange the position of cylinder adapter (2-30) per the location recorded in Section 2 step 2.1.6 and retain with ferry screws (2-90) with gasket seals (6-80).
- 3.3.7 If removed, install pipe plug (2-110) into cylinder adapter (2-30) pressure port location as recorded in Section 2 step 2.1.6.
- 3.3.8 Coat o-ring seal (6-40) with lubricant and install into cylinder adapter (2-30). NOTE: Install the o-ring seal into seal groove at the inner end of the cylinder adapter inner diameter threads.
- 3.3.9 Install o-ring seal (6-50) onto piston rod (2-10). NOTE: The o-ring should be installed against the shoulder of the piston rod.

3.3.10 Install piston (2-20) onto piston rod. NOTE: One side of piston (2-20) has a raised boss in the center that has a seal groove to accept an O-ring. This side should be installed against the shoulder of piston rod (2-10).

3.3.11 Install hex lock nut (2-70) onto piston rod (2-10).

CAUTION: When installing hex lock nut (2-70) the flat side of the nut should rest up against piston (2-20).

3.3.12 Torque tighten light hex Lok nut (2-70) to 146 foot pounds / 198 N-m $\pm 5\%$ lubricated.

3.3.13 Piston Seal Installation:

3.3.13.1 Standard and High Temperature actuators:

3.3.13.1.1 Coat two u-cup seals (6-10) with lubricant.

3.3.13.1.2 Install one u-cup seal into the innermost piston seal groove. The lip of the cup seal should point outward toward the outside edge of the piston.

3.3.13.1.3 Install one u-cup seal into the outermost piston seal groove. The lip of the cup seal should point outward toward the outside edge of the piston.

3.3.13.2 Low Temperature or trim -11 T-Seal Set installation as follows:

3.3.13.2.1 Coat piston seal grooves with lubricant.

3.3.13.2.2 Apply lubricant to one T-seal (6-10). T-Seal is composed of one rubber seal and two skive-cut back-up rings.

3.3.13.2.3 Install T-seal into piston outboard seal groove.

3.3.13.2.4 Install a back-up ring on each side of the T-seal. NOTE: When installing the back-up rings, do not align the skive-cuts.

NOTE: If the back-up rings are too long and the rings overlap beyond the skive-cuts, then the rings must be trimmed with a razor sharp instrument.

3.3.14 Push the piston in towards the housing as far as it will go.

3.3.15 Coat the threads and bore of cylinder (3) or (3-10) with lubricant.

CAUTION: When installing the cylinder into the cylinder adapter be careful not to cross the threads.

CAUTION: Exercise caution during cylinder installation to prevent pinching lip of the u-cup seal during installation. It is necessary to depress the seal lip while working the cylinder over it.

3.3.16 Install lubricated cylinder (3) or (3-10) over piston (2-20). Rotate the cylinder assembly clockwise and screw into cylinder adapter(2-30).

3.3.17 Using a chain wrench tighten cylinder (3) or (3-10) into cylinder adapter (2-30).

NOTE: While the chain wrench is still positioned on the cylinder and after the cylinder is tight, take a mallet and rap (hit) the chain wrench handle a couple of times. This will seat the cylinder assembly into the o-ring seal located in the cylinder adapter. Repeat this step if, during testing, the area between the cylinder assembly and the cylinder adapter is leaking.

3.3.18 Rotate the yoke to the full clockwise (CW) position. Place yoke weather cover (6-110) and position indicator (1-110) on yoke (1-140) with the pointer facing piston rod (2-10) and perpendicular to cylinder (3) or (3-10) and rod cover (2-60). Refer to step 4.3.3 for information concerning actuators not equipped with weather cover (6-110).

3.3.19 Install and tighten yoke position indicator/yoke weather cover screws (1-120). These screws will need to be rechecked for tightness after the actuator has been cycled and tested.

3.4 M3 JACKSCREW REASSEMBLY TO ROD COVER

NOTE: If the age of the actuator is unknown or if the M3 jackscrew has been replaced at some unknown point in time, then review all of Section 3.4 for a M3 jackscrew description that is installed on the actuator being reassembled.

3.4.1 Reassembly of M3 jackscrews manufactured after December, 1990 (current M3 design).

3.4.1.1 Apply a light coating of lubricant to the threads of jackscrew assembly (2-120).

3.4.1.2 Insert the M3 assembly (2-120) through the open end of rod cover (2-60). Screw the M3 through the rod cover end cap until the end of the assembly protrudes out of the rod cover out board end.

3.4.1.3 Turn the jackscrew until the retaining nut comes into contact with the inside of rod cover (2-60).

3.4.1.4 Install seal nut (2-130) onto jackscrew assembly (2-120).

3.4.1.5 Rotate seal nut (2-130) until it is up against rod cover (2-60).

3.4.1.6 Rotate the slotted nut onto outboard end of the jackscrew assembly (2-120) with the nut slot facing toward the rod cover. Continue to rotate the slotted nut until one of the slots in the nut is aligned with the cross-drilled "through hole" in the jackscrew assembly (2-120).

CAUTION: When aligning the slot and the cross drilled hole make certain that the back of the slot is at least one thread from being aligned with the hole.

3.4.1.7 Insert the roll pin through the slotted nut and through jackscrew assembly (2-120).

NOTE: Check to verify that equal amounts of roll pin is exposed on both sides of the slotted nut and the jackscrew assembly (2-130).

3.4.1.8 Turn seal nut (2-130) until fully tight against rod cover (2-60).

NOTE: If desirable, wipe away excess lubricant on jackscrew assembly (2-120) after operation. If preferred, lubricant may be left on jackscrew assembly (2-120) to provide additional corrosion protection.

3.4.2 Reassembly of M3 Jackscrews manufactured March, 1982 through December, 1990.

3.4.2.1 If removed, install seal nut (2-130) onto the inboard end of jackscrew assembly (2-120) with the insert side facing away from the retaining nut.

3.4.2.2 Rotate seal nut (2-130) until it is up against the retaining nut.

3.4.2.3 Apply a generous coating of lubricant to jackscrew assembly threads.

3.4.2.4 Screw jackscrew assembly (2-120) into the outer end of rod cover (2-60). Turn jackscrew assembly (2-120) until the end of the jackscrew assembly protrudes out of the open end of rod cover (2-60).

3.4.2.5 Install a flat washer and spirol pin onto the turndown end of jackscrew assembly (2-120).

3.4.2.6 Turn jackscrew assembly (2-120) until the flat washer just comes into contact with the end cap of rod cover (2-60).

3.4.2.7 Turn seal nut (2-130) until fully tight against rod cover (2-60).

NOTE: If desirable, wipe away excess lubricant on Jackscrew after operation. If preferred, lubricant may be left on Jackscrew to provide additional corrosion protection.

3.4.3 Reassembly of M3 Jackscrews manufactured July, 1978 through February, 1982.

3.4.3.1 If removed, install seal nut (2-130) onto jackscrew assembly (2-120) with the insert side facing away from the retaining nut.

3.4.3.2 Rotate seal nut (2-130) until it is up against the retaining nut.

3.4.3.3 Apply a generous coating of lubricant to the threads of jackscrew assembly (2-120).

- 3.4.3.4 Rotate jackscrew assembly (2-120) into the end cap of rod cover (2-60) until the end of the jackscrew assembly protrudes out of the open end of rod cover (2-60).
 - 3.4.3.5 To retain jackscrew assembly (2-120) in rod cover (2-60) install hex head cap screw into the threaded hole in the turndown area of the jackscrew assembly (2-120).
 - 3.4.3.6 Rotate jackscrew assembly (2-120) until the retaining screw just comes into contact with the end cap of rod cover (2-60).
 - 3.4.3.7 Rotate seal nut (2-130) until fully tight against rod cover (2-60).
- NOTE: If desirable, wipe away excess lubricant on Jackscrew after operation. If preferred, lubricant may be left on Jackscrew to provide additional corrosion protection.

3.4.4 Reassembly of M3 jackscrews manufactured before July, 1978.

- 3.4.4.1 If removed, install seal nut (2-130) onto jackscrew assembly (2-120) with the insert side facing away from the retaining nut.
 - 3.4.4.2 Rotate seal nut (2-130) until it is up against the retaining nut.
 - 3.4.4.3 Apply a generous coating of lubricant to the threads of jackscrew assembly (2-120).
 - 3.4.4.4 Rotate jackscrew assembly (2-120) into the end cap of rod cover (2-60). Rotate jackscrew assembly (2-120) until the end of the jackscrew assembly protrudes just out of the end cap of rod cover (2-60).
 - 3.4.4.5 Rotate seal nut (2-130) until fully tight against end cap of rod cover (2-60).
- NOTE: If desirable, wipe away excess lubricant on Jackscrew after operation. If preferred, lubricant may be left on Jackscrew to provide additional corrosion protection.

3.5 M3 JACKSCREW REASSEMBLY CYLINDER ASSEMBLY

NOTE: If the age of the actuator is unknown or if the M3 jackscrew has been replaced at some unknown point in time, then review all of Section 3.5 for a M3 jackscrew description that is installed on the actuator being reassembled.

3.5.1 Reassembly of M3 jackscrew manufactured after 1990 (current M3 design).

- 3.5.1.1 Apply a light coating of lubricant to the threads of jackscrew assembly (3-20).
- 3.5.1.2 Insert the jackscrew assembly (3-20) through the open end of cylinder (3-10). Rotate the jackscrew into the cylinder end cap until the end of the assembly protrudes out of the end cap of the cylinder.

3.5.1.3 Rotate the jackscrew until the M3 retainer comes into contact with the inside of the cylinder end cap.

3.5.1.4 Install seal nut (3-30) onto the jackscrew assembly (3-20). Rotate the seal nut until it is up against the cylinder end cap.

CAUTION: When aligning the slot and the cross drilled hole make certain that the back of the slot is at least one thread from being aligned with the hole.

3.5.1.5 Rotate the slotted nut onto the outboard end of the jackscrew stud until one of the slots in the nut is aligned with the cross-drilled "through hole" in the stud.

NOTE: The nut slots will be facing toward the cylinder end cap.

3.5.1.6 Insert the roll pin through the slotted nut and through the jackscrew stud making sure that equal amounts of the roll pin is exposed on both sides of the slotted nut and the jackscrew stud.

3.5.1.7 Turn nut seal until fully tight against end cap.

NOTE: If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, lubricant may be left on jackscrew to provide additional corrosion protection.

3.5.2 Reassembly of M3 Jackscrews manufactured 1982 through 1990.

3.5.2.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with the insert side facing away from the retaining nut.

3.5.2.2 Rotate the nut seal until it is up against the retaining nut.

3.5.2.3 Apply a generous coating of lubricant to the M3 threads.

3.5.2.4 Rotate the jackscrew assembly (3-20) into the cylinder end cap. Rotate the jackscrew until the end of the assembly protrudes out of the threaded end of the cylinder.

3.5.2.5 Install a washer and pin onto the turndown end of the M3.

3.5.2.6 Rotate the jackscrew until the washer just comes into contact with the cylinder end cap.

3.5.2.7 Rotate nut seal until fully tight against end cap.

NOTE: If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, grease may be left on jackscrew to provide additional corrosion protection.

3.5.3 Reassembly of M3 Jackscrews manufactured July, 1978 through 1981.

- 3.5.3.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with the insert side facing away from the retaining nut.
- 3.5.3.2 Rotate the nut seal until it is up against the retaining nut.
- 3.5.3.3 Apply a generous coating of lubricant to the M3 threads.
- 3.5.3.4 Rotate the jackscrew assembly (3-20) into the cylinder end cap. Rotate the jackscrew until the end of the assembly protrudes out of the threaded end of the cylinder.
- 3.5.3.5 To retain the M3 in the cylinder, screw a hex head cap screw into the threaded hole in the turndown area of the M3 stud.
- 3.5.3.6 Rotate the jackscrew until the retaining screw just comes into contact with the cylinder end cap.
- 3.5.3.7 Rotate nut seal until fully tight against end cap.

NOTE: If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, grease may be left on jackscrew to provide additional corrosion protection.

3.5.4 Reassembly of M3 Jackscrews manufactured before July, 1978.

- 3.5.4.1 If removed, install nut seal (3-30) onto jackscrew assembly (3-20) with the insert side facing away from the retaining nut.
- 3.5.4.2 Rotate the nut seal until it is up against the retaining nut.
- 3.5.4.3 Apply a generous coating of lubricant to the M3 threads.
- 3.5.4.4 Rotate the jackscrew assembly (3-20) into the cylinder end cap until the end of the assembly protrudes just out of the cylinder end cap.
- 3.5.4.5 Rotate nut seal until fully tight against end cap.

NOTE: If desirable, wipe away excess lubricant on jackscrew after operation. If preferred, grease may be left on jackscrew to provide additional corrosion protection.

3.6 ACTUATOR TESTING

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

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

3.6.2 All leak testing will use 65 psig pneumatic pressure or the pressure used by the customer to operate the actuator during normal operation.

CAUTION: Test the actuator using a properly adjusted self-relieving regulator, with gauge.

3.6.3 Prior to testing for leaks, alternately apply and release pneumatic pressure, as listed in step 3.6.2, to each side of the pistons to stroke the actuator fully. Repeat this cycle approximately five times. This will allow the new seals to seek their proper service condition.

3.6.4 Apply pneumatic pressure, as listed in step 3.6.2, to the pressure inlet port in cylinder adapter (2-30).

NOTE: If excessive leakage is noted, generally a leak testing solution bubble which is formed over the area that is to be checked and this bubble breaks three seconds or less after starting to form, the actuator must be disassembled and the cause of leakage must be determined and corrected.

3.6.5 Apply leak testing solution to the following areas:

3.6.5.1 Form a leak testing solution bubble over the inlet port hole in the outboard end of cylinder (3) or (3-10). Checks the piston to cylinder wall and piston to piston rod seals.

3.6.5.2 The threaded joint between cylinder (3) or (3-10) and cylinder adapter (2-30), checks the cylinder to cylinder adapter o-ring seal.

3.6.5.3 The joint between cylinder adapter (2-30) and housing (1-10).

3.6.5.4 The snubber port hole located in top of housing (1-10), checks the cylinder adapter to piston rod seal.

3.6.6 Remove pressure from the pressure inlet port in cylinder adapter (2-30).

3.6.7 Apply pneumatic pressure, as listed in step 3.6.2, to the inlet port in outboard end of cylinder (3-10).

3.6.8 Form a leak testing solution bubble over the inlet port in cylinder adapter (2-30). If excessive leakage is noted, generally a bubble which breaks three seconds or less after starting to form, the actuator must be disassembled and the cause of leakage must be determined and corrected. Checks piston to cylinder and piston to piston rod seals.

3.6.9 Remove pressure from the inlet port in the outboard end of cylinder (3) or (3-10).

3.7 RETURN TO SERVICE

3.7.1 Replace the software components of snubber (1-130) and then install the snubber into the housing (1-10).

3.7.2 Adjust both stop screws (1-60) back to settings recorded in Section 2 step 2.6.1 under General Disassembly.

- 3.7.3 Tighten both jam nut (1-70) securely, while holding stop screws (1-60).
- 3.7.4 Install and tighten yoke position indicator/yoke weather cover screws (1-120). NOTE: These screws will need to be rechecked for tightness after the actuator has been cycled.
- 3.7.5 For actuators equipped with a M3 jackscrew and require an optional handwheel, M3HW, install the handwheel (8-10) on to the M3 assemblies (2-120) and (3-20) using the following procedure. Refer to information note step 4.3.9 for old style Jackscrew handwheel.
 - 3.7.5.1 Place the handwheel (8-10) onto the Jackscrew and over nut (the handwheel hub has a cast hexagon hole that fits over the pinned nut).
 - 3.7.5.2 Place lock washer (8-20) onto Jackscrew up against handwheel hub.
 - 3.7.5.3 Place hex nut (8-30) onto Jackscrew and thread up against lock washer, tighten until lock washer is flat.
- 3.7.6 After actuator is reinstalled on the device it is to operate all accessories should be hooked up, leak tested, and then tested for proper operation and replaced if found defective.
- 3.7.7 The actuator is now ready for returning to service.

SECTION 4 – ACTUATOR SUPPORT INFORMATION

4.1 ACTUATOR WEIGHT TABLE

ACTUATOR MODEL	APPROXIMATE WEIGHT **		ACTUATOR MODEL	APPROXIMATE WEIGHT **	
	Lbs.	Kg		Lbs.	Kg
HD731	164	74	HD731-M3HW	200	90
HD731-M3	174	79			

** Weights listed for each model are for bare actuators without valve mounting brackets and accessories.

4.2 TOOL TABLE

HD731/M3/HW TOOL STYLE AND WRENCH SIZES				
ITEM NO.	ITEM QTY.	WRENCH SIZE	DESCRIPTION OR LOCATION	RECOMMENDED WRENCH STYLE
1-30	4	3/4"	Cover Screws	Socket
1-60	2	1/2" (4)	Stop Screws	Open End or Adjustable
1-70	2	1-5/16"	Hex Jam Nut	Open End or Adjustable
1-100	1	7/16"	Pipe Plug	Open End
1-120	4	3/16"	Socket Cap Screws	Allen (1)
1-130	1	7/8"	Snubber Valve	Deep Socket
2-70	1	1-5/8"	Standard Hex Nut	Socket
2-90	4	1/2"	Ferry Cap Screws	12 Point Socket (1) (3)
2-100	4	1/2"	Ferry Cap Screws	12 Point Socket (1) (3)
2-110	1	7/16"	Pipe Plug	Open End
3	1	(2)	Cylinder Assembly	Chain Wrench (1)
3-10	1	(2)	Cylinder Assembly	Chain Wrench (1)
3-30	1	1-13/16"	M3 Seal Nut	Open End or Adjustable
8-30	1	1-13/16"	Heavy Hex Nut	Open End or Adjustable
-	2	1-13/16"	M3 Slotted Hex Nut	Open End or Adjustable

- (1) No alternate style tool recommended.
- (2) Bettis recommends a short handled Chain Wrench with a 40" inch chain.
- (3) Early models used socket head cap screws - wrench style will change to Allen.
- (4) Actuators manufactured prior to middle of 1994 used square head stop screws - wrench size changes to 5/8" inch Open End or Adjustable.

4.3 PRODUCR IMPROVEMENT AND REVISIONS

- 4.3.1 On HD series "B" models the yoke o-ring grooves are machined into the yoke journals. On the HD series "C" and current models the yoke o-ring grooves are machined into the housing cover and into the housing.
- 4.3.2 HD actuators manufactured through the late 1970's where originally shipped with a rod seal and a anti-extrusion seal. This combination is replaced with the current Polypak seal. The dimensional stack of the rod seal and the anti-extrusion seal is greater than the rod seal provided in the current Service/Seal Kit. This dimensional difference does not affect the ability of the current Polypak seal to provide sealing in this application.
- 4.3.3 Early model actuators may not have a position indicator or a weather cover. These items may be added to your actuator.
- 4.3.4 Early model actuators used nylon "Zytel 101" stop screw seal (6-90). The nylon seal is replaced with the wrought copper/Cu alloy gasket seal.

- 4.3.5 Early model actuators did not use any gasket seal washers (6-80) on the housing cover screws (1-30). The current Service/Seal kits provide wrought copper alloy (ASTM B-152 C11000) gasket seal washers and Bettis would recommend that they be used.
- 4.3.6 Early model actuators used lock washers on the cylinder adapter retaining screws (2-90). During the early 1970's the lock washers were replaced with wrought copper alloy (ASTM B-152 C11000) gasket seal washers (6-90). The current Service/Seal kits provide these wrought copper alloy washers and Bettis would recommend that they be used in place of the original lock washers.
- 4.3.7 All asbestos has been eliminated from the gasket material used in Bettis Actuators. The current gasket material used is Non Asbestos Synthetic Fiber.
- 4.3.8 Old style M3 jackscrew with handwheel was of one piece construction and the handwheel is not removable or replaceable as an option.
- 4.3.9 Early model actuators used socket cap screws instead of ferris cap screws as cylinder adapter (2-30) and rod cover (2-60) retaining screws.
- 4.3.10 Actuators manufactured after mid year 2000 may not have a pipe plug, item (1-100), in the housing (1-10).

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			APPROVED	T. Jeansonne	27 March 2002

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