

**BETTIS**

**SERVICE INSTRUCTIONS**

**DISASSEMBLY AND REASSEMBLY**

**FOR MODELS**

**NHD522, NHD722 AND NHD732**

**DOUBLE ACTING SERIES**

**PNEUMATIC ACTUATORS**

PART NUMBER: 124908

REVISION: "A"

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## 1.0 INTRODUCTION

1.1 This service procedure is offered as a guide to enable general maintenance to be performed on Bettis, NHD522, NHD522-M3, NHD522-M3HW, NHD722, NHD722-M3, NHD722-M3HW, NHD732, NHD732-M3, and NHD732-M3HW Double Acting Series Pneumatic Actuators. 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.

1.2 In order to assure and maintain the present level of qualification and auditable to the Bettis Qualification Test Report Part Number 037274 the following is required:

1.2.1 All maintenance or service work must be performed by a certified technician. A Certified Technician is a person who has successfully completed the manufacture's prescribed course and demonstrated the ability to supervise and/or perform applicable specified product related procedures.

1.2.2 Maintain a service interval of six hundred twenty-five cycles or five years which ever occurs first.

### 1.3 BASIC SERVICE INFORMATION:

**WARNING: Complete actuator refurbishment requires the actuator be dismantled from the valve or device it is operating.**

1.3.1 This procedure is written with the understanding that the actuator has been removed from the valve, the air or power gas has been removed from the power cylinders and all piping and accessories mounted on the actuator have been removed.

### 1.4 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.

1.5 **SAFETY STATEMENT:** Products supplied by Bettis, in its "as shipped" condition, are intrinsically safe if the instructions contained within this Service Instruction are strictly adhered to and executed by a well trained, equipped, prepared and competent technician.

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

**WARNING:** This procedure should not supersede or replace any customers plant safety or work procedures. If a conflict arises between this procedure and the customers procedures the differences should be resolved in writing between an authorized customers representative and a authorized Bettis representative.

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

## **2.0 SUPPORT ITEMS AND TOOLS**

- 2.1 Support Items - Service Kit, commercial leak testing solution, and non-hardening thread sealant.
- 2.2 Tools - All tools are American Standard inch. 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). For recommended tool style and size chart refer to last page of this procedure.

## **3.0 BETTIS REFERENCE MATERIALS**

- 3.1 Assembly Drawing Part Number 124874.

## **4.0 GENERAL**

- 4.1 This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
- 4.2 Numbers in parentheses, ( ) indicate the bubble number (item reference number) used on Bettis Assembly Drawing and actuator Parts List.
- 4.3 This procedure is written using the stop screw side of housing (1-10) as a reference and this side will be considered the front of the actuator. Housing cover (1-20) will be considered as the top of the actuator.
- 4.4 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 screws, ect.
- 4.5 When removing seals from seal grooves, use a commercial seal removing tool or a small standard screwdriver with the sharp edges rounded off.
- 4.6 Use a non-hardening thread sealant on all pipe threads.

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

- 4.7 Disassembly of actuator should be done in a clean area on a work bench when possible.

- 4.8 Some NHD Series Actuator models are heavy and will require a means of assistance. For actuator approximate weight refer to the following chart.

ACTUATOR MODEL	APPROXIMATE WEIGHT (LBS) *	ACTUATOR MODEL	APPROXIMATE WEIGHT (LBS) *
NHD522	108	NHD722-M3HW	145
NHD522-M3	118	NHD732	207
NHD522-M3HW	123	NHD732-M3	217
NHD722	125	NHD732-M3HW	227
NHD722-M3	135		
* Weights listed for each model are for bare actuators without valve mounting brackets and accessories.			

- 4.9 LUBRICATION REQUIREMENTS: Dow Corning Molykote 44, medium grade (Refer to Bettis Qualification Test Report Part Number 037274 Appendix "D").

**CAUTION:** Lubricants other than the lubricant qualified in the latest revision of the Bettis Nuclear Qualification Test Report Part Number 037274 cannot be used without prior written approval of Bettis Product Engineering.

- 4.9.1 The actuator should require approximately 10 ounces of lubricant. Excess lubricant in the actuator is not a problem with the exception listed in step 4.9.2.
- 4.9.2 The actuator cylinder bore is the only critical area where over lubrication can cause a problem. Refer to Section 10 Step 10.16 for proper cylinder bore lubrication.

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

- 4.10 It is a good practice to operate the actuator with the nominal operating pressure (NOP), as listed on the actuator name tag or the pressure used by the customer to operate the actuator during normal operation, before starting the general disassembly of the actuator. Notate and record any abnormal symptoms such as jerky or erratic operation.

## 5.0 GENERAL DISASSEMBLY

- 5.1 If not already done remove all operating pressure from actuator cylinder (3-10).
- 5.2 Actuators equipped with -M3HW jackscrew with handwheel option, remove hex nut (8-30), lockwasher (8-20), and handwheel (8-10). Refer to step 15.8 for information on non removable handwheels.
- 5.3 The setting of stop screws (1-60) should be checked and setting recorded before stop screws are loosened or removed. NOTE: Stop screws will be removed later in this procedure.
- 5.4 Removed socket cap screws (1-120) from position indicator (1-110) yoke weather cover (6-110) and remove position indicator/yoke weather cover.

- 5.5 Remove snubber (1-130) from the top of housing (1-10).

## **6.0 PNEUMATIC CYLINDER DISASSEMBLY**

- 6.1 The following steps may be performed on one cylinder and then on the other cylinder or simultaneously on both cylinders.
- 6.2 Secure the chain wrench around the cylinder (3-10) as close to the welded end cap as possible. Using the mallet, break the cylinder loose and then remove the cylinder by rotating in a counter clockwise direction. When setting the cylinder aside, care should be taken to protect the chamfered edge and cylinder threads.
- 6.3 Unscrew and remove hex nut (2-70) with lockwasher (2-80).
- 6.4 Remove piston (2-20) from piston rod (2-10).

NOTE: Identify each cylinder adapter (2-30) left or right and record the inlet port locations.

- 6.5 Unscrew and remove four cylinder adapter ferry screws (2-90) with gasket seals (6-80) from cylinder adapter (2-30).
- 6.6 Remove cylinder adapter (2-30), taking care not to scratch piston rod (2-10) or disengage rod bushings (2-40).
- 6.7 Complete steps 6.7.1 through 6.7.7 only if the actuator is equipped with a M3 jackscrew assembly.
- 6.7.1 With cylinder (3-10) on a work bench, lubricate jackscrew assembly (3-20) threads with lubricant.
- 6.7.2 Using a 3/16 inch pin punch, drive out and remove the spiral pin from the outboard slotted nut.
- 6.7.3 Remove the slotted nut from the jackscrew assembly (3-20).
- 6.7.4 Loosen and remove the heavy hex jam nut (3-30) from the jackscrew assembly (3-20).
- 6.7.5 Remove countersunk washer (6-120) and thread seal (6-130) from the jackscrew assembly (3-20).
- 6.7.6 Screw jackscrew assembly (3-20) into cylinder (3-10) until it is disengaged from the end cap of cylinder (3-10).
- 6.7.7 Remove jackscrew assembly (3-20) from the open end of cylinder (3-10).

## 7.0 HOUSING DISASSEMBLY

- 7.1 Remove cover screw (1-30) with gasket seals (6-100). NOTE: On NHD732 models the gasket seals will be item (6-80).

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

- 7.2 Remove housing cover (1-20) from housing (1-10).
- 7.3 Rotate the yoke arms of yoke (1-140) to the center position of housing (1-10).
- 7.4 Remove the upper yoke roller (1-50) from yoke pin (1-40).
- 7.5 Remove yoke pin (1-40) from yoke arms of yoke (1-140).
- 7.6 Holding rod bushings (2-40) in place, remove piston rod (2-10) out through the rod bushings (2-40).
- 7.7 Remove both rod bushings (2-40) from housing (1-10).
- 7.8 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.

- 7.9 Remove lower yoke roller (1-50).
- 7.10 Remove stop screws (1-60), jam nuts (1-70), and gasket seals (6-90). Be sure to identify the stop screws left and right.
- 7.11 It is not necessary to remove pipe plug (1-100) from housing (1-10) or pipe plugs (2-110) from cylinder adapters (2-30).

## 8.0 GENERAL REASSEMBLY

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

- 8.1 Taking care not to scratch or damage seal grooves, remove and discard all seals and gaskets.
- 8.2 All parts should be cleaned to remove all dirt and other foreign material prior to inspection.

- 8.3 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.**

- 8.4 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, power cylinders will be assembled using lubricant as identified in step 4.9.

## **9.0 HOUSING REASSEMBLY**

- 9.1 If removed, install pipe plug (1-100) into the drain port of housing (1-10).
- 9.2 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.
- 9.3 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).
- 9.4 Lubricate 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).

- 9.5 Install yoke (1-140) into the bore located in the bottom area of housing (1-10).
- 9.6 Coat one yoke roller (1-50) with lubricant and place into the lower yoke arm slot nearest the cylindrical portion of the yoke.
- 9.7 Coat two rod bushings (2-40) with lubricant and install one into each side of housing (1-10).
- 9.8 Apply a light coat of lubricant to piston rod (2-10) and install through both bushings (2-40) in housing (1-10).
- 9.9 Coat yoke pin (1-40) with lubricant and install through piston rod (2-10) and into lower yoke roller (1-50).
- 9.10 Coat remaining yoke roller (1-50) with lubricant and install over yoke pin (1-40) and into the slot of the upper arm of yoke (1-140).
- 9.11 Install stop screws (1-60), stop screw gasket seals (6-90), and stop screw jam nuts (1-70).
- 9.12 Coat the remaining o-ring seal (6-20) with lubricant and install into the seal groove in housing cover (1-20).

- 9.13 Coat the yoke bore in housing cover (1-20) with lubricant.
- 9.14 Install cover gasket (6-60) onto the top of housing (1-10).
- 9.15 Install housing cover (1-20) onto the top of housing (1-10). Retain the housing cover with four cover screws (1-30) and gasket seals (6-80). NOTE: For 522/722 actuators, the gasket seals will be item number (6-100).

## 10.0 PNEUMATIC CYLINDER REASSEMBLY

NOTE: The following steps may be performed on one cylinder and then on the other cylinder or simultaneously on both cylinders.

- 10.1 Coat piston rod seal (6-30) with lubricant and install, lip first, into cylinder adapter (2-30).

**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).**

- 10.2 Install adapter gasket (6-70) over piston rod (2-10), rod bushing (2-40) and up against the end of housing (1-10).

**CAUTION: Care should be taken to not scratch or damage piston rod (2-10) when installing cylinder adapter (2-30).**

- 10.3 Install gasket seals (6-80) onto ferry cap screws (2-90).

- 10.4 Install the cylinder adapter (2-30) over the end of the piston rod (2-10).

NOTE: Arrange the position of cylinder adapter (2-30) per the identification recorded in the note between steps 6.4 and 6.5.

- 10.5 Install ferry screws (2-90) with gasket seals (6-80) through cylinder adapter (2-30), adapter gasket (6-70) and into the end of housing (1-10).

- 10.6 If removed, install a pipe plug (2-110) into cylinder adapter (2-30) port location as recorded in section 6.

- 10.7 Coat o-ring seal (6-40) with lubricant and install into cylinder adapter (2-30). NOTE: Install o-ring seal (6-40) into seal groove at the inner end of the cylinder adapter inner diameter threads.

- 10.8 Coat o-ring seal (6-50) with lubricant and install onto piston rod (2-10).

- 10.9 Coat one piston u-cup seal (6-10) with lubricant and install into piston seal groove with the lip of the seal pointing outward toward the side of piston (2-20).

- 10.10 Coat the second u-cup seal (6-10) with lubricant and install into remaining piston seal groove with lip of the seal pointing outward toward the side of piston (2-20).

**CAUTION:** 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 the piston rod (2-10) and over o-ring seal (6-50).

- 10.11 Install piston (2-20) onto piston rod (2-10).
- 10.12 Install lockwasher (2-80) onto piston rod (2-10).
- 10.13 Install hex lock nut (2-70) onto piston rod (2-10).
- 10.14 Torque tighten hex nut (2-70) to approximately 146 foot pounds.
- 10.15 For actuators equipped with a jackscrew assembly, completed steps 10.15.1 through 10.15.10. For actuators not equipped with jackscrew assembly continue on to step 10.16.

- 10.15.1 Apply a light coating of lubricant to the threads of jackscrew assembly (3-20).
- 10.15.2 Insert the jackscrew assembly (3-20) through the open end of cylinder (3-10). Screw the jackscrew into the cylinder end cap until the end of the assembly protrudes out of the end cap of the cylinder.
- 10.15.3 Turn the jackscrew until the M3 retainer comes into contact with the inside of the cylinder end cap.
- 10.15.4 Install thread seal (6-130) onto jackscrew assembly (3-20).
- 10.15.5 Install countersunk washer (6-120) onto jackscrew assembly (3-20).
- 10.15.6 Install hex jam nut (3-30) onto the jackscrew assembly (3-20). Screw the hex jam nut until it is up against countersunk washer (6-120).

**CAUTION:** When aligning the slotted nut the nuts slot and the cross drilled hole in the jackscrew assembly stud, make certain that the back of the slot is at least one thread from being aligned with the cross drilled hole hole.

- 10.15.7 Screw 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 end cap of cylinder (3-10).

- 10.15.8 Insert the spiral pin through the slotted nut and through the jackscrew stud making sure that equal amounts of the spiral pin is exposed on both sides of the slotted nut and the jackscrew stud.
- 10.15.9 Turn hex jam nut until fully tight against countersunk washer (6-120).

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

10.16 Apply a very light film of lubricant to the entire bore of the cylinder (3-10). After the entire bore of the cylinder has a light film of lubricant wipe away any excess amounts of the lubricant.

**CAUTION:** Exercise care to prevent damage to the piston cup seal lip during cylinder installation. It is necessary to depress the seal lip while working the cylinder over it.

10.17 Install the cylinder (3-10) over piston (2-20).

**CAUTION:** When using the chain wrench on the cylinder it should be secured as close to the welded end cap as possible.

10.18 Rotating the cylinder clockwise, screw cylinder (3-10) into the cylinder adapter and tighten with the chain wrench.

## 11.0 ACTUATOR TESTING

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

11.2 Before leak testing may be accomplished, it will be necessary to provide a piping system whereby pressure may be applied simultaneously to all common pressure ports

11.3 All leak testing will use 65 psig pneumatic pressure.

11.4 Before testing for leaks, alternately apply and release the 65 psig pressure to each side of the pistons to stroke the actuator fully in each direction. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.

11.5 Simultaneously apply 65 psig pressure to the pressure ports in the end of the right side cylinder (3-10) and in the left side cylinder adapter (2-30).

11.6 Apply leak testing solution to the following areas:

11.6.1 The pressure inlet port in the right side cylinder adapter (2-30), checks piston to cylinder and piston to piston rod seals.

11.6.2 The pressure inlet port hole in the end of the left side cylinder, checks the piston to cylinder wall and piston to piston rod seals.

11.6.3 The threaded joint between the left side cylinder and left side cylinder adapter (2-30), checks the cylinder to cylinder adapter o-ring seal.

- 11.6.4 The joint between the left cylinder adapter and the housing.
- 11.6.5 The snubber port hole located in the housing, checks the cylinder adapter to piston rod seal.
- 11.7 Remove pressure from the pressure ports in the end of the right side cylinder (3-10) and in the left side cylinder adapter (2-30).
- 11.8 Simultaneously apply 65 psig pressure to the pressure ports in the end of the left side cylinder (3-10) and in the right side cylinder adapter (2-30).
- 11.9 Apply leak testing solution to the following areas:
  - 11.9.1 The pressure inlet port in the left side cylinder adapter (2-30), checks piston to cylinder and piston to piston rod seals.
  - 11.9.2 The pressure inlet port hole in the end of the right side cylinder, checks the piston to cylinder wall and piston to piston rod seals.
  - 11.9.3 The threaded joint between the right side cylinder and right side cylinder adapter (2-30), checks the cylinder to cylinder adapter o-ring seal.
  - 11.9.4 The joint between the right side cylinder adapter and the housing.
  - 11.9.5 The snubber port hole located in the housing, checks the cylinder adapter to piston rod seal.
- 11.10 Remove pressure from the pressure ports in the end of the right side cylinder (3-10) and in the left side cylinder adapter (2-30).
- 11.11 If an actuator was disassembled and repaired, the above leakage test must be performed again.

## **12.0 RETURN TO SERVICE**

- 12.1 Replace the software components of the snubber (1-130) and then install the snubber into the housing (1-10).
- 12.2 Adjust both stop screws (1-60) back to settings recorded in section 5 under General Disassembly.
- 12.3 Tighten both jam nut (1-70) securely, while holding stop screws (1-60).
- 12.4 Rotate the yoke to the full clockwise (CW) position. Position the yoke weather cover (6-110) and position indicator (1-110) on the yoke (1-140) with the pointer facing the piston rod and perpendicular to the cylinder assemblies.
- 12.5 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.

- 12.6 For actuators equipped with a jackscrew assembly (3-20) and require an optional handwheel (8-10), install the handwheel using the following procedure.
- 12.6.1 Place handwheel (8-10) onto jackscrew assembly (3-20) and over the pinned slotted nut. NOTE: The hub of handwheel (8-10) has a cast hexagon hole that fits over the pinned slotted nut.
- 12.6.2 Place lockwasher (8-20) onto jackscrew assembly (3-20) and up against hub of handwheel (8-10).
- 12.6.3 Install and tighten hex nut (8-30) onto jackscrew assembly (3-20).
- 12.7 The actuator is now ready for returning to service.

### NHD522, NHD722 & NHD732 TOOL STYLE AND WRENCH SIZES

ITEM NO.	ITEM QTY.	NHD522/722 WRENCH SIZE	NHD732 WRENCH SIZE	LOCATION	RECOMMENDED WRENCH STYLE
1-30	4	9/16"	3/4"	Cover Screws	Socket
1-60	2	3/8"	1/2"	Stop Screws	Open End or Adjustable
1-70	2	15/16"	1-5/16"	1-5/16"	Open End or Adjustable
1-100	1	7/16"	7/16"	Pipe Plug	Open End
1-120	4	3/16"	3/16"	Socket Cap Screws	Allen
1-130	1	7/8"	7/8"	Snubber Valve	Deep Socket
2-70	2	1-1/4"	1-5/8"	Standard Hex Nut	Socket
2-90	8	7/16"	1/2"	Ferry Cap Screws	12 Point Socket <b>(1) (3)</b>
2-110	2	7/16"	7/16"	Pipe Plugs	Open End
3-10	2	<b>(2)</b>	<b>(2)</b>	Cylinder Assembly	Chain Wrench <b>(1)</b>
3-30	2	1-13/16"	1-13/16"	Heavy Hex Jam Nut	Open End or Adjustable
8-30	2	1-13/16"	1-13/16"	Heavy 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 model actuators used socket head cap screws in this location - wrench style will change to Allen.

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			CHECKED Bill Cornelius	1 December 1997
			APPROVED Tom Jeansonne	1 December 1997

\* Signatures on file Bettis Actuator & Controls, Waller, Texas

