

Biffi FCBB Double-Acting Series Pneumatic Actuators

Disassembly and Reassembly



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Table of Contents

Section 1: Introduction

| | | |
|------|--|---|
| 1.1 | General Service Information | 1 |
| 1.2 | Definitions | 2 |
| 1.3 | General Safety Information | 2 |
| 1.4 | Biffi Actuator Reference Materials | 3 |
| 1.5 | Service Support Items | 3 |
| 1.6 | Operating Media | 3 |
| 1.7 | Lubrication Requirements | 3 |
| 1.8 | General Tool Information..... | 4 |
| 1.9 | Actuator Weight | 4 |
| 1.10 | Actuator Storage..... | 4 |
| 1.11 | Actuator Installation..... | 4 |
| 1.12 | Actuator Start-up | 5 |
| 1.13 | Actuator Operation | 6 |

Section 2: Actuator Disassembly

| | | |
|-----|--------------------------------------|---|
| 2.1 | General Disassembly | 7 |
| 2.2 | Pneumatic Cylinder Disassembly | 7 |
| 2.3 | Housing Disassembly | 9 |

Section 3: Actuator Reassembly

| | | |
|-----|--|----|
| 3.1 | General Reassembly..... | 11 |
| 3.2 | Actuator Reassembly per FCBB Models Listed in Step 3.1.5.1 | 11 |
| 3.3 | Actuator Reassembly per FCBB Models Listed in Step 3.1.5.2 | 15 |

Section 4: Actuator Testing

| | | |
|-----|-----------------------|----|
| 4.1 | Actuator Testing..... | 21 |
|-----|-----------------------|----|

Section 5: Troubleshooting

| | | |
|-----|-----------------------|----|
| 5.1 | Fault Insertion | 23 |
| 5.2 | Operational Test..... | 24 |

Section 6: Removal and Decommissioning

| | | |
|--|-----------------------------------|----|
| | Removal and Decommissioning | 25 |
|--|-----------------------------------|----|

Section 7: Document Revision

Document Revision26

Appendix A: List of Tables

List of Tables27

Appendix B: List of Drawings

B.1 Part Number VA001-005-72-4, FCBBXXX Assembly Drawing28
B.2 Part Number VA001-005-73-3, FCBBXXX-M3HW Assembly Drawing29

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

C.1 Intended Use30
C.2 ATEX Marking30
C.3 Safety Instructions31
C.4 Maximum Temperatures32

Section 1: Introduction

1.1 General Service Information

- This service procedure is offered as a guide to enable general maintenance to be performed on Biffi™ FCBB double-acting series actuators. The following is a list of general FCBB model numbers.

Table 1. FCBB Model Numbers

| | MODEL ⁽¹⁾ | |
|-----|----------------------|----------|
| 315 | 315-M3 | 315-M3HW |
| 420 | 420-M3 | 420-M3HW |
| 520 | 520-M3 | 520-M3HW |
| 525 | 525-M3 | 525-M3HW |
| 725 | 725-M3 | 725-M3HW |

Note:

1. 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 has 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 (), indicate the bubble number (reference number) used on the Biffi 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.

-
- Biffi 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).

ES: Extended stop screw (for travel stop adjustment over a full 100° travel range).
ES is not intended for use as a manual override.

M3: Manual jackscrew override

1.3 General Safety Information

Products supplied by Biffi, 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 Biffi actuators, this procedure should be reviewed and implemented for safe disassembly and reassembly. Close attention should be given to the WARNINGS, CAUTIONS and NOTES from 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 a customer's authorized representative and an authorized Biffi representative.

⚠ WARNING

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

1.4 Biffi Actuator Reference Materials

- FCBBXXX Assembly Drawing use part number VA001-005-72-4 in Appendix B.
- FCBBXXX-M3HW Assembly Drawing use part number VA001-005-73-3 in Appendix B.

1.5 Service Support Items

- 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 Biffi Engineering to evaluate any possible restrictions or modifications which may need to be made for compatibility.

1.7 Lubrication Requirements

- 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 Biffi product engineering. The lubricant item number on some assembly drawings is item (5) while the service kits lubricant item number is item number (500).

- All temperature services -45.5 to 176.6 °C / -50 to +350 °F use ESL-5 lubricant. ESL-5 lubricant is contained in the module service kit in tubes and the tubes are marked ESL-4, 5 and 10 lubricant.

1.8 General Tool Information

- All threads on FCBB 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 226 Nm / 2000 lb-in.

1.9 Actuator Weight

Table 2. Actuator Weight

| Actuator Model FCBB | Approximate Weight ⁽¹⁾ | | Actuator Model FCBB | Approximate Weight ⁽¹⁾ | |
|------------------------|-----------------------------------|------|------------------------|-----------------------------------|----|
| | kg | lb | | kg | lb |
| 315 | 9.1 | 20 | 520-M3HW | 17.2 | 38 |
| 315-M3 | 10.5 | 23.2 | 525 | 20 | 44 |
| 315-M3HW | 11.3 | 25 | 525-M3 | 22.7 | 50 |
| 420 | 10 | 22 | 525-M3HW | 25.4 | 56 |
| 420-M3 | 13.4 | 29.4 | 725 | 31 | 68 |
| 420-M3HW | 15 | 33 | 725-M3 | 34 | 75 |
| 520 | 12.7 | 28 | 725-M3HW | 37 | 81 |
| 520-M3 | 15.7 | 34.4 | - | - | - |

Note:

1. 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 manufacturer's representative.

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 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 Start-up

1.12.1 Pre start-up checks

1. Unit has been mounted on valve properly. Gear flange mounting bolts, stem key, setscrew(s) installed and secured.
2. No tubing damaged or accessories dislodged during shipping or installation.
3. Indicated position confirms valve position.
4. All switching valves in normal operating position as per schematic/instructions.

1.12.2 Check connections

1. Pneumatic/hydraulic components connected as per schematic enclosed or in service manual supplied.
 2. Pneumatic supply connected to identified ports.
 3. Electrical connections terminals are secure.
 4. Wiring as per enclosed diagram or service manual supplied.
-

NOTE:

When the actuator is first put 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, exercising the seals, resulting in a service ready condition.

1.12.3 Speed of operation

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

1. Power supply line length
2. Power supply line size
3. Power supply line pressure
4. Control valve and fitting orifice size
5. Torque requirements of the valve
6. Size of the actuator
7. 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:

1. Larger supply lines
2. Larger control valve
3. Higher supply pressure *
4. Quick exhaust valves

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

Slower operating times may be obtained by using flow control valves to meter the exhaust. Excessive exhaust flow metering may cause erratic operation. Normally, incoming supply should not be metered.

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 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 the actuator with the pressure used by the customer during normal operation. Note and record any abnormal symptoms such as jerky or erratic operation.

- 2.1.1** Remove all operating pressure from actuator.
- 2.1.2** Record the settings of stop screw or M3 jackscrews (1-70) and (4-30) before stop screws are loosened or removed.

NOTE:

In place of stop screws, the actuator may be equipped with one or two ES (Extended Stops) or M3/M3HW (1-70) located at the outboard end of housing (1-10) and M3/M3HW (4-30) at the end cap (4-20).

2.2 Pneumatic Cylinder Disassembly

NOTE:

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

- 2.2.1** Remove hex nut (4-40) as follows: FCBB315 through FCBB725 standard end cap stop screw or extended stop (ES), use step 2.2.1.1. FCBB315 through FCBB725 with -M3 or -M3HW, use step 2.2.1.2.
 - 2.2.1.1** For FCBB315 through 725: end cap stop screw or extended stop screw (ES).
 - 2.2.1.1.1** Loosen and remove hex nut (4-40) and washer (4-90) from stop screw (4-30) located in end cap (4-20).
 - 2.2.1.1.2** Remove stop screw (4-30) from the end cap (4-20).

2.2.1.2 For FCBB315/420/520/525/725-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 handwheel (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 (4-40) from M3 jackscrew (1-70).

NOTE:

FCBB315/420/520/525/725-M3 or M3HW models the M3 jackscrew (1-70) cannot be removed now. The M3 used in these models can be removed later in this procedure using step 2.2.8.

ES (4-30), stop screw (4-30) or FCBB315-M3 (1-70), does not require removal from end cap (4-20) unless replacing with a new ES, stop screw or M3.

2.2.2 Remove housing side hex nut (8-20) from center bar (8-10).

2.2.3 Remove outer end cap (4-20) with center bar (8-10) from outboard end of cylinder (4-10).

2.2.4 While holding housing torque shaft (1-30) pull cylinder (4-10) away from housing (1-10).

2.2.5 Slide cylinder (4-10) over piston seal (5-40) and remove.

2.2.6 Remove piston (4-50) from housing (1-10).

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.

2.2.7 On actuator models FCBB415/520/725, remove cylinder adapter (4-15) from flange of housing (1-10).

2.2.8 M3 Jackscrew removal from end cap (4-20)

2.2.8.1 FCBB315/415 with an M3 remove M3 jackscrew (4-30) from the backside of end cap (4-20).

2.2.8.2 FCBB420/520/525/725 with an M3 jackscrew remove per the following steps.

2.2.8.2.1 Remove retainer ring (5-60) from M3 adapter (4-55).

2.2.8.2.2 Remove M3 adapter (4-55) from end cap (4-20).

NOTE:

The M3 adapter will be removed from backside of end cap (4-20) with the M3 jackscrew.

ES (4-30), stop screw (4-30) or FCBB315-M3 jackscrew (1-70), does not require removal from end cap (4-20) unless replacing with a new ES, stop screw or M3.

2.3 Housing Disassembly

NOTE:

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

- 2.3.1** Remove hex nut (1-80) as follows: FCBB315 through 725 standard housing stop screw or extended stop (ES), use step 2.3.1.1. FCBB315-M3/M3HW through FCBB725-M3/M3HW, use step 2.3.1.2.
 - 2.3.1.1** FCBB315 through 725 housing stop screw or extended stop screw.
 - 2.3.1.1.1** Loosen and remove hex nut (1-80) and CSK washer (2-35) from stop screw (1-70) located in housing (1-10).
 - 2.3.1.1.2** Remove stop screw (1-70) from the end of housing (1-10).
 - 2.3.1.2** FCBB315/420/520/525/725-M3 or M3HW
 - 2.3.1.2.1** Remove retainer ring (12-30) and groove pin (12-20) from optional hex drive hub or from handwheel (12-10).
 - 2.3.1.2.2** Remove optional hex drive hub or handwheel (12-10) from M3 jackscrew (1-70).
 - 2.3.1.2.3** Loosen and remove hex nut (1-80) from M3 jackscrew (1-70).
-

NOTE:

FCBB315, 420, 520, 525, 725-M3 or M3HW models the M3 cannot be removed now. The M3 used in these models can be removed later in this procedure using step 2.3.7 or 2.3.8.

Stop screw (1-70) does not require removal from the housing (1-10) unless replacing with a new ES, stop screw or M3.

- 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 in order to remove the washers.

- 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** Actuator models FCBB315/415 with an M3 or M3HW mounted at 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 housing (1-10).

- 2.3.8** Actuator models FCBB420/520/525/725 with an 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 housing (1-10) with the M3 jackscrew (1-70).

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. 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.

⚠ 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, lightly coat with approved grease, all moving parts.
 - 3.1.4.2** Lightly coat all seals with lubricant before installing into seal grooves.
- 3.1.5** Reassemble the actuator models per the following listing:
 - 3.1.5.1** Reassemble the following models per step 3.2:
FCBB315/420/520/525 and FCBB725.
 - 3.1.5.2** Reassemble the following models per step 3.3: FCBB315-M3, 315-M3HW, 420-M3, 520-M3, 525-M3 and FCBB725-M3 (also included M3 jackscrew with handwheels i.e., M3HW).

3.2 Actuator Reassembly per FCBB Models Listed in Step 3.1.5.1

NOTE:

Review Section 3, steps 3.1.1 through 3.1.5 before proceeding with actuator reassembly. The following steps used to reassemble the following models: FCBB315, 420, 520, 525 and 725.

Use Assembly Drawing Part Number VA-001-005-72-4 in Appendix B for this section.

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.

- 3.2.1** Apply a coating of lubricant to the torque shaft holes located on each side of housing (1-10).
- 3.2.2** Prior to installing new seals: Fit the torque shaft snap ring groove with installation rings that come with the FCBB service kits. These rings help guide the torque-shaft through the housing and seals which will prevent seal damage. It is a good idea to first take out both old seals, then install the rings onto the shaft, and then install seals in housing. Once this is done, remove installed rings and proceed.
- 3.2.3** Coat the O-ring seal (2-20) with grease upon installation.

NOTE:

The cup/lip of torque shaft seal will be installed facing inward into the housing.

- 3.2.4** 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).
- 3.2.5** 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 next disassembly occurs. Refer to the assembly drawing for correct yoke key spring and yoke key orientation.

- 3.2.6** 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 O-ring seal (2-20).

NOTE:

Two new retaining rings (1-60) are contained in the Biffi FCBB Service Kits.

- 3.2.7** Install one of the new retaining ring (1-60) and washer (1-65) 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) and washer (1-65) to the other side of the torque shaft (1-30).

⚠ CAUTION

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

- 3.2.8** Rotate the torque shaft (1-30) so that the arms of yoke (1-20) point out the open end of housing (1-10).
- 3.2.9** 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).
- 3.2.10** Coat entire length of center bar (8-10) with lubricant including the threads.
- 3.2.11** Install hex nut (8-20) onto one end of center bar (8-10).
- 3.2.12** Insert center bar (8-10) into the center hole of housing (1-10). Slide center bar through housing until the hex nut (8-20) is flush against housing (1-10).
- 3.2.13** Coat one O-ring seal (5-10) with lubricant and install onto outer diameter flange located on housing adapter end of housing (1-10).
- 3.2.14** Actuators equipped with cylinder adapter (4-15), models FCBB520/725, do the following steps:
 - 3.2.14.1** Install cylinder adapter (4-15) onto the flange of housing (1-10) and over O-ring seal (5-10), with the stepped outer diameter, of cylinder adapter (4-15), facing away from housing (1-10).
 - 3.2.14.2** Install one O-ring seal (5-15) onto stepped diameter of cylinder adapter (4-15).
- 3.2.15** Coat the following areas of piston (4-50) with lubricant: The outer diameter seal groove, inner diameter seal groove, head of piston and exposed ends of yoke pin.
- 3.2.16** Coat O-ring seal (5-20) with lubricant and install in the internal seal groove in the head of piston (4-50).
- 3.2.17** Coat piston 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.
- 3.2.18** Install bushing (4-80) between the two arms of yoke (1-20).
- 3.2.19** With the piston head facing away from housing (1-10) and with yoke pin up, install piston (4-50) onto center bar (8-10).
- 3.2.20** Carefully slide piston (4-50) along center bar (8-10) until yoke pin engages the two slots in the arms of yoke (1-20).

NOTE:

While holding the center bar flush against the housing, push piston (4-50) into housing (1-10) as far as the piston will go. Check to see that bushing (4-80) is positioned between the yoke (1-20) and the stem of piston (4-50).

- 3.2.21** Apply a coating of lubricant to entire bore of cylinder (4-10).
- 3.2.22** Pneumatic cylinder installation:
 - 3.2.22.1** For FCBB520 and 725 models, install the lubricated cylinder (4-10) over the piston and up against the O-ring seal (5-15) on the stepped diameter flange of cylinder adapter (4-15).
 - 3.2.22.2** For FCBB315, 420 and 525 models, install the lubricated cylinder (4-10) over the piston and up-against the O-ring seal (5-10) on the flange of housing (1-10).

3.2.23 End cap seal installation

3.2.23.1 Coat O-ring seal (5-20) with lubricant and install in the internal seal groove of end cap (4-20).

3.2.23.2 Install O-ring seal (5-15) onto outer diameter of end cap (4-20).

3.2.24 Install end cap (4-20) onto center bar (8-10) and into cylinder (4-10).

NOTE:

Position the end cap (4-20) so that the inlet port is at the bottom and the ES or stop screw (4-30) is at the top.

⚠ WARNING

If step v is not completed as described, the center bar O-ring seals (5-20) may become a source of pressure leakage and cause the actuator to fail.

3.2.25 Install the second hex nut (8-20) onto the cylinder end of center bar (8-10). Adjust the two hex nuts (8-20) such that the approximate same number of threads is exposed on the ends of the center bar (8-10).

⚠ WARNING

Do not allow end cap (4-20) to rotate during center bar tightening. The end cap must maintain the position as described in step 3.2.23.

3.2.26 Tighten center bar (8-10) to the proper torque as specified in Table 3.

Table 3. Tightening Torque Center Bar (1)

| FCBB Actuator Model | Maximum Torque | |
|---------------------|----------------|--------|
| | Nm | lb-in. |
| 315 | 75 | 55 |
| 420 and 520 | 136 | 100 |
| 525 and 725 | 176 | 130 |

3.2.27 If removed, install ES or stop screw (4-30) into end cap (4-20).

3.2.28 Install O-ring seal (5-30) onto the ES or stop screw (4-30). Install the O-ring seal against the end cap (4-20).

3.2.29 Install new washer (4-90) onto the ES or stop screw (4-30). Install the washer against the end cap (4-20).

3.2.30 Install hex nut (4-40) onto stop screw (4-30).

NOTE:

Leave hex nut hand tight.

3.2.31 If removed, install ES or stop screw (1-70) into housing (1-10).

3.2.32 Install O-ring seal (2-30) and CSK washer (2-35) onto the ES or stop screw (1-70). Install O-ring seal against the housing (1-10).

3.2.33 Install hex nut (1-80) onto ES or stop screw (1-70). Leave hex nut hand tight.

3.2.34 Adjust both stop screws or ES (1-70) and (4-30) back to the setting recorded in Section 2 step 2.1.2 under general disassembly. Tighten both hex nuts (4-40) and (1-80) securely, while holding the ES or stop screws in place/position.

3.3 Actuator Reassembly per FCBB Models Listed in Step 3.1.5.2

NOTE:

The following steps are used to reassemble the models: FCBB315-M3, FCBB420-M3, FCBB520-M3, FCBB525-M3 and FCBB725-M3 (also include M3 jackscrew with handwheel i.e., M3HW). Use Assembly Drawing Part Number VA001-005-73-3 in Appendix B for this section.

In Section 3.3 where the step indicates to “lubricate, coat or apply lubricant”, use lubricant as identified in Section 1.7 for lubricating the part being installed.

3.3.1 M3 Jackscrew (1-70) housing installation for FCBB315/415-M3 and FCBB315/415-M3HW Model Actuators.

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

NOTE:

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

3.3.1.2 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).

3.3.1.3 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 housing (1-10).

3.3.1.4 Install hex nut (1-80) and CSK washer (2-35) onto M3 jackscrew (1-70).

NOTE:

Rotate the hex nut down the M3 jackscrew until it is next to the housing (1-10).

3.3.1.5 Continue reassembly at step 3.3.3.

3.3.2 M3 Jackscrew Housing Installation for FCBB420-M3 through FCBB725-M3 Model Actuators (includes M3HW models).

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

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

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

3.3.2.4 Insert and rotate 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. M3 adapter (1-90) will be installed from the inside of housing (1-10).

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

3.3.2.6 Install retainer ring (2-40) into outboard groove located on the outer diameter of M3 adapter (1-90).

3.3.2.7 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.

3.3.2.8 Install hex nut (1-80) and CSK washer (2-35) onto M3 jackscrew (1-70).

NOTE:

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

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

3.3.4 Coat O-ring seals (2-20) with lubricant and install in the grooves located in the torque shaft through holes located on each side of housing (1-10).

NOTE:

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

3.3.5 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).

3.3.6 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 next disassembly occurs. Refer to assembly drawing for correct yoke key spring and yoke key orientation.

3.3.7 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 O-ring seal (2-20).

⚠ CAUTION

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

NOTE:

Two new retaining rings (1-60) and washers (1-65) are contained in the Biffi FCBB Service Kits.

3.3.8 Install one of the new retaining ring (1-60) and washer (1-65) 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).

3.3.9 Rotate the torque shaft (1-30) so that the arms of yoke (1-20) point out the open end of housing (1-10).

3.3.10 Coat O-ring seal (5-20) with lubricant and install in the internal seal groove of the center bar "hole" located in housing (1-10).

3.3.11 Coat the following areas of piston (4-50) with lubricant: The outer diameter seal groove, inner diameter seal groove, head of piston and exposed ends of yoke pin.

3.3.12 Coat O-ring seal (5-20) with lubricant and install in the internal seal groove in the head of piston (4-50).

3.3.13 Coat piston 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.

3.3.14 Coat entire length of center bar (8-10) with lubricant, including the threads.

3.3.15 Install piston (4-50) onto center bar (8-10).

-
- 3.3.16** Install bushing (4-80) between the two arms of yoke (1-20).
 - 3.3.17** With the piston head facing away from housing (1-10) and with yoke pin up, install center bar (8-10) in the open end of housing (1-10) and push the center bar through the center bar "hole" of housing (1-10).
 - 3.3.18** Install hex nut (8-20) onto one end of center bar (8-10) that is protruding through the center bar "hole" of housing (1-10).
 - 3.3.19** Carefully slide piston (4-50) along center bar (8-10) until yoke pin engages the two slots in the arms of yoke (1-20).

NOTE:

While holding the center bar flush against the housing, push piston (4-50) into housing (1-10) as far as the piston will go. Check to see that bushing (4-80) is positioned between the yoke (1-20) and the stem of piston (4-50).

- 3.3.20** Coat one O-ring seal (5-10) with lubricant and install onto outer diameter flange located on housing adapter end of housing (1-10).
- 3.3.21** Actuators equipped with cylinder adapter (4-15), models FCBB520 and 725, do the following steps:
 - 3.3.21.1** Install cylinder adapter (4-15) onto the flange of housing (1-10) and over O-ring seal (5-10) with the stepped outer diameter of cylinder adapter (4-15) facing away from housing (1-10).
 - 3.3.21.2** Install one O-ring seal (5-15) onto stepped diameter of cylinder adapter (4-15).
- 3.3.22** Apply a coating of lubricant to entire bore of cylinder (4-10).
- 3.3.23** Pneumatic cylinder installation
 - 3.3.23.1** For FCBB520 and 725 models, install the lubricated cylinder (4-10) over the piston and up-against the O-ring seal (5-15) on the stepped diameter flange of cylinder adapter (4-15).
 - 3.3.23.2** For FCBB315, 420 and 525 models, install the lubricated cylinder (4-10) over the piston and up-against the O-ring seal (5-10) on the flange of housing (1-10).
- 3.3.24** Coat O-ring seal (5-20) with lubricant and install into internal diameter seal groove of the end cap (4-20).
- 3.3.25** M3 Jackscrew (4-30) End Cap Installation for FCBB315/415-M3 Model Actuators (includes M3HW models).
 - 3.3.25.1** Apply a light coating of lubricant to the threads of M3 jackscrew (4-30).

NOTE:

The M3 jackscrew will be installed from the cylinder side of end cap (4-20).

- 3.3.25.2** Install and rotate M3 jackscrew (4-30) into end cap (4-20).

NOTE:

Rotate the M3 jackscrew into the end cap (4-20) until the inboard end of the M3 jackscrew is up against the end cap (4-20).

3.3.25.3 Install seal (5-30) onto M3 jackscrew (1-70).

NOTE:

Move the O-ring seal (2-30) down the M3 jackscrew until it is next to the end cap (4-20).

3.3.25.4 Continue reassembly at step 3.3.27.

3.3.26 M3 jackscrew end cap (4-20) installation for FCBB420-M3 through FCBB725-M3 Model Actuators (includes M3HW models).

3.3.26.1 Apply a coating of lubricant to outer diameter and inner diameter threads of M3 adapter (4-55).

3.3.26.2 Coat O-ring seal (5-45) with lubricant and install into outer diameter seal groove located in the M3 adapter (4-55).

3.3.26.3 Apply a light coating of lubricant to the threads of M3 jackscrew (4-30).

3.3.26.4 Install and rotate M3 jackscrew (4-30) into M3 adapter (4-55).

NOTE:

Rotate the M3 jackscrew into the M3 adapter (4-55) until the inboard end of the M3 jackscrew is up against the M3 adapter (4-55). The M3 adapter will be installed from the cylinder side of end cap (4-20).

3.3.26.5 Install M3 adapter (4-55) into end cap (4-20).

3.3.26.6 Install retainer ring (5-60) into outboard groove located on outer diameter of M3 adapter (4-55).

3.3.26.7 Install thread seal (5-30) onto M3 jackscrew (1-70).

NOTE:

Move the thread seal (5-30) down the M3 jackscrew until it is next to the M3 adapter (4-55).

3.3.26.8 Install hex nut (4-40) and CSK washer (5-35) onto M3 jackscrew (1-70).

NOTE:

Rotate the hex nut down the M3 jackscrew until it is next to the M3 adapter (4-55).

3.3.27 End cap outer diameter seal installation.

3.3.27.1 For FCBB415/520/725 models, install O-ring seal (5-15) onto the outer diameter of end cap (4-20).

3.3.27.2 For FCBB315/420/525 models, install O-ring seal (5-10) onto the outer diameter of end cap (4-20).

NOTE:

Position the end cap (4-20) so that the inlet port is at the bottom and the M3 jackscrew (4-30) is at the top of the actuator.

3.3.28 Install end cap (4-20) onto center bar (8-10) and cylinder (4-10).

⚠ WARNING

If step 3.3.29 is not completed as described, the center bar O-ring seals (5-20) may become a source of pressure leakage and cause the actuator to fail.

3.3.29 Install the second hex nut (8-20) onto the cylinder end of center bar (8-10). Adjust the two hex nuts (8-20) such that the approximate same number of threads is exposed on the ends of the center bar (8-10).

⚠ WARNING

Do not allow end cap (4-20) to rotate during center bar tightening. The end cap must maintain the position as described in step 3.3.27. M3 jackscrew must be installed to be in alignment with the target located on the piston assembly (4-50).

3.3.30 Tighten center bar hex nuts (8-20) to the proper torque as specified in Table 4.

Table 4. Tightening Torque Center Bar (2)

| FCBB Actuator Model | Maximum Torque | |
|---------------------|----------------|--------|
| | Nm | lb-in. |
| 315 | 75 | 55 |
| 420 and 520 | 136 | 100 |
| 525 and 725 | 176 | 130 |

3.3.31 Adjust both M3 jackscrews (4-30) and (1-70) back to setting recorded in Section 2, General Disassembly. Tighten both M3 jackscrew hex nuts (4-40) and (1-80) securely, while holding M3 jackscrews (1-70).

3.3.32 M3 hex drive hub or handwheel installation as follows:

3.3.32.1 Install hex drive hub (12-10) or handwheel (12-10) onto M3 jackscrews (4-30) and (1-70) and align the "hole" of the drive hub with the "hole" located in the outboard end of M3 jackscrews (4-30) and (1-70).

3.3.32.2 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: 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 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's 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 both sides 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** Cylinder to housing joint on FCBB315, 420, and 525 or cylinder to cylinder adapter to housing joints on FCBB520 and 725 actuators.
 - 4.1.6.2** On the outboard end of housing (1-10) at the center bar hex nut. Check the center bar to housing O-ring seal (5-20).
 - 4.1.6.3** Housing stop screw/ES/M3 jackscrew O-ring seal (2-30).
 - 4.1.6.4** Torque shaft (1-30) to housing (1-10) interface. Check O-ring seals (2-25) and (2-20).
 - 4.1.6.5** End cap (4-20) port "hole". Checks the piston to cylinder seal (5-40) and piston to center bar seal (5-20).
- 4.1.7** Apply the pressure listed in step 4.1.3 to the end cap inlet port and allow the actuator to stabilize.

- 4.1.8** Apply a leak testing solution to the following areas:
 - 4.1.8.1** Cylinder to end cap joint. Check O-ring seal (5-10) on FCBB315, 420 and 525 or check O-ring seal (5-15) on FCBB520 and 725 actuators.
 - 4.1.8.2** Housing (4-10) inlet port hole. Checks the piston to cylinder seal (5-40) and piston to center bar seal (5-20).
 - 4.1.8.3** End cap stop screw or M3 jackscrew O-ring seal.
 - 4.1.8.4** Remove pressure from pressure inlet port in the end cap (4-20).
- 4.1.9** If an actuator was disassembled and repaired as a result of this procedure, the above leakage test must be performed again.
- 4.1.10** 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 actuator's 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, Biffi should be contacted for guidance.

- 4.1.11** After the actuator is installed back on the valve, all accessories should be hooked up and tested for proper operation and replaced, if found defective.

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 a wide range of Biffi actuators as possible. Reference to equipment 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 and visually inspect for significant wear and 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 and reassemble cylinder assembly as necessary |
| | Defective valve | Consult the valve OEM 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 and clear or replace as necessary |
| | Defective controls | Examine the controls, refurbish or renew as necessary and refer to component manufacturer's documentation |
| | Defective piston seal | Dismantle the cylinder assembly, remove the defective piston seal and fit new seal and reassemble |
| | Defective rod seal | Dismantle the cylinder assembly, remove the defective rod seal and fit new seal and reassemble |
| | Defective housing seal | Dismantle the housing assembly, remove the defective seal and fit new seal and reassemble |
| | High valve torque or valve seized | Consult the valve OEM documentation |

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 to complete open/close cycles with complete closing of the valve.

5.2.1.1.2 Verify 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 No° 1 open/close cycles 15% of the stroke.

5.2.2.1.2 Verify 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 an FCBB-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 Biffi representative.

CAUTION

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

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

Separate the parts composing the actuator according to their nature (e.g., metallic and 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 actuator. Remove accessories (if equipped) and control from actuator.
2. Remove all equipment mounted on top of actuator (limit switches, end of stroke valve, and relevant pneumatic/electric connection, etc.).
3. Remove mounting bolts and actuator is ready to be removed from valve. For complete actuator tear down, refer to Section 2.

Section 7: Document Revision

Table 6. Revision Overview

| Rev | Date | ECN | Description | By * |
|-----|------------|-----|--|---------------------|
| 0 | June 2020 | N/A | Creation | N/A |
| 1 | March 2022 | N/A | Added Warning for Electrostatic Charge | N/A |
| 2 | July 2024 | N/A | MarCom use only | Massimiliano Franco |
| 3 | July 2024 | N/A | Added ATEX Safety Instructions for Use in (Potential) Explosive Atmosphere | Massimiliano Franco |

Note:

* Signatures on file at Biffi Italia s.r.l.

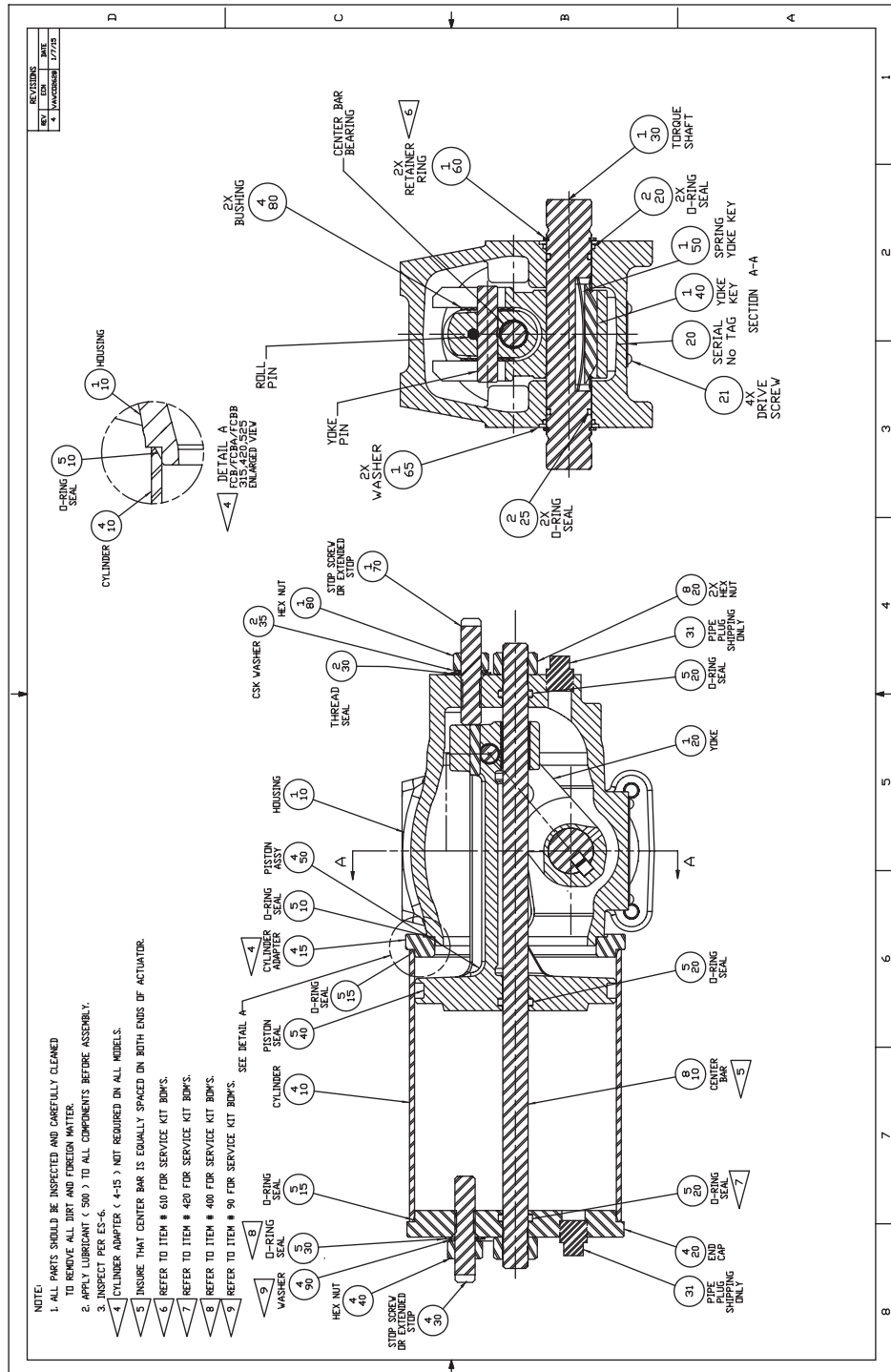
The data in this table refers to the parent document (VCIOM-13250-EN).

Appendix A: List of Tables

| | | |
|------------|--|----|
| Table 1. | FCBB Model Numbers | 1 |
| Table 2. | Actuator Weight | 4 |
| Table 3. | Tightening Torque Center Bar (1) | 14 |
| Table 4. | Tightening Torque Center Bar (2) | 20 |
| Table 5. | Symptoms and Solutions Table | 23 |
| Table 6. | Revision Overview..... | 26 |
| Table C-1. | Ambient and ATEX Temperatures..... | 32 |

Appendix B: List of Drawings

B.1 Part Number VA001-005-72-4, FCBBXXX Assembly Drawing



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 ATEX Marking

Complete ATEX 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: -29 to 93 °C / -20 to 200 °F
- Low Temperature: -40 to 65 °C / -40 to 150 °F
- High Temperature: -18 to 176 °C / 0 to 350 °F
- Special Low Temperature *: -60 to 100 °C / -76 to 212 °F

NOTES:

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.
 3. * Not applicable for all products and available with Carbon Steel (CS) material.
-

C.3 Safety Instructions

1. Before the installation, please carefully read the service instructions. Biffi is not responsible for damages caused by operations not complying with the instructions contained in such 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 presences 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 under end user responsibility to avoid the explosive mixture inside the actuator.
11. To avoid increasing dust explosion risk, periodically clean dust deposits from all equipment.
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 2 mm / 0.08 in.
14. For single acting actuators, it is necessary to use safe air and to convey by a piping inlet/exhaust of the cylinder outside of the Ex-zone (Safe Area).
15. 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.
16. It is under end user responsibility to make sure the electrical equipment installed on the actuators have a separated ATEX evaluation and they are designed according to the ATEX Directive and they are suitable for the installation zone, group of gas, temperature class, maximum surface temperature, EPL and range of temperature.
17. It is forbidden to use this equipment in a different way if it is not included in the instruction manual. Biffi is not responsible for damages caused by an improper and/or dangerous 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 ATEX Temperatures

| Temperature | | | Valid Actuator Trim |
|-------------------------------|------------|-------------------------------|--------------------------------|
| Ambient Range | ATEX Class | TX (ATEX Surface Temperature) | |
| -29 to 75 °C / -20 to 167 °F | T6 | T85 °C / T185 °F | Standard Temperature Trim |
| -29 to 90 °C / -20 to 194 °F | T5 | T100 °C / T212 °F | |
| -29 to 93 °C / -20 to 200 °F | T4 | T103 °C / T217 °F | |
| -40 to 65 °C / -40 to 150 °F | T6 | T75 °C / T167 °F | Low Temperature Trim |
| -18 to 125 °C / 0 to 257 °F | T4 | T135 °C / T275 °F | High Temperature Trim |
| -18 to 176 °C / 0 to 350 °F | T3 | T186 °C / T367 °F | |
| -60 to 75 °C / -76 to 167 °F | T6 | T85 °C / T185 °F | Special Low Temperature Trim * |
| -60 to 90 °C / -76 to 194 °F | T5 | T100 °C / T212 °F | |
| -60 to 100 °C / -76 to 212 °F | T4 | T110 °C / T230 °F | |

Notes:

1. * Not applicable for all products and available with Carbon Steel (CS) material.
2. The specified values are valid with condition: Maximum cycle frequency of actuator is less than 1 Hz at a maximum of 50 cycles per hour and at maximum load.
3. The upper temperature limit can differ according to the soft seal used. Refer to the scope of supply.

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