

Bettis CBB Spring-Return Series Pneumatic Actuators

Disassembly and Reassembly



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Section 1: Introduction

1.1 General Service Information

- This service procedure is offered as a guide to enable general maintenance to be performed on Bettis™ CBB-SR Spring-Return Series Actuators. The following table is a list of general CBB-SR models numbers.

Table 1. CBB-SR Model Numbers

Model ⁽¹⁾		
CBB315-SR	CBB315-SR-M3	CBB315-SR-M3HW
CBB415-SR	CBB415-SR-M3	CBB415-SR-M3HW
CBB420-SR	CBB420-SR-M3	CBB420-SR-M3HW
CBB520-SR	CBB520-SR-M3	CBB520-SR-M3HW
CBB525-SR	CBB525-SR-M3	CBB525-SR-M3HW
CBB725-SR	CBB725-SR-M3	CBB725-SR-M3HW

NOTE:

- Also includes actuator models with -10 and -11 as a suffix.

NOTE:

When the actuator model number has “-S” as a suffix, then the actuator is special and may have some differences that may not be included in this procedure.

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

NOTE:

Storage time is counted as part of the service interval.

- This procedure is applicable with the understanding that all electrical power and pneumatic pressure have been removed from the actuator.
- Remove all piping and mounted accessories that will interfere with the module(s) that are to be worked on.
- This procedure should only be implemented by a technically competent technician who should take care to observe good workmanship practices.
- Numbers in parentheses (), indicates the bubble number (reference number) used on the Bettis Assembly Drawing and Actuator Parts List.
- When removing seals from seal grooves, use a commercial seal removing tool or a small screwdriver with sharp corners rounded off.
- Use a non-hardening thread sealant on all pipe threads.

⚠ CAUTION

Apply the thread sealant per the manufacturer's instructions.

- 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 are provided to assist maintenance personnel to carry out maintenance procedures.

NOTE:

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

M3: Jackscrew or jackscrew assembly

ES: Extended stop(s)

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 customer's plant safety or work procedures. If a conflict arises between this procedure and the customer's procedures the differences should be resolved in writing between an authorized customer's representative and an authorized Emerson representative.

⚠ WARNING

Electrostatic Charge - An electrostatic charge risk is present on the actuator surface; in case of cleaning, use only antistatic cloth; in case of maintenance, avoid all rubbing/frictions that could electrostatically charge the equipment.

1.4 Bettis Reference Materials

- CBBXXX-SRX Assembly Drawing, use part number VA152230-D.
- CBBXXX-SRX-M3HW Assembly Drawing, use part number VA152608-F.

1.5 Service Support Items

- Bettis Service Kit
- Commercial leak testing solution
- Non-hardening thread sealant

1.6 Operating Media

- Recommended to use clean, dry air or inert gas.
- Other gases may be used with direction from Emerson engineering to evaluate any possible restrictions or modifications which may need to be made for compatibility.

1.7 Lubrication Requirements

- 1.7.1** The actuator should be relubricated at the beginning of each service interval using the following recommended lubricants.

NOTE:

Lubricants other than those listed below should not be used without prior written approval of Bettis' product engineering. The lubricant item number on some assembly drawings is item (5) while the Bettis service kit's lubricant item number is item number (500).

- 1.7.2** All temperature services -50 to +350 °F / -45.5 to 176.6 °C use Bettis ESL-5 lubricant. ESL-5 lubricant is contained in the Bettis Module Service Kit in tubes and the tubes are marked ESL-4, 5 and 10 lubricant.

1.8 General Tool Information

- All threads on CBB-Series actuators are inch unified and NPT.
- All tools/hexagons are American Standard inch. Two adjustable wrenches, Allen wrench set, small standard screwdriver with sharp edges rounded off, medium-size standard screwdriver, diagonal cutting pliers, external snap ring pliers, flat file, drive ratchet/deep well socket set and torque wrench (up to 2000 lb-in. / 226 N•m).

1.9 Actuator Weight

Table 2. Actuator Weight

Actuator Model	Approximate Weight ⁽³⁾		Actuator Model	Approximate Weight ⁽³⁾	
	lb	kg		lb	kg
315-SR40 ⁽¹⁾	22	10.0	520-SR40 ⁽¹⁾	45	20.4
315-SR60 ⁽¹⁾	23	10.4	520-SR60 ⁽¹⁾	48	21.8
315-SR80 ⁽¹⁾	26	11.8	520-SR80 ⁽¹⁾	49	22.2
315-SR100 ⁽¹⁾	25	11.4	520-SR100 ⁽¹⁾	53	24.0
415-SR40 ⁽¹⁾	27	12.2	525-SR40 ⁽²⁾	62	28.1
415-SR60 ⁽¹⁾	29	13.2	525-SR60 ⁽²⁾	65	29.5
415-SR80 ⁽¹⁾	30	13.6	525-SR80 ⁽²⁾	65	29.5
415-SR100 ⁽¹⁾	31	14.1	525-SR100 ⁽²⁾	67	30.4
420-SR40 ⁽¹⁾	37	16.8	725-SR40 ⁽²⁾	97	44.0
420-SR60 ⁽¹⁾	39	17.7	725-SR60 ⁽²⁾	98	44.5
420-SR80 ⁽¹⁾	40	18.1	725-SR80 ⁽²⁾	104	47.2
420-SR100 ⁽¹⁾	41	18.6	725-SR100 ⁽²⁾	107	48.5

NOTES:

1. When model has -M3HW add 2.0 lb / 0.9 kg.
2. When model has -M3HW add 4.0 lb / 1.8 kg.
3. Weight is for bare actuator without accessories or valve adaptation.

1.10 Actuator Storage

For applications where the actuator is not put into immediate service, it is recommended that the actuator be cycled with regulated clean/dry pneumatic pressure at least once per month. Indoor storage, if available, is recommended for all actuators. Care should be taken to plug all open ports on actuator and controls to keep out foreign particles and moisture. Also, actuators should not be stored in an atmosphere harmful to resilient seals. For extended storage, contact the factory.

1.11 Actuator Installation

Since there are many valve and actuator combinations, it is not practical to include detailed instructions for each type. Mountings are designed to be as simple as possible to keep guess work out of installation.

Actuators are shipped from the factory with the travel stops adjusted for approximately ninety-degree rotation. Generally, it is necessary to make slight travel stop adjustments once the actuator is installed on the valve. Refer to the valve manufacturer's recommendations for specific requirements. When the valve has internal stops, the actuator should be adjusted at the same points.

NOTE:

The actual "stopping" should be done by the actuator. If the valve does not have internal stops, adjust the actuator to the full open position. Using this as a reference point, rotate the valve until it is closed and adjust to the valve manufacturer's specifications for total rotation.

Good instrument practices are also recommended. Clean/dry regulated pneumatic pressure is essential for long service life and satisfactory operation. It should be noted that new pneumatic lines often have scale and other debris in them and these lines should be purged of all foreign material.

NOTE:

Scale and debris can damage control valves, solenoids, seals, etc

1.12 Actuator Startup

1.12.1 Pre-start-up checks

- a. Unit has been mounted on valve properly. Gear flange mounting bolts, stem key and set screw(s) are installed and secured
- b. No tubing damaged or accessories dislodged during shipping or installation
- c. Indicated position confirms valve position
- d. All switching valves in normal operating position as per schematic/instructions

1.12.2 Check connections

- a. Pneumatic/hydraulic components connected as per schematic enclosed or in service manual supplied
- b. Pneumatic supply connected to identified ports
- c. Electrical connection terminals are secure
- d. Wiring as per enclosed diagram or service manual supplied

NOTE:

When the actuator is first placed into service, it should be cycled with regulated pneumatic pressure. This is necessary because the seals have been stationary, causing them to take a "set". Therefore, the actuator should be operated through several cycles to exercise the seals so as to achieve a service ready condition.

1.12.3 Speed of operation

The actuator speed of operation is determined by a number of factors, including:

- a. Power supply line length
- b. Power supply line size
- c. Power supply line pressure
- d. Control valve and fitting orifice size
- e. Torque requirements of the valve
- f. Size of the actuator
- g. Setting of speed controls

Due to the interaction of these variables it is difficult to specify a "normal" operating time. Faster operating times may be obtained by using one or more of the following:

- a. Larger supply lines
- b. Larger control valve
- c. Higher supply pressure *
- d. Quick exhaust valves

NOTE: * Not to exceed maximum operating pressure of actuator or control components.

- 1.12.4** Slower operating time may be obtained by using flow control valves to meter the exhaust. Excessive exhaust flow metering may cause erratic operation.

1.13 Actuator Operation

1.13.1 Controlled operation

Controlled operation is accomplished by pressurizing and/or depressurizing the appropriate cylinder inlet(s) of a double-acting.

Do not exceed the pressures indicated on actuator nameplate.

1.13.2 Manual operation

All pressure must be vented or equalized on both sides of the pneumatic piston prior to manual operation.

Section 2: Actuator Disassembly

2.1 General Disassembly

⚠ WARNING

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

⚠ CAUTION

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

NOTE:

Before starting the general disassembly of the actuator it is a good practice to operate 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.

- 2.1.1** Remove all operating pressure from the actuator, allowing the spring to stroke. The spring will rotate the yoke to its fail position.
- 2.1.2** Record the settings of stop screw or M3 jackscrews (1-70) and (4-30) before stop screws are loosened or removed.
- 2.1.3** Record the settings of stop screw/ES /M3 jackscrews (1-70) and stop screw (4-30)/ES (4-30) before they are loosened or removed.

NOTE:

In place of stop screws the actuator may be equipped with one or two ES or one M3/M3HW (1-70) located on outboard end of housing (1-10).

2.2 Spring Cylinder Disassembly

NOTE:

Review Section 2 steps 2.1.1 through 2.1.2 before proceeding with cylinder disassembly.

The spring in CBB-Series spring-return actuators is preloaded.

The actuator must be disassembled in the following manner:

2.2.1 Remove hex nut (1-80) as follows: For CBB315 through 725 standard housing stop screw or extended stop (ES), use step 2.2.1.1. For CBB315-SR-M3/M3HW through CBB725-SR-M3/M3HW, use step 2.2.1.2.

2.2.1.1 For CBB315 through 725 housing stop screw or extended stop screw (ES):

2.2.1.1.1 Loosen and remove hex nut (1-80) and washer (2-35) from stop screw (1-70) located in housing (1-10).

2.2.1.1.2 Remove stop screw (1-70) located in housing (1-10).

2.2.1.2 For CBB315/420/520/525/725-SR-M3 or M3HW:

2.2.1.2.1 Remove retainer ring (12-30) and groove pin (12-20) from optional hex drive hub or from hand wheel (12-10).

2.2.1.2.2 Remove optional hex drive hub or handwheel (12-10) from M3 jackscrew (1-70).

2.2.1.2.3 Loosen and remove hex nut (1-80) from M3 jackscrew (1-70).

NOTE:

For CBB420, 520, 525, 725-SR-M3 or M3HW models: the M3 jackscrew (1-70) cannot be removed now. The M3 jackscrew used in these models can be removed later in this procedure per step 2.3.7.

2.2.2 Loosen and remove hex nut (4-40) and washer (4-90) from end cap stop screw (4-30) or from end cap extended stop (4-30).

NOTE:

Extended stop or end cap stop screw (4-30) does not require removal from end cap (4-20) unless a new extended stop or stop screw is being replaced.

- 2.2.3** Remove breather (30) from end cap (4-20).
- 2.2.4** For models with breather -11 cold temperature, do the following:
 - 2.2.4.1** Remove breather (30-10), elbow (30-30) and hex nipple (30-20) from end cap (4-20).
- 2.2.5** Remove acorn nut (8-20) and gasket seal (5-50) from end cap (4-20).
- 2.2.6** Use a ratchet and socket on the welded nut, located on the housing end of the center bar assembly (8-10). Rotate center bar assembly (8-10) counterclockwise (CCW). This will cause end cap (4-20) to gradually unscrew from center bar assembly (8-10).

NOTE:

The end cap (4-20) can be held in position by holding the end cap (4-20) with an adjustable wrench.

- 2.2.7** Continue to rotate center bar assembly (8-10) counterclockwise until the spring preload is eliminated. As preload is reduced it may be necessary to keep end cap (4-20) from turning.
- 2.2.8** After the spring preload is eliminated, unscrew and remove end cap (4-20) from center bar assembly (8-10).
- 2.2.9** Remove spring (4-70) from within spring cylinder (4-10).
- 2.2.10** Hold torque shaft (1-30) and pull spring cylinder (4-10) away from housing (1-10); slide spring cylinder over piston (4-50) and remove.
- 2.2.11** For CBBXXX-SR-M3/M3HW models, do the following:
 - 2.2.11.1** Remove spacer (1-110) from center bar assembly (8-10).
- 2.2.12** For CBBXXX-SR models, do the following:
 - 2.2.12.1** Remove spacer (4-25) from center bar assembly (8-10).
- 2.2.13** Pull piston (4-50) out of housing (1-10) and carefully slide piston off of center bar assembly (8-10).

NOTE:

Piston (4-50) is an assembly made up of one roll pin and one yoke pin; do not attempt to disassemble the piston assembly.

- 2.2.14** On models CBB415-SR, CBB520-SR and CBB725-SR, remove cylinder adapter (4-15).

2.3 Housing Disassembly

- 2.3.1** Remove center bar assembly (8-10) from housing (1-10).
- 2.3.2** Remove both retaining rings (1-60) from torque shaft (1-30).
Remove washers (1-65) from housing.
- 2.3.3** The following steps may be required before disassembly can continue.
 - 2.3.3.1** If torque shaft (1-30) has any raised burrs or sharp edges they should be removed.

NOTE:

When removing burrs and sharp edges, remove as little metal as possible.

- 2.3.3.2** If there is excessive paint build-up on torque shaft (1-30) it should be removed.
- 2.3.4** Remove the torque shaft (1-30) by pushing it out one side of housing (1-10).
- 2.3.5** Remove yoke key (1-40) and yoke key spring (1-50) from torque shaft (1-30).
- 2.3.6** Remove yoke (1-20) from housing (1-10).
- 2.3.7** For actuator models CBB315-SR with a M3 or M3HW mounted in the outboard end of housing (1-10), remove M3 jackscrew (1-70) from housing (1-10).

NOTE:

The M3 jackscrew (1-70) will be removed from the inside of the housing (1-10).

- 2.3.8** For actuator models CBB420, 520, 525 and 725 with a M3 or M3HW mounted in the outboard end of housing (1-10) complete steps 2.3.8.1 and 2.3.8.2.
 - 2.3.8.1** Remove retainer ring (2-40) from M3 adapter (1-90).
 - 2.3.8.2** Remove M3 adapter (1-90) from housing (1-10).

NOTE:

The M3 adapter will be removed from the inside of the housing (1-10) with the M3 jackscrew.

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 the actuator being refurbished.

- 3.1.1** Remove and discard all old seals and gaskets.
- 3.1.2** All parts should be cleaned to remove all dirt and other foreign material prior to inspection.
- 3.1.3** All parts should be thoroughly inspected for excessive wear, stress cracking, galling and pitting. Attention should be directed to threads, sealing surfaces and areas that will be subjected to sliding or rotating motion. Sealing surfaces of the cylinder, torque shaft and center bar must be free of deep scratches, pitting, corrosion and blistering or flaking coating. On the CBB models, there are two O-rings on the torque shaft and two extra O-rings beneath the washers on the housing. These items **MUST** be replaced upon reassembly.

NOTE:

Coat the torque-shaft O-ring (2-25) with grease upon installation. The following steps are used to reassemble the following models: CBB315, 420, 520, 525 and 725. Use Assembly Drawing Part Numbers VA152230-D and VA152608-F in Appendix B for this section.

CAUTION

Actuator parts that reflect any of the above-listed characteristics may need replacement with new parts.

- 3.1.4** Installation lubrication instructions
 - Use the correct lubrication as defined in Section 1.7.
 - 3.1.4.1** Before installation, coat all moving parts with lubricant.
 - 3.1.4.2** Coat all seals with lubricant, before installing into seal grooves.

3.2 Housing Reassembly

NOTE:

In Section 3.2 where the step indicates to “lubricate, coat or apply lubricant”, use lubricant as identified in Section 1.7 for lubricating the part being installed. Review Section 3, steps 3.1.1 through 3.1.4 before proceeding with housing reassembly. Housing M3 jackscrew (1-70) installation: Use step 3.2.1 for CBB315/415-SR-M3, and step 3.2.2 for CBB420/520/525/725-SR-M3 includes M3HW models.

3.2.1 M3 jackscrew installation for CBB315/415-SR-M3.

- 3.2.1.1**
- Apply a light coating of lubricant to the threads of M3 jackscrew (1-70).

NOTE:

M3 jackscrew (1-70) will be installed from inside of the housing (1-10).

- 3.2.1.2**
- Insert and rotate M3 jackscrew (1-70) into housing (1-10).

NOTE:

Rotate the M3 jackscrew into the housing until the inboard end of the M3 jackscrew is up against the inside of housing (1-10).

- 3.2.1.3**
- Install O-ring seal (2-30) onto M3 jackscrew (1-70) until it is flush with the housing.

- 3.2.1.4**
- Install hex nut (1-80) onto M3 jackscrew (1-70) until it is hand-tight.

3.2.2 M3 jackscrew installation for CBB420/520/525/725-SR-M3.

- 3.2.2.1**
- Apply a coating of lubricant to outer diameter and inner diameter threads of M3 adapter (1-90).

- 3.2.2.2**
- Coat O-ring seal (2-45) with lubricant and install into outer diameter seal groove located in the M3 adapter (1-90).

- 3.2.2.3**
- Apply a light coating of lubricant to the threads of M3 jackscrew (1-70).

- 3.2.2.4**
- Install and rotate the M3 jackscrew (1-70) into M3 adapter (1-90).

NOTE:

Rotate the M3 jackscrew into the adapter until the inboard end of the jackscrew is up against the adapter.

- 3.2.2.5**
- Install M3 adapter (1-90) into housing (1-10).

NOTE:

The M3 adapter will be installed from inside of the housing (1-10).

- 3.2.2.6**
- Install retainer ring (2-40) onto groove in M3 adapter (1-90).

- 3.2.2.7**
- Install O-ring seal (2-30) onto M3 jackscrew (1-70).

NOTE:

Move the O-ring seal (2-30) down the M3 jackscrew until it is next to the M3 adapter.

- 3.2.2.8**
- Install hex nut (1-80) onto M3 jackscrew (1-70).

NOTE:

Rotate the hex nut down the M3 jackscrew until it is next to the M3 adapter.

3.2.3 Apply a coating of lubricant to the torque shaft holes located on each side of housing (1-10).

3.2.4 Coat torque shaft wiper seals (2-20) with lubricant and install in one of the grooves located in the torque shaft bore of the housing (1-10).

NOTE:

The cup of torque shaft wiper seal will be installed facing down into the housing.

3.2.5 Coat yoke (1-20) with lubricant and install into housing (1-10). Apply a generous amount of lubricant to the slots in the arms of yoke (1-20).

3.2.6 Insert the yoke key spring (1-50) with the ends pointing down into the slot in the torque shaft (1-30) and place the yoke key (1-40) on top of the spring with the tapered side outward.

⚠ WARNING

If the yoke key (1-40) is installed incorrectly the housing may be damaged when the next disassembly occurs. Refer to assembly drawings for correct yoke key spring and yoke key orientation.

3.2.7 Hold the yoke key (1-40) down with your thumb; insert the torque shaft (1-30) by gently rotating it into the housing (1-10) and yoke (1-20) on the opposite side of the installed torque shaft wiper seal (2-20).

NOTE:

Torque shaft should be installed with the key rotated 180° opposite the yoke key slot. When the torque shaft (1-30) is flush with the housing (1-10), push the torque shaft (1-30) through until the empty seal groove is exposed. Install the other torque shaft wiper seal (2-20) into the groove. The cup of the torque shaft wiper seal again needs to be installed facing inward into the housing. Two new retaining rings (1-60) are contained in the Bettis CBB Service Kits.

3.2.8 Install one of the new retaining rings (1-60) onto the exposed end of the torque shaft, making certain it is properly seated in the groove of the torque shaft (1-30). Gently push and rotate the torque shaft (1-30) until the retaining ring (1-60) is pressed against the housing (1-10). Install the other retaining ring (1-60) to the other side of the torque shaft (1-30).

⚠ CAUTION

Rotate the torque shaft until the yoke key snaps into the yoke keyway.

- 3.2.9** Rotate the torque shaft (1-30) so that the arms of yoke (1-20) point outward.
- 3.2.10** Coat O-ring seal (5-20) with lubricant and install into inner diameter seal groove located in the center bar hole of housing (1-10).
- 3.2.11** Coat entire length of center bar (8-10) with lubricant including the threads.
- 3.2.12** Insert center bar assembly (8-10) into the center hole of housing (1-10). Slide center bar assembly through housing until center bar assembly nut is flush against the housing (1-10).

WARNING

Be careful when installing the center bar assembly to avoid scratching it.

- 3.2.13** Recoat center bar assembly (8-10) with lubricant.
- 3.2.14** Coat one O-ring seal (5-10) with lubricant and install onto outer diameter flange located on housing adapter end of housing (1-10).
- 3.2.15** For actuators equipped with cylinder adapter (4-15), models CBB415-SR, CBB520-SR and CBB725-SR, do steps 3.2.15.1 and 3.2.15.2.
 - 3.2.15.1** Install cylinder adapter (4-15) onto housing flange, with the stepped outer diameter, of cylinder adapter (4-15), facing away from housing (1-10).
 - 3.2.15.2** Install one O-ring seal (5-15) onto stepped diameter of cylinder adapter (4-15).

3.3 Spring Cylinder Reassembly

- 3.3.1** Coat piston (4-50) outer diameter seal groove, inner diameter seal groove, head of piston and exposed ends of yoke pin with lubricant.
- 3.3.2** Coat O-ring seal (5-20) with lubricant and install in the internal seal groove in the head of piston (4-50).
- 3.3.3** Coat seal (5-40) with lubricant and install into outer diameter seal groove of piston (4-50). The piston seal will fit very loosely in the outer diameter seal groove.
- 3.3.4** Install bushing (4-80) between the two arms of yoke (1-20).
- 3.3.5** With the piston head facing away from housing (1-10) and with yoke pin up, install piston (4-50) onto center bar assembly (8-10).
- 3.3.6** Carefully slide piston (4-50) along center bar (8-10) until yoke pin engages the yoke slots.

NOTE:

While holding the center bar assembly flush against the housing, push piston (4-50) into housing (1-10) as far as the piston will go.

- 3.3.7** Apply a coating of lubricant to entire bore of spring cylinder (4-10).
- 3.3.8** Spring cylinder installation
- 3.3.8.1** For CBB415-SR, CBB520-SR and CBB725-SR models, install the lubricated spring cylinder (4-10) over the piston and up against the O-ring seal on the stepped diameter flange of cylinder adapter (4-15).
- 3.3.8.2** For CBB315-SR, CBB420-SR and CBB525-SR models, install the lubricated spring cylinder (4-10) over the piston and up against the O-ring seal on the flange of housing (1-10).
- 3.3.9** For CBBXXX-SR-M3/M3HW models, do the following
- 3.3.9.1** Install spacer (1-110) onto center bar assembly (8-10).
- 3.3.10** For CBBXXX-SR models, do the following
- 3.3.10.1** Install spacer (4-25) onto center bar assembly (8-10).
- 3.3.11** Apply a coat of lubricant to the spring (4-70). Install the spring into the spring cylinder by carefully sliding the spring into the open spring cylinder end until the spring contacts the head of piston (4-50).
- 3.3.12** End cap seal installation
- 3.3.12.1** For CBB415-SR, CBB520-SR and CBB725-SR models, install O-ring seal (5-15) onto end cap (4-20).
- 3.3.12.2** For CBB315-SR, CBB420-SR and CBB525-SR models, install O-ring seal (5-10) onto end cap (4-20).
- 3.3.13** If removed, install stop screw/ES (4-30) into end cap (4-20) and set stop screw to the approximated setting recorded in Section 2 step 2.1.2.

NOTE:

While holding the center bar assembly flush against the housing, push piston (4-50) into the housing (1-10) as far as the piston will go.

- 3.3.14** Install end cap (4-20) onto center bar assembly (8-10) by rotating the end cap in a clockwise direction.
- 3.3.15** Position the end cap (4-20) so that the breather port is at the bottom and the stop screw/ES (4-30) is at the top.

 WARNING

Do not allow end cap (4-20) to rotate during center bar assembly tightening. The end cap must maintain the position as described in step 3.3.14.

- 3.3.16** Keep end cap (4-20) from turning by holding end cap with an adjustable wrench.
- 3.3.17** Using a ratchet and socket on the center bar assembly nut, rotate center bar assembly clockwise (CW). This will cause end cap (4-20) to gradually screw further onto center bar assembly (8-10).

- 3.3.18** Continue to rotate center bar assembly (8-10) clockwise until spring (4-70) is fully compressed, spring cylinder is seated against the flange of housing (1-10) or adapter (4-15) and end cap (4-20) is properly seated in spring cylinder (4-10).
- 3.3.19** Tighten center bar assembly (8-10) to the proper torque as specified in the following table.

Table 3. Tightening Torque Center Bar

CBB Actuator Model	Maximum Torque	
	lb-in	N•m
315-SR and 415-SR	55	75
420-SR and 520-SR	100	136
525-SR and 725-SR	130	176

- 3.3.20** Place seal gasket (5-50) on the exposed end of the center bar assembly (8-10).
- 3.3.21** Place acorn nut (8-20) on the exposed outboard end of center bar assembly (8-10) and tighten securely.
- 3.3.22** Install the stop screw/ES/M3 jackscrew (1-70) for CBB315/415-SR-M3 and non-M3 model actuators as follows:
- 3.3.22.1** Install stop screw/ES/M3 jackscrew (1-70) into housing (1-10) and screw in until stop screw contacts the piston.
- 3.3.22.2** Install O-ring seal (2-30) onto stop screw/ES/M3 jackscrew (1-70) until it is flush with the housing.
- 3.3.22.3** For CBBXXX-SR-M3/M3HW models, install hex nut (1-80) onto stop screw (1-70) until it is hand-tight.
- 3.3.22.4** For CBBXXX-SR modles, install hex nut (4-40) and washer (1-90) onto stop screw (1-70) until hand-tight.
- 3.3.22.5** Install hex nut (1-80) onto stop screw (1-70) until it is hand-tight.
- 3.3.23** Install O-ring seal (5-30) onto the stop screw/ES (4-30) until it is flush with the end cap.
- 3.3.24** Install new washer (4-90) onto the stop screw/ES (4-30) until it is close to the end cap.
- 3.3.25** Install hex nut (4-40) onto stop screw/ES (4-30) until it is hand tight.
- 3.3.26** Adjust stop screw/ES/M3 jackscrew (1-70) and stop screw / ES (4-30) back to setting recorded in Section 2 step 2.1.2 under General Disassembly. Tighten both stop screw hex nuts (4-40) and (1-80) securely, while holding stop screw (1-70) and (4-30).
- 3.3.27** M3 hex drive hub or handwheel installation as follows:
- 3.3.27.1** Install hex drive hub (12-10) or handwheel (12-10) onto M3 jackscrew (1-70) and align the "hole" of the drive hub with the "hole" located in the M3 jackscrew.
- 3.3.27.2** Install retainer ring (12-30) and groove pin (12-20) into the hex drive hub (12-10) or handwheel (12-10).

Section 4: Actuator Testing

4.1 Actuator Testing

- 4.1.1** Leak Test - General: A small amount of leakage may be tolerated. Generally, a small bubble which breaks about three seconds after starting to form is considered acceptable.
- 4.1.2** All areas, where leakage to atmosphere may occur, are to be checked using a commercial leak testing solution.

WARNING

Pressure is not to exceed the maximum operating pressure rating listed on the serial number tag (20).

- 4.1.3** All leak testing will use the customer normal operating pressure or the actuator name tag Normal Operating Pressure (NOP).

NOTE:

When testing the actuator, use a proper adjusted regulator to apply pressure to the actuator.

- 4.1.4** Before testing for leaks, apply and release the pressure listed in step 4.1.3 to the housing side of the piston. Repeat this cycle approximately five times. This will allow the new seals to seek their service condition.
- 4.1.5** Apply the pressure listed in step 4.1.3 to the housing side of the piston and allow the actuator to stabilize.
- 4.1.6** Apply a leak-testing solution to the following areas:
- 4.1.6.1** Spring cylinder to housing joint on CBB315-SR, CBB420-SR and CBB525- SR or spring cylinder to cylinder adapter to housing joints on CBB415-SR, CBB520-SR and CBB725-SR actuators.
 - 4.1.6.2** On the out board end of housing (1-10) at the center bar assembly nut. Check the center bar to housing O-ring seal (5-20).
 - 4.1.6.3** Housing stop screw O-ring seal (2-30).
 - 4.1.6.4** Torque shaft (1-30) to housing (1-10) interface. Check rod wiper seals (2-20).
 - 4.1.6.5** End cap (4-20) port hole. Check the piston to cylinder seal (5-40) and piston to center bar seal (5-20).
 - 4.1.6.6** Remove pressure from pressure inlet port in the housing (1-10).
- 4.1.7** If an actuator was disassembled and repaired as a result of this procedure, the above leakage test must be performed again.
- 4.1.8** Operational (Functional) Test: This test is used to verify proper function of the actuator.

NOTE:

This test is to be done off of the valve or when valve stem is not coupled to the actuator torque shaft.

- 4.1.8.1** Adjust the pressure regulator to the pressure rating that the customer uses to operate the actuator during normal service.
- 4.1.8.2** Apply the above pressure to the actuator and allow the actuator to stabilize. The actuator should stroke a full 90° travel with the stops properly set.
- 4.1.9** Shell Pressure Test: Optional pressure test can be performed on the actuator by applying pressure to both sides of the piston simultaneously for a period of two (2) minutes. If any leakage occurs across a static seal, the unit must be disassembled and the cause of leakage determined and corrected.

WARNING

The actuators main pressure bearing parts will be tested in controlled conditions by pressuring both sides of the piston to avoid damage and over-torquing of the actuator components. If further future testing in the field is necessary, Emerson should be contacted for guidance.

4.2 Return to Service

- 4.2.1** Install breather (30) into end cap (4-20).
- 4.2.2** For models with breather -11 cold temperature, do the following:
 - 4.2.2.1** Install breather (30-10), elbow (30-30) and hex nipple (30-20) into end cap (4-20).
- 4.2.3** After the actuator is installed back on the valve, all accessories should be hooked up and tested for proper operation and then replaced, if found defective.

4.3 Pressure Requirement and Limitations for CBB-SR Actuators

Table 4. Pressure Requirement and Limitations

Actuator Model	Nominal Operating Pressure		Maximum Operating Pressure		Actuator Model	Nominal Operating Pressure		Maximum Operating Pressure	
	psig	barg	psig	barg		CBB	psig	barg	psig
315-SR40	40	2.76	155	10.69	520-SR40	40	2.76	110	7.59
315-SR60	60	4.14	152	10.48	520-SR60	60	4.14	116	8.00
315-SR80	80	5.52	150	10.34	520-SR80	80	5.52	120	8.27
315-SR100	100	6.89	164	11.31	520-SR100	100	6.89	132	9.10
415-SR40	40	2.76	100	6.89	525-SR40	40	2.76	146	10.07
415-SR60	60	4.14	112	7.72	525-SR60	60	4.14	151	10.41
415-SR80	80	5.52	117	8.07	525-SR80	80	5.52	159	10.96
415-SR100	100	6.89	114	7.86	525-SR100	100	6.89	163	11.24
420-SR40	40	2.76	157	10.83	725-SR40	40	2.76	102	7.03
420-SR60	60	4.14	156	10.76	725-SR60	60	4.14	115	7.95
420-SR80	80	5.52	161	11.10	725-SR80	80	5.52	124	8.55
420-SR100	100	6.89	166	11.45	725-SR100	100	6.89	124	8.55

Section 5: Troubleshooting

5.1 Fault Insertion

In the unlikely event of a fault developing, the following symptoms and solutions table is provided to assist the service engineer. This table is designed to cover as wide a range of Emerson's Bettis actuators as possible. Reference to equipment that is not supplied should be ignored.

Table 5. Symptoms and Solutions Table

Symptom	Potential Causes	Remedy
Erratic movement	Irregular supply of operating medium	Check operating medium for consistent supply pressure and correct as necessary.
	Inadequate lubrication	Dismantle, relubricate and reassemble.
	Worn parts	Dismantle. Visually inspect for significant wear. Actuator replacement may be required.
	Defective valve	Consult the valve OEM's documentation.
Short stroke	Incorrectly set stops (valve and/or actuator)	Check the position of the travel stops and readjust as necessary.
	Hardened grease	Dismantle, remove any hard grease, relubricate and reassemble.
	Debris left in the cylinder or housing during maintenance	Disassemble cylinder assembly to remove debris. Reassemble cylinder assembly as necessary.
	Defective valve	Consult the valve manufacturer's documentation.
Apparent lack of torque	Inadequate supply pressure	Ensure supply pressure is above the minimum operating pressure of the actuator and that output torque produced at supply pressure exceeds valve torque demand.
	Incorrect speed control settings	Adjust speed controls to increase flow.
	Exhaust port blocked	Remove and clean the exhaust port silencers and replace.
	Pipe work blocked, crushed or leaking	Examine the pipe work for blockages, crushed pipe or leakage. Clear or replace as necessary.
	Defective controls	Examine the controls, refurbish or renew as necessary. Refer to component manufacturer's documentation.
	Defective piston seal	Dismantle the cylinder assembly and remove the defective piston seal. Fit new seal and reassemble.
	Defective rod seal	Dismantle the cylinder assembly, remove the defective rod seal. Fit new seal and reassemble.
	Defective housing seal	Dismantle the housing assembly and remove the defective seal. Fit new seal and reassemble.
	High valve torque or valve seized	Consult the valve OEM documentation.
	Defective spring	Check for noise and/or erratic operation. Replace spring if required.

5.2 Operational Test

5.2.1 Full Stroke Test

The "Full Stroke Test" ("On-line") must be performed to satisfy the PFD_{AVG} (average probability of failure on demand) value. The full stroke test frequencies will be defined by the final installer to achieve the defined SIL level.

5.2.1.1 Procedure

- 5.2.1.1.1 Stroke the actuator/valve assembly two complete open/close cycles with complete closing of the valve.
- 5.2.1.1.2 Verify if the open/close cycles functioned correctly (e.g., check locally or automatically via logic solver, the correct movement of the actuator/valve).
- 5.2.1.1.3 Upon successful completion of the above-described Full Stroke Test procedure, the "Test Coverage" can be considered 99%.

5.2.2 Partial Stroke Test (when requested)

The "Partial Stroke Test" ("On-line") can be performed to improve the PFD_{AVG} value and to satisfy PFD_{AVG} value.

A typical partial stroke value is 15% of the stroke and the recommended test interval is about every one to three months.

5.2.2.1 Procedure

- 5.2.2.1.1 Operate the actuator/valve assembly for 15% of the stroke.
- 5.2.2.1.2 Verify if the partial stroke test functioned correctly (e.g., check locally, or automatically via Logic solver, or via the PST system the correct movement of the actuator/valve was 15% of the stroke).

NOTE:

The above test is only applicable on systems equipped with a partial stroke feature.

Section 6: Removal and Decommissioning

WARNING

Always follow safe work practices to remove and disassemble a CBB-Series actuator.

The below basic 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 a customer's authorized representative and an authorized Emerson representative.

CAUTION

Make sure the actuator is isolated before removing from the valve. Turn OFF the power medium and bleed off all pressure first, including storage tank (if present). Next, bleed off pilot pressure, and disconnect pneumatic pressure supply, pilot tubing and electrical wiring (if equipped).

Before starting the disassembly, a large area should be created around the actuator as to allow any kind of movement.

Separate the parts comprising the actuator according to their nature (e.g., metallic, plastic materials, fluids, etc.) and send them to differentiated waste collection sites, as provided for by the laws and provisions in force.

1. Drain tanks and remove tubing from the actuator. Remove accessories (if equipped) and control from the actuator.
2. Remove all equipment mounted on top of the actuator (limit switches, end of stroke valve and relevant pneumatic/electric connection, etc.).
3. Remove mounting bolts and the actuator is ready to be removed from the valve. For complete actuator tear down, refer to Section 2 of this manual.

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Appendix C: Safety Instructions for Use in (Potential) Explosive Atmosphere



C.1 Intended Use

The actuator series have been designed to comply with the explosion safety requirements in the Ex-standards EN IEC 60079-0:2018, EN ISO 80079-36, EN ISO 80079-37:2016 and EN 1127-1:2019. These standards contain the requirements for non-electrical equipment in potentially explosive atmospheres.

The actuators comply with the constructional safety type "c" requirements. The actuators are designed for gas group IIB or IIC and dust group IIIC applications and are applicable in temperature classes T6 to T3 depending on model. The Equipment Protection Level is Gb for gas and Db for dust, so the actuators can be used in Ex classified hazardous zones 1/21.

C.2 Explosive Atmosphere Marking

Complete Explosive Atmosphere Marking:



 II 2 G Ex h IIB or IIC T6 to T3 Gb
 II 2 D Ex h IIIC T85 °C to T200 °C Db

Ambient Temperature Ranges (T_{amb}):

- Standard Temperature: -20 to 200 °F / -29 to 93 °C
- Low Temperature: -40 to 150 °F / -40 to 65 °C
- High Temperature: 0 to 350 °F / -18 to 176 °C

NOTE:

1. The minimum and maximum temperatures can vary according to the project design (gaskets, O-rings and grease used) as well as other certifications within the given range. Please refer to the special conditions for safe use.
2. Hazardous area is likely to occur in normal operation occasionally in greater than 10 and less than 1000 hours/year.

C.3 Safety Instructions

1. Before the installation, please carefully read the service instructions. Emerson is not responsible for damages caused by operations not complying with the instruction manuals.
2. All the operations shall be done by a trained and qualified operator. All maintenance operations must be performed in accordance with the instructions detailed in the maintenance manual.
3. The assembly cannot be installed and used in classified areas as zone 0 to 20, mines (group I).
4. The equipment shall be installed in a place where the risk of lightning is covered by the relevant industrial code of practice.
5. Assembly, disassembly and maintenance is only allowed at the actuator, when at the time of the activity, there are no explosive mixtures.
6. During maintenance operations, the user must take all appropriate measures to prevent risks related to the toxicity of substances, using appropriate protective equipment (e.g., gloves, goggles, face mask), according to the extent provided the technical and organizational point of use and the recommendations provided in the specifications of the used substances.
7. All the mechanical components do not have ignition sources during the normal working process. The user shall check periodically the vibration presence and/or abnormal noises and it must stop the unit immediately, check the causes and contact the manufacturer.
8. Actuators do not have an inherent ignition source due to electrostatic discharge, but explosion hazards may be present due to the discharge of static electricity from other valve assembly components.
 - a. To avoid personal injury or property damage, make sure that the valve is grounded to the pipeline before placing the valve assembly into service.
 - b. Use and maintain alternate shaft-to-valve body bonding, such as a shaft-to-body bonding strap assembly.
 - c. The equipment must be earthed through an anti-loosening and anti-rotation device. The user must regularly check the effectiveness of the ground connection.
 - d. A warning is present into the label: "Potential electrostatic charging hazard".
9. When equipment is installed in a hazardous area location (potentially explosive atmosphere), prevent sparks by proper tool selection and avoiding other types of impact energy.
10. It is the end user's responsibility to avoid allowing the explosive mixture from entering the actuator. As such, safe air from outside of the Ex-zone (Safe Area) must be used to feed the pneumatic cylinder.

Note: For single acting actuators, a closed-loop control system is one of the options that can be used to avoid allowing the explosive mixture from entering the actuator.

11. Regularly clean dust deposits from the actuator to minimize the risk of explosion due to dust.
12. Proper care must be taken to avoid generation of static electricity on the non-conductive external surfaces of the equipment (e.g., rubbing of surfaces, etc.).
13. The paint protection must not exceed 200 µm if the actuator is used in a group IIC atmosphere. For group IIA or IIB atmospheres, the paint protection must not exceed a thickness of 0.08 in / 2 mm.
14. After maintenance operations carried out, perform a few actuator operations to check that its movement is regular and that there is no air/oil leakage through the seals/gaskets.
15. It is under end user responsibility to make sure the electrical equipment installed on the actuators have a separated Explosive Atmosphere evaluation and they are designed according to the Explosive Atmosphere Directive/Regulation, and they are suitable for the installation zone, group of gas, temperature class, maximum surface temperature, EPL and range of temperature.
16. Using this equipment in ways not specified in the instruction manual is not permitted. Emerson is not liable for any damages resulting from improper or hazardous use.

C.4 Maximum Temperatures

WARNING

The actuator's surface temperature is dependent upon process operating conditions. Personal injury or property damage caused by fire or explosion can result if the actuator's surface temperature exceeds the acceptable temperature for the hazardous area classification. To avoid an increase of instrumentation and/or accessory surface temperature due to process operating conditions, ensure adequate ventilation, shielding or insulation of these actuator components installed in a potentially hazardous or explosive atmosphere.

Table C-1. Ambient and Explosive Atmosphere Temperatures

Temperature			Valid Actuator Trim
Ambient Range	Explosive Atmosphere Class	TX (Explosive Atmosphere Surface Temperature)	
-20 to 167 °F / -29 to 75 °C	T6	T185 °F / T85 °C	Standard Temperature Trim
-20 to 194 °F / -29 to 90 °C	T5	T212 °F / T100 °C	
-20 to 200 °F / -29 to 93 °C	T4	T217 °F / T103 °C	
-40 to 150 °F / -40 to 65 °C	T6	T167 °F / T75 °C	Low Temperature Trim
0 to 257 °F / -18 to 125 °C	T4	T275 °F / T135 °C	High Temperature Trim
0 to 350 °F / -18 to 176 °C	T3	T367 °F / T186 °C	

NOTES:

The specified values are valid with condition: Maximum cycle frequency of the actuator is less than 1 Hz at a maximum of 50 cycles per hour and at maximum load.

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