





Limitorque Fluid Power Systems

**USER INSTRUCTIONS**  
**LHS/LHH SERIES HEAVY-DUTY ACTUATORS**

Doc. Number: FCD LFENIM0003-02-A4-05/21

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# 1 STANDARD INFORMATION

## USING FLOWSERVE VALVES, ACTUATORS AND ACCESSORIES CORRECTLY

The following instructions are designed to assist in unpacking, installing and performing maintenance on Flowserve products. Product users and maintenance personnel should thoroughly review this bulletin prior to installing, operating or performing any maintenance.

In most cases Flowserve actuators and accessories are designed for specific applications with regard to medium, pressure and temperature. For this reason, they should not be used in other applications without first contacting the manufacturer.

### 1.1. TERMS CONCERNING SAFETY

The safety terms **DANGER**, **WARNING**, **CAUTION** and **NOTE** are used in these instructions to highlight particular dangers and/or to provide additional information on aspects that may not be readily apparent.



**DANGER:** indicates that death, severe personal injury and/or substantial property damage will occur if proper precautions are not taken.



**WARNING:** indicates that death, severe personal injury and/or substantial property damage can occur if proper precautions are not taken.



**CAUTION:** indicates that minor personal injury and/or property damage can occur if proper precautions are not taken.



**NOTE:** indicates and provides additional technical information, which may not be very obvious, even to qualified personnel.

Compliance with other, not particularly emphasized notes, with regard to transport, assembly, operation and maintenance and with regard to technical documentation (e.g., in the operating instruction, product documentation or on the product itself) is essential, in order to avoid faults, which in themselves might directly or indirectly cause severe personal injury or property damage.

**1.2. GENERAL USAGE**

To prolong actuator life, use the recommended oils below or their equivalent. Pay attention to follow positioner and other control prescriptions regarding the supply fluid.

**Hydraulic OIL required for Hydraulic Cylinder**

**For Temperature Conditions  
-20 °C to +100 °C**

Supply Oil Characteristics*	
Flashpoint COC [°C]	192
Density at 15 °C [kg/l]	0,857
Viscosity at 40 °C [mm <sup>2</sup> /s]	22
*Suggested Oil = AGIP ARNICA 22 or equivalent	

**For Low Temperature Conditions  
-60 °C to +100 °C**

Supply Oil Characteristics*	
Flashpoint Pensky Martin Closed Cup [°C]	104
Relative Density at 15,6 °C	0,87
Viscosity at -40 °C [mm <sup>2</sup> /s]	14,1
Viscosity at -54 °C [mm <sup>2</sup> /s]	1450
Pourpoint [°C]	< -60
*Suggested Oil = SHELL AEROSHELL FLUID 41 or equivalent	



**NOTE:** for the recommended **lubricants** and other Maintenance instructions follow par.4 of the present IOM



**WARNING:** It is recommended to use, the type of oil listed in the present IOM (tables on the left)

Periodically check that the oil is in good condition and clean. The cleanliness level for actuator without control system is minimum NAS 1638 Class 8 – ISO 4406 19/17/14. For actuators with control system the oil cleanliness level required by each control system component is normally more stringent. Please verify with Flowserve Service or control system components manufacturer.

In case you need to do the complete filling of the hydraulic cylinder please ask to your Flowserve representative to give you the dedicated Operative Instruction.


For different conditions, contact your local Flowserve representative.

LHS/LHH actuator standard ambient temperature range is: -29°C to 100°C (-4°F to 212°F)\*\*. Low temperature -60°C (-76°F) and High temperature 160°C (320°F) ranges (polar, cold, arid and tropical temperature requirements in accordance with IEC 60721) are available with different materials of construction. In any case, please refer to the temperature range indicated in actuator nameplate.



**NOTE:** For PED certified applications the standard operating temperature range is -20°C to 100°C (-4°F to 212°F). For lower temperature applications the range can be extended to -40°C to +100°C (-40°F to 212°F) or -50°C to +100°C (-58°F to 212°F) with different materials of construction. In any case, please refer to the temperature range specified on the actuator nameplate.

\*\* more stringent temperature limitation can derive from OIL type / Certifications requirements

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It is the end user's responsibility to guarantee that the ambient temperature is in accordance with actuator nameplate indications.



**WARNING:** Do not exceed the minimum and maximum allowable temperatures indicated on the actuator nameplate. Additional factors like the valve and pipe temperatures, sun direct exposure and other environmental conditions shall be considered, not to exceed the temperature range.



**WARNING:** Do not exceed the allowable pressure range of the supply fluid, as stated in the actuator nameplate. It is very important to make the standard maintenance at all safety components. In case of PED certified cylinders, the value of design pressure of the cylinder is indicated on a specific and separate nameplate. It is necessary to verify that the supply line to the actuator does not exceed the design pressure stated in the cylinder nameplate.



In case of PED certified cylinders, the fluid category is indicated on the specific nameplate on the cylinder.

### **1.3. PROTECTIVE CLOTHING**

Flowserve products are often used in dangerous applications (e.g., extremely high pressures, dangerous, flammable, combustible, toxic or corrosive media). When performing service, inspection or repair operations, always ensure that the valve and actuator are depressurized and that the valve has been cleaned and is free from harmful substances. In such cases pay particular attention to personal protection equipment (protective clothing, gloves, glasses, etc.).

### **1.4. QUALIFIED PERSONNEL**


Only qualified personnel should perform installation, operation or maintenance activities. Qualified personnel are people who, on account of their training, experience, instruction and their knowledge of relevant standards, specifications, accident prevention regulations and operating conditions, have been authorized by those responsible for the safety of the plant to perform the necessary work and who can recognize and avoid possible dangers.



**NOTE:** The operations of installation and maintenance on LHS/LHH Actuators can be performed by qualified personnel ONLY.

### **1.5. OTHER REQUIREMENTS FOR IN-PLANT INSTALLATION**

- Pipelines must be correctly aligned to ensure that the valve is not fitted under tension.
- If not expressly agreed, fire protection is not supplied along with the actuator and it must be provided by the user.

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## 1.6. SPARE PARTS

Use only Flowserve brand original spare parts. Flowserve cannot accept responsibility for any damages that occur from using spare parts or fastening materials from other manufacturers. If Flowserve products (especially sealing materials) have been in storage for long periods, check them for corrosion or deterioration before usage. A table with the list of the main spare parts for standard ON/OFF applications can be found in Paragraph 4.8 at Table 1.

## 1.7. SERVICE/REPAIR

To avoid injury to personnel or damage to products, safety terms must be strictly adhered to. Modifying this product, substituting non-factory parts, or using maintenance procedures other than as outlined in this instruction manual could drastically affect performance and be hazardous to personnel and equipment, and may void existing warranties.

Between actuator and valve there are moving parts. To avoid injury, Flowserve provides pinch-point-protection in the form of cover plates, especially where side-mounted positioners are fitted. These protections are according to Machine Directive 2006/42/EC recommendations. If these plates are removed for inspection, service or repair special attention is required. After completing work, the cover plates must be refitted.

In addition to the operating instructions and the obligatory accident prevention directives valid in the country of use, all recognized regulations for safety and good engineering practices must be followed.



**WARNING:** Before products are returned to Flowserve for repair or service Flowserve must be provided with a certificate which confirms that the product has been decontaminated and is clean. Flowserve will not accept deliveries if a certificate has not been provided (a form can be obtained from Flowserve).

## 1.8. ACTUATOR LIFTING AND HANDLING

Only Allen wrenches and hexagonal wrenches of few sizes are required for the overall operations. The lifting equipment consists of commercial chains and slings of adequate dimensions.

In order to prevent damage to actuator accessories, before starting the lifting operations, ensure that the lifting tools, like chain and clevis hook, are in the correct position and don't interfere with the control panel and related tubing.

For determination of correct lifting equipment always check actuator weight. This Information is always available in Order Documentation supplied along with actuator. Usually actuator weight is reported on the packing slip and on the overall-dimensions drawings.

LHS/LHH actuators are provided with special lifting points, consisting of male/female eyebolts or lifting lugs. Lifting points position and type varies according to weight, dimensions and construction features of individual LHS/LHH models. In order to identify the location of the lifting points, refer to Order Documentation supplied with the actuator.

For actuator weight, please, refer to Figure 29 and 30 in the Annex section and Order Documentation supplied with the actuator. For the general actuator dimensions please refer to LHS/LHH technical bulletin LFENTB0003, available on [www.flowserve.com](http://www.flowserve.com) and Order Documentation supplied with the actuator.



**CAUTION:** Lifting and handling of the actuator should be done by qualified personnel and in compliance with the laws and regulations in force.



**WARNING:** During the lifting operations do not stand under the actuator. The actuator should be handled with appropriate lifting equipment



**DANGER:** Actuator lifting lugs or eyebolts are appropriate for actuator lifting only. They are not designed to support the combined weight of the valve and actuator assembly together.



**WARNING: ONLY for LHS/LHH-30 model and larger sizes:**



Figure 1: Lifting Lug for Spring Can Lifting Only



**DANGER:** For lifting and handling, use the eyebolts on the housing. The eyebolt on the spring can is only for the mounting/dismounting steps or eventually for balancing the actuator.

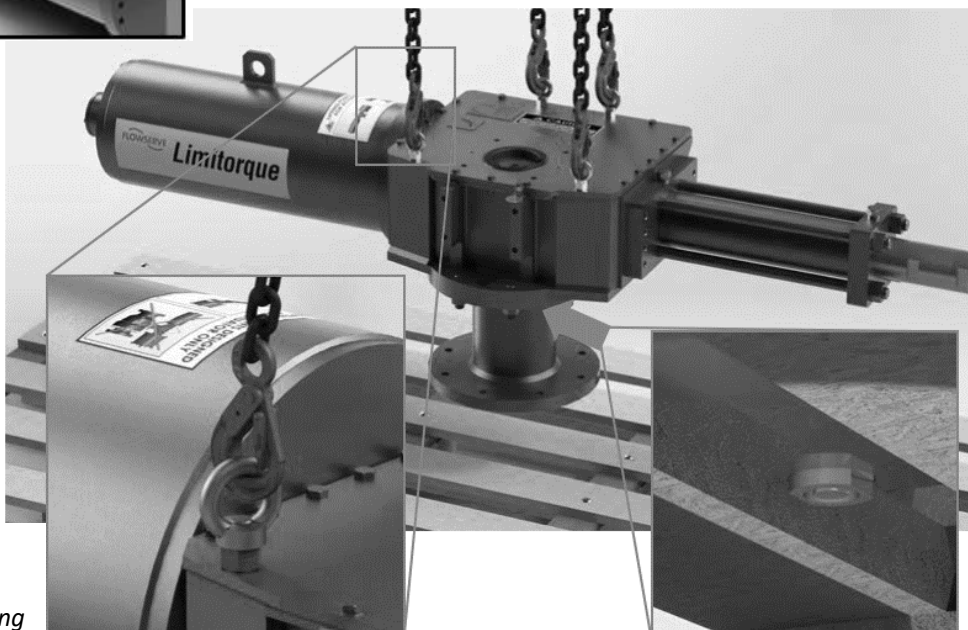


Figure 2: Correct Lifting of Hydraulic Single Acting Actuator

Figure 3: Use of Eyebolt on the Scotch Yoke Housing Cover

Figure 4: Vent Valve Correct Position

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**WARNING: ONLY for LHS/LHH-15, LHS/LHH-20 and LHS/LHH-25 model sizes:**



**DANGER:** For lifting and handling, use the appropriate lifting lug located on the spring can and bind, with properly sized lifting belts, the tube of the hydraulic cylinder near head flange, without involving tie rods.



Figure 5: Correct Lifting of LHS/LHH-25 and smaller- Single Acting Actuator Models

*Lifting Lug for Spring Can and for Actuator Balancing  
(Only for Lifting LHS/LHH-15, 20 and 25 Models)*

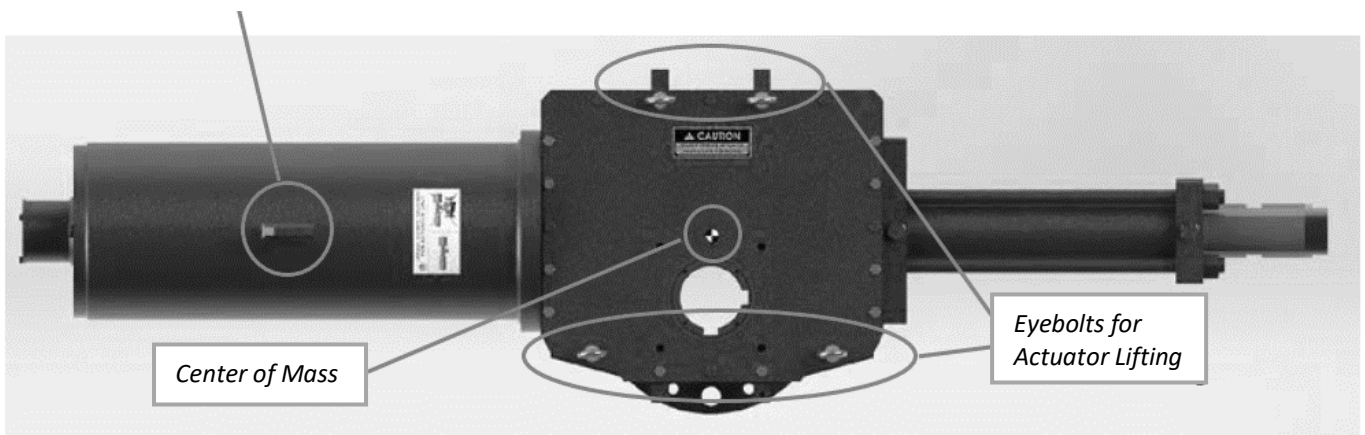


Figure 6: Single Acting Actuator Center of Gravity Position and Lifting Arrangement of LHS/LHH-30 and larger



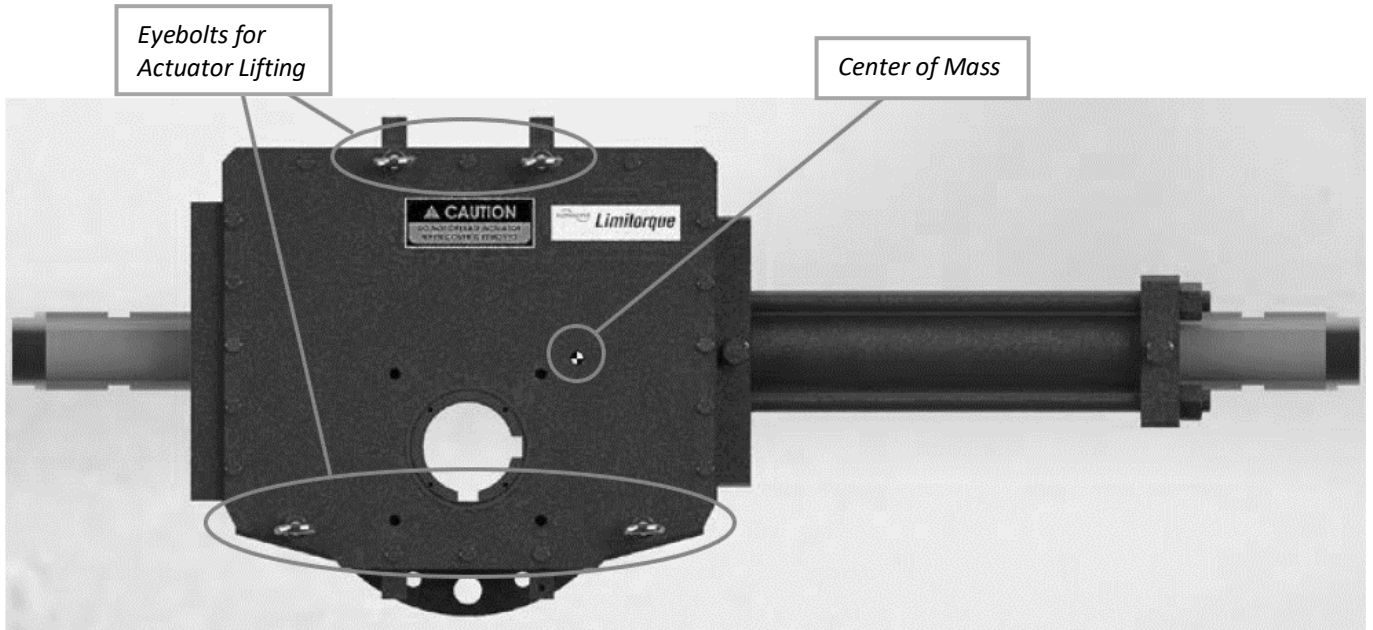


Figure 7: Double Acting Actuator Center of Gravity Position and Lifting Arrangement of LHS/LHH-30, And larger

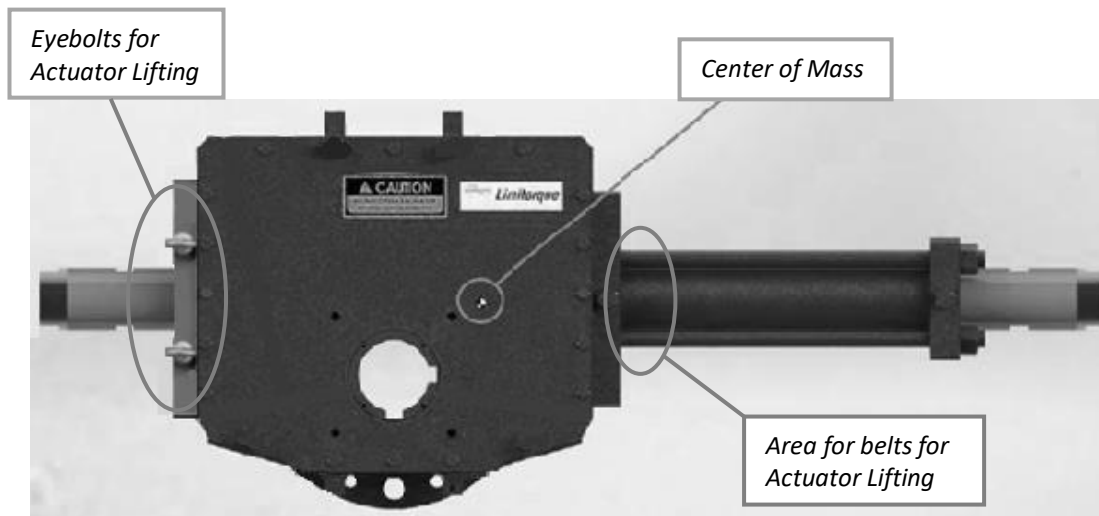


Figure 8: Double Acting Actuator Center of Gravity Position and Lifting Arrangement of LHS/LHH-25, and smaller



**WARNING:** For lifting and handling use the appropriate lifting arrangement. Do not lift the actuator with the valve assembled.



**WARNING:** After transportation, inspect the components to look for any damage.



**DANGER:** NEVER lift the actuator with the valve assembled.

## 1.9. STORAGE

Flowserve actuators are typically provided with an epoxy resin coating or with other painting systems as agreed with the customer. This means that Flowserve products are well protected from corrosion. Nevertheless, in order to maintain good working conditions and a good finish, until the actuator is installed in the plant, it is necessary to follow a few rules during the storage period:

- 1.9.1. Flowserve products must be stored adequately in a clean, dry environment.
- 1.9.2. Ensure that caps are fitted to protect the hydraulic connections and the cable entries, to prevent the ingress of foreign materials or leaking of hydraulic oil (when present). These caps should not be removed until the product is actually mounted into the system.
- 1.9.3. If the storage is outdoors, or if long-term storage is necessary, (more than four months), the plastic protection plugs must be replaced with metal plugs, because the plastic plugs are not weatherproof, whereas the metal ones guarantee weatherproof protection.
- 1.9.4. The actuator must be placed on a wooden pallet, in order to not damage the coupling base and avoid the other surfaces resting on the ground.

In case of long-term storage (more than four months), additionally perform the following measures:

- a) Coat the coupling parts (spool piece base, flanges, bushings, joints) with protective oil or grease.
- b) If possible, blank off the spool piece base flange with a protection disk.
- c) Provide a tarpaulin cover or some other means of protection, especially if the storage is outdoors.

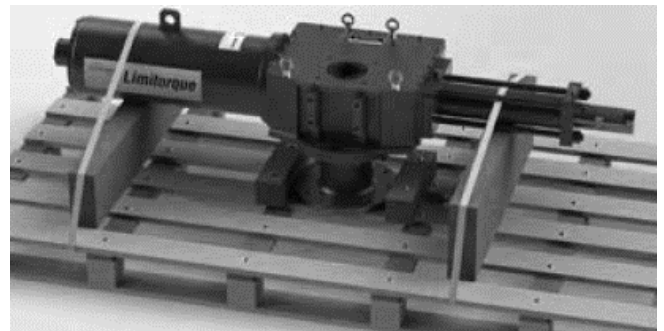



Figure 9: Actuator's Safe Packed Position on Wooden Pallet



**NOTE:** Flowserve Limitorque actuators are equipped with special adhesives indicating that it is forbidden to lift the actuator with an assembled valve.



**CAUTION:** Do not lean the actuator on cylinder tie rods.

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## 1.10. VALVE AND ACTUATOR VARIATIONS

These instructions cannot claim to cover all details of all possible product variations, nor can they provide information for every possible example of installation, operation or maintenance. If there are any uncertainties in this respect particularly in the event of missing product-related information, clarification must be obtained via the appropriate Flowserve sales office.

## 1.11. UNPACKING

- 1.11.1. Each delivery includes a packing slip. When unpacking, check all delivered actuators and accessories using this packing slip.
- 1.11.2. Report transportation damage to the carrier immediately.
- 1.11.3. In case of discrepancies, contact your nearest Flowserve location.
- 1.11.4. If necessary, retouch minor damage to the paint coating which may have occurred during transport or storage.



**WARNING:** Ensure that the addendum “ATEX/PED/Machinery Directive Safety Manual - LPS-LDG-LGO-LHS-LHH Actuators” (doc. LFENEU000A) accompanies this manual, when the actuator is under one (or more) of the following European Directives:

- 2006/42/EC - Machinery Directive
- 2014/34/EU - ATEX Directive
- 2014/68/EU - PED Directive

If this addendum is not available to you, please contact Flowserve.



**NOTE:** When the actuator has SIL requirements according to IEC 61508, ensure that the “LHS/LHH Series Functional Safety Manual” accompanies this manual and is referred to for equipment usage.



**NOTE:** Hydraulic cylinder design is based on seismic acceleration of 0.5 g provided as reference by EN 1998-1:2004. It is under user’s responsibility to verify that seismic loads of the geographical installation region of the actuator are in conformity with the reference acceleration value of 0.5 g. For any support, please contact your Flowserve Limitorque representative.

# 2 INSTALLATION INSTRUCTIONS

The LHS/LHH Series is a fully modular design, Scotch yoke actuator; with torque range up to 550.000 Nm (up to 405.000 ft-lbs), with a mounting base in compliance with ISO 5211 and Figure 31 “LHS/LHH Series Coupling Dimension”. It may also be customized, if required.

The LHS/LHH hydraulic Scotch yoke spring return actuators adopt a push-to-compress spring design.



**WARNING:** Actuator operation/pressure limitations must be in accordance with Technical Bulletin (LFENTB0003); contact Flowserve to get the last version.

LHS/LHH actuators are suitable for use in on/off, modulating and control applications. They can also be used in safety services such as emergency shutdown (ESD) or high-integrity pressure protection systems (HIPPS). LHS/LHH actuators permit to perform Safety Functions through one of the two following “fail actions”: “Fail Close” or “Fail Open”, by choosing the suitable design configuration (in case of single acting actuators) or by choosing the suitable pneumatic control system (in case of double acting actuators).

LHS/LHH Actuators are usually supplied with valve interface obtained through a bracket/spool piece and a valve coupling joint, customized according to order requirements.



**WARNING:** Actuator operation/pressure limitations must be in accordance with the job documentation supplied along with the actuator, and with main data reported on actuator nameplate. If you are not in possession of all relevant information for the correct operation of the actuator, contact Flowserve before starting any activity.

## 2.1. VALVE AND ACTUATOR CHECK



**DANGER:** Before installation check the order-no., serial-no. and/or the tag-no. to ensure that the valve/actuator is correct for the intended application.



**NOTE:** The failsafe direction of rotation is identified by a dedicated plate, as shown in Figure 10, in accordance with EN 15714-4.


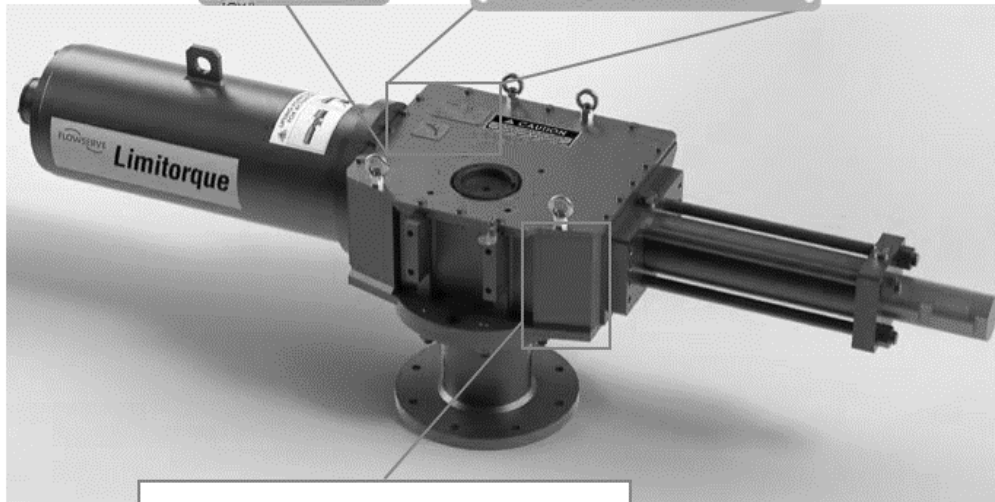
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Figure 10: Fail CW Plate. According to EN15714-4 Standard



Figure 11: Nameplate Sample



The Flowserve nameplate can also be fixed on the cover of the Scotch yoke housing if it is not possible in the front zone

Figure 12: Standard Nameplate Position

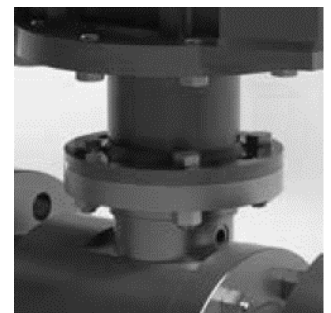
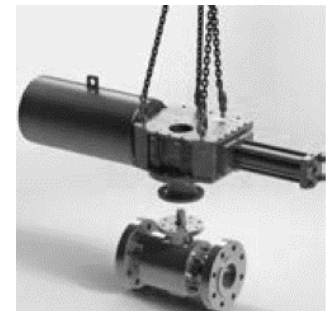
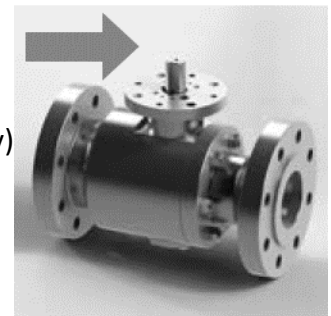
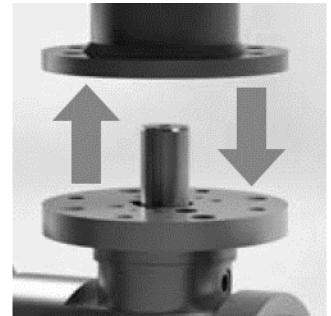
Before starting any installation activity, check also that Actuator pressure limitations and environmental limitations (Ambient Temperature and, if applicable, Explosion Risk Marking), are in accordance with plant requirements. This Information is always reported on actuator nameplate, as shown in typical Actuator Nameplate, shown in Figure 11.

Before mounting the actuator to the valve, manually open and close the valve (if possible), to ensure it is not stuck. Be sure valve and Limitorque open and closed positions coincide (i.e., valve closed, position=actuator closed position). The assembly position of the actuator, with reference to the valve, has to be in accordance with the plant requirements and Job Order Documentation.

## 2.2. CONNECTION WITH VALVE AND MOUNTING KIT

The LHS/LHH actuator is usually supplied with bracket/spool piece already assembled. Stem adapters / coupling joint is assembled during connection with valve, through the steps described here below. To assemble the actuator onto the valve, perform the following steps:

- 2.2.1. Check the mounting surfaces, of actuator bracket and valve and check the stem adapters to assure proper fit. In particular, clean the flanges of valve and spool bracket to remove oils and greases since the torque is transmitted by friction. Also, remove any rust that may have occurred during storage
- 2.2.2. Secure the valve (possibly with the stem oriented vertically) in Close position in case of Single Acting Fail Close actuator and in Open position in case of Single Acting Fail Open actuator; in case of Double Acting Fail Last actuator, secure the valve in the same Close/Open position as the actuator that will be installed onto the valve.
- 2.2.3. Install the pins or centering ring on the valve side of the bracket (if any)
- 2.2.4. Install valve stem adaptor.
- 2.2.5. Lift the actuator by the special lift points (eyebolts), using a proper lifting system. Position the actuator over the valve and lower to engage the stem adaptor to the actuator bore. Continue to lower until the spool piece sits on valve mounting surface. This coupling has to take place without force and only with the weight of the actuator. The mounting bolts (or studs) of the valve should easily fit into the bolt holes of the spool piece without any binding. If needed, turn or stroke the actuator a few degrees and/or adjust the actuator travel-stops. The mounting nuts (or bolts) connecting the base of the spool piece to the valve flange must be evenly tightened according to tightening torque table without lubricant (Table 2 in Annex section).



**WARNING:** In case of spool piece/bracket installation by the client, it is mandatory to refer “Mounting Interface Dimensions” provided with order documentation, or to follow more specific instructions also included in the job documentation supplied along with the actuator. These assembling instructions include details of prescribed stud bolts and their maximum allowable threaded length.



**WARNING:** The lifting lugs or eyebolts are appropriate for actuator lifting only. They are **not designed to support the combined weight of the valve and actuator together**. During the lifting operations do not stand under the actuator. The actuator should be handled with appropriate lifting means. The weight of the actuator is reported on the packing slip and on the overall dimensions drawing furnished with the documentation accompanying the actuator.



**NOTE:** In some cases, the coupling between valve and actuator can be direct, without the need of a spool piece. In these cases, Flowserve can provide an intermediate adaptor flange (fitted under the actuator base) and a special bushing to be inserted into the yoke bore.



**CAUTION:** The actuator lifting and handling should be made by qualified personnel and in compliance with the laws and provisions in force.

### 2.3. TRAVEL-STOP BOLT AND ACCESSORIES

Actuated valves may require accurate travel-stop adjustments to obtain optimum performance and valve seat life. If required, adjust the travel-stop bolt of the actuator for the proper open/close valve positions, per valve manufacturer's recommendations.

The LHS/LHH actuators have travel-stop adjustments in both the clockwise and counter-clockwise directions. The +/- 5-degree adjustment feature provides shaft rotation from 80 to 100 degrees overall.

The adjustment of the travel-stop is performed in accordance with the following steps. After the adjustment of the travel-stop, hydraulically stroke the actuator several times to assure proper operation. If the actuator is equipped with limit switches, positioner or other accessories, adjust them at this time.



**DANGER:** Do not attempt this maintenance operation with cylinder under pressure



**WARNING:** Before performing any maintenance operation it's mandatory to remove the pressure inside the cylinder. Make sure that the hydraulic connection ports are not pressurized. Also make sure that all hydraulic power devices cannot be operated. Make sure that the actuator is in the fail position, i.e., that it is not locked in a position with the spring compressed because of jams or by means of locking tools.

#### 2.3.1. Travel-stop bolt adjustment

Refer to figure 13 for next instructions and descriptions:



**DANGER:** Always use proper personal protection devices (eye shields and others) and collecting basins, for collecting possible oil splash/drops dripping from stopper during adjustment operations.



**DANGER:** Always make a check in order to have a safety engagement of the stopper bolt in the tail flange during this operation. In case of need to fully remove the travel stop, it is mandatory do not have pressure inside the cylinder in order to avoid any possible risk for the operators.



**NOTE:** If necessary, in order to facilitate unscrewing of the cylinder stopper bolt and only for spring return actuator, feed the hydraulic cylinder from the connection port placed on the tail flange (the flange where the stopper is screwed) at minimum necessary pressure to facilitate stopper unscrewing (starting from 0 barg and slowly increasing the pressure up to max 50 barg, until the spring begins to compress, and stopper get free from piston load);



**NOTE:** the following procedure can be applied even for the adjustment of the stop bolt installed on the center body for double effect actuators.

2.3.1.1 Using appropriate wrench, hold still the stopper bolt cover (d) and using a second wrench, unscrew and remove the cover plug (f) together with the o-ring (e).

2.3.1.2 Manually screw or unscrew the stopper bolt (c) in the flange (a), using appropriate Allen key, until desired position has been reached. Do not use automatic devices (e.g. electric/air screwier, etc...); During this operation, it is required to lightly unscrew the stopper bolt cover (d) as less as possible in order to don't make lose too much compression to the o-ring (b) installed between the flange (a) and the stopper bolt cover itself (d).

2.3.1.3 Using appropriate Allen key, hold still the stopper bolt (c) and using a second wrench screw the stopper bolt cover (d) with the proper torque against the flange (a). During this operation pay attention to don't pitch the o-ring between the flange and the stopper bolt cover in order to don't damage it;

2.3.1.4 Using appropriate wrench, hold still the stopper bolt cover (d) and using a second wrench, screw with the proper torque the cover plug (f) with the o-ring (e) against the cover (d). During this operation pay attention to don't pitch the o-ring between the stopper bolt cover and the cover plug in order to don't damage it.

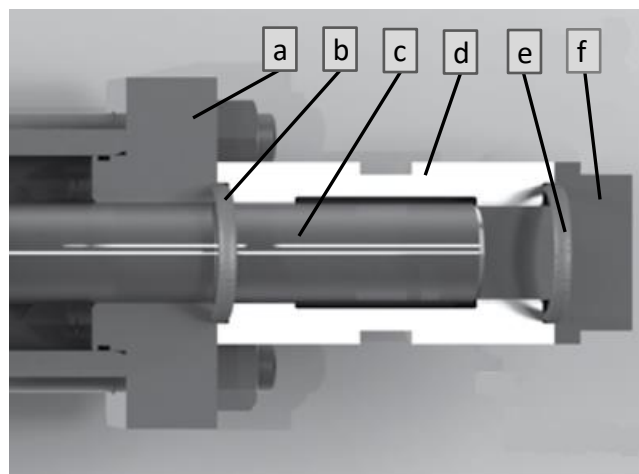


Figure 13: Standard Stopper View



### 2.3.2. Spring container travel-stop bolt adjustment

Refer to figure 24 for next instructions and descriptions.

2.3.2.1 Using appropriate wrench, unscrew the hex screws (10) and remove the stop bolt cap (9).

2.3.2.2 Manually screw or unscrew the end stop (7) using appropriate Allen key until desired position has been reached.

2.3.2.3 Reinstall the stop bolt cap (9) and tighten the hex screws (10).

### 2.4. GROUNDING SYSTEM

For the actuator earthing, use the special grounding kit, shown in Figures 14, 15 and 16:

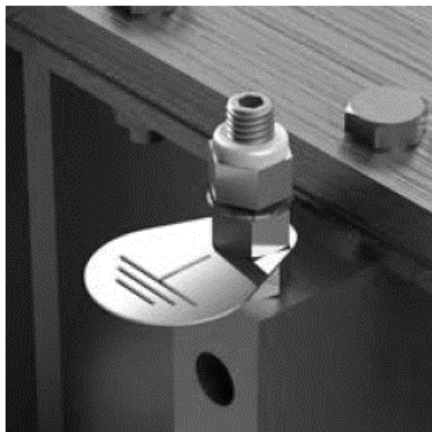


Figure 14: Grounding Kit Detail

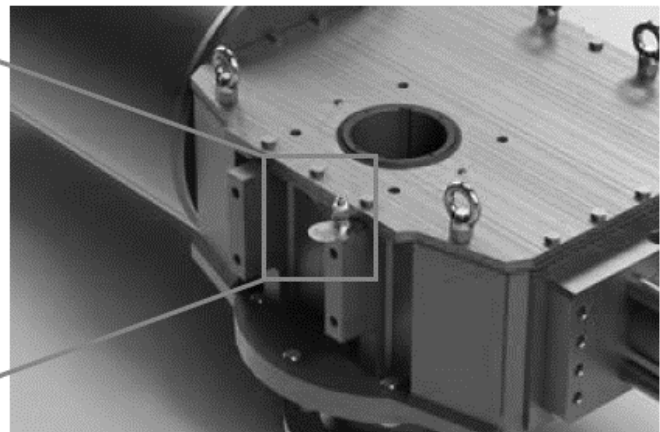


Figure 15: Grounding Kit Assembled

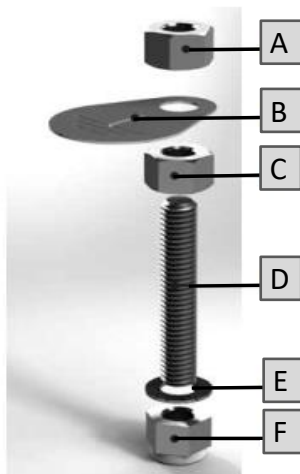


Figure 16: Grounding Kit Exploded View

Letter	Description
A	High Nut
B	Ground Nameplate
C	High Nut
D	Grub Screw
E	Lock Washer
F	High Locking Nut with Nylon Insert

## 2.5. INITIAL OPERATION

Before initial operation of the actuator, perform the following checks:

- 2.5.1. Check that all electrical supply, control and signal lines are properly connected, by following the dedicated customer procedures.
- 2.5.2. Check that the pressure and quality of the supply fluids are as prescribed.
- 2.5.3. Check the absence of leaks in the hydraulic connections. If necessary, tighten the pipe fittings.
- 2.5.4. Check that the environmental conditions are compatible with the design conditions. For information, contact Flowserve.

## 2.6. FAIL OPEN AND FAIL CLOSE CONFIGURATION

The actuator is designed for work in both configurations: fail open and fail close. For conversion from one configuration to the other, refer to next paragraph.

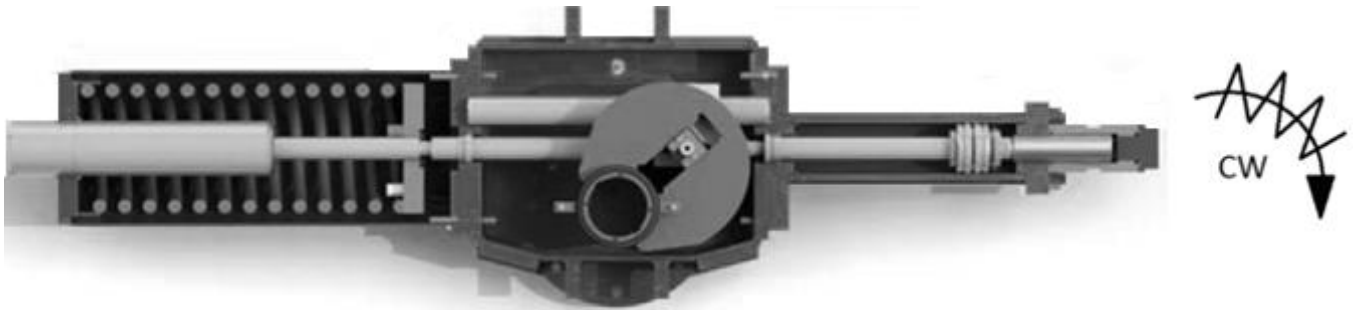


Figure 17: Single Acting LHS/LHH Actuator Configuration: Fail Close – Fail Clockwise

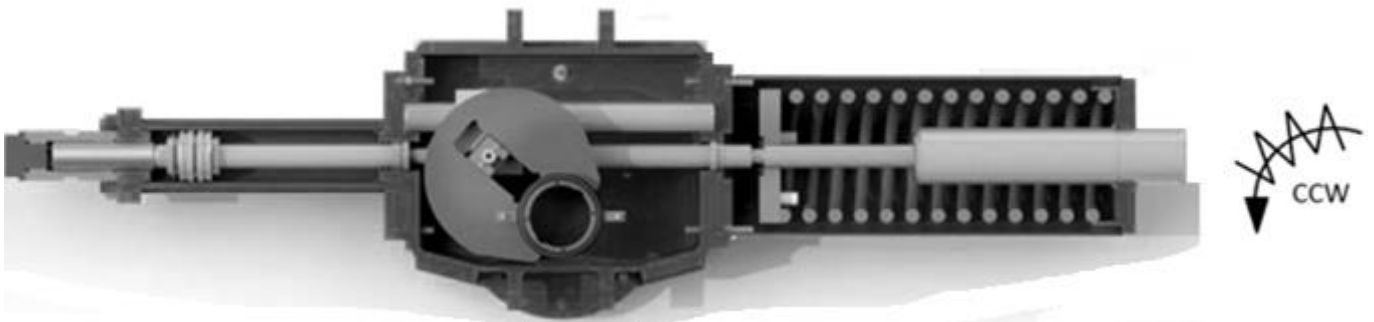


Figure 18: Single Acting LHS/LHH Actuator Configuration: Fail Open – Fail Counterclockwise

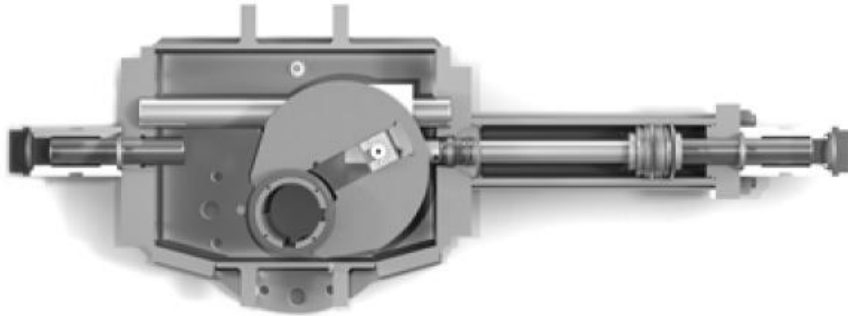


Figure 19: Double Acting LHS/LHH Actuator Configuration: Close Position

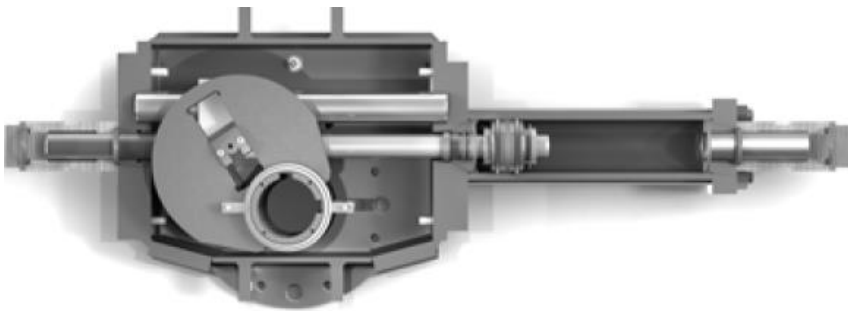


Figure 20: Double Acting LHS/LHH Actuator Configuration: Open Position



Figure 21: Single Acting LHS/LHH in Fail Close Configuration with Valve



Figure 22: Double Acting LHS/LHH with Valve

# 3 FIELD CONVERSION

## Field Conversion from Fail Clockwise to Fail Counterclockwise or Vice Versa (for Spring Return Actuators)

**NOTE:**

- The clockwise/counterclockwise designation needs to be changed on the nameplate.
- Additional adapters are required for field conversion from Fail CW to CCW and vice versa.

There are two different situations, requiring different sequences of instructions:

- The actuator is already disassembled from the valve.
- The actuator is assembled on the valve.

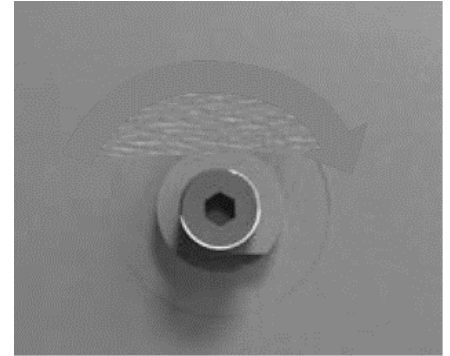
The reference drawings are Figures 23, 24, 25 and 26.

### 3.1. ACTUATOR DISASSEMBLED FROM THE VALVE

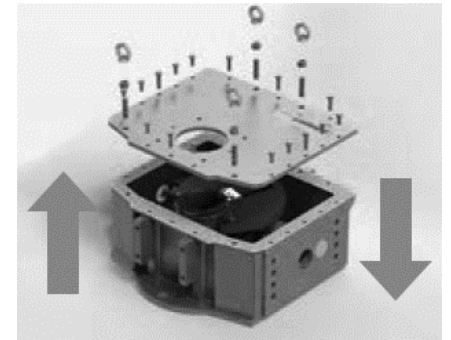


**WARNING:** Ensure that the hydraulic connection ports of the cylinder are disconnected. Also make sure that all hydraulic supplies to the control unit and all power supplies are disconnected. Finally, make sure that the actuator is in fail position, i.e., that it is not locked in a position with the spring compressed by means of locking devices.

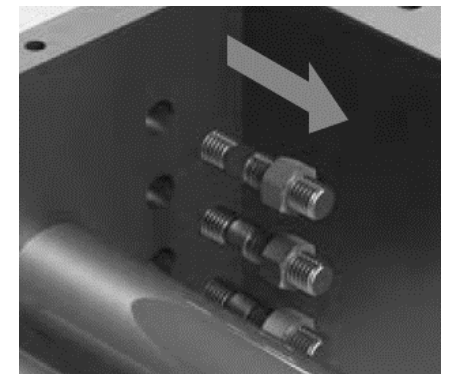
- 3.1.1.** Unscrew and remove the end stop (25) from the hydraulic cylinder. For removing the stop, refer to paragraph 2.3. If necessary, feed the hydraulic cylinder from the port on the head flange (19) at minimum necessary pressure to facilitate the movement of the Scotch yoke and assure the total retraction of the piston rod (20). Remove the pressure. In this way the spring is fully extended.



- 3.1.2.** Remove the cover (46) from the housing by unscrewing all Of the locking components: hex screws (45), hex head shoulder bolts (44) and eyebolts (42) plus upper nuts (43). Leave the studs (41) screwed into the housing (51).



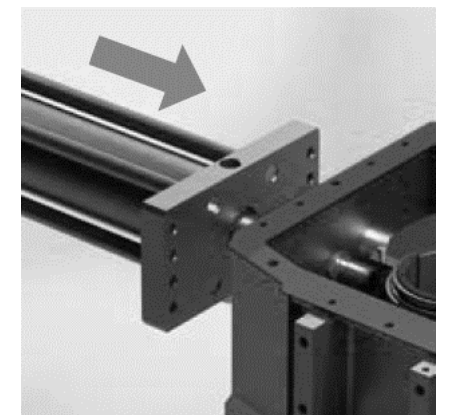
- 3.1.3.** Remove the spring can, carefully following the instructions given in paragraph 4.5. Manually rotate the yoke (36) counterclockwise (or clockwise, depending on the original fail configuration) up to a position of approximately 45°. Locate the studs (57) that connect the pneumatic cylinder to the housing. With the Scotch yoke rotated of 45°, it is possible to easily access these studs. Carefully unscrew the nuts (56). Pull out the whole hydraulic cylinder with the studs (57) screwed inside it (the stem is fully retracted).



**!** **NOTE:** Take care during removal, so as not to damage the piston rod or the stud threads.

- 3.1.4.** Change the adapter kit. Replace the adapters (54 and 55) designed for fail close (open) action, with the new ones designed for the opposite action.

**!** **NOTE:** Take care to choose the adapter kit suitable for the Scotch yoke type in use (symmetric or canted).



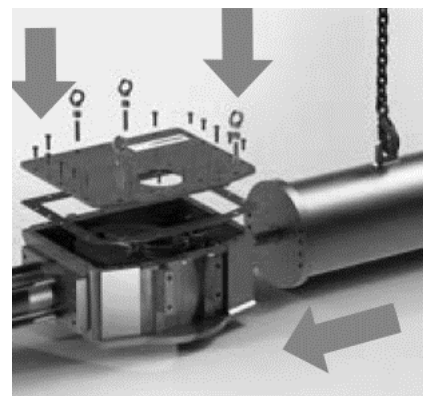
Reassemble the hydraulic cylinder with adapter, using the reverse procedure as described in point 3.1.3.



**NOTE:** You can identify the cylinder adapter to the spring can adapter through the three grub screws (53).

**3.1.5.** Manually rotate the Scotch yoke (36) until the guide block (48) is in contact with the piston rod adapter (54), in correspondence of the relevant slot.

Reassemble the spring can, as instructed in paragraph 4.5. Reposition the cover, taking care to replace the cover gasket (47) and tighten the screws in according with the torque table 2. Readjust the stops, as instructed in paragraph 2.3. Operate the actuator few times to check the functioning in the new fail configuration.



**3.2. ACTUATOR CONNECTED TO THE VALVE (and the valve can be stroked)**



**NOTE:** If the valve cannot be stroked, due to the requirements of the plant, the actuator must be removed from the valve and the procedure described in paragraph 3.1 shall be followed. Then the actuator should be reinstalled in the same position of the valve, following the instructions given in paragraph 2.2.



**WARNING:** Ensure that the hydraulic supplies to the control unit and all power supplies are disconnected and if necessary, remove the control panel and accessories from the actuator. Finally, make sure that the actuator is in fail position, i.e., that it is not locked in a position with the spring compressed by means of locking devices.

**3.2.1.** Connect the hydraulic supply directly to the cylinder hydraulic port on the end flange and apply the minimum necessary pressure to move the actuator to approximately 45°. If the actuator is provided with a manual override, you can use it to perform this operation.

**3.2.2.** Measure the position of the spring can end stop (7) before removing it (this information will be useful when reassembling), and then lock the spring in the compressed position by means of a specifically designed locking tool (provided by Flowserve upon request) for this maintenance. This tool shall be inserted in the opening of the spring can end flange (11) where the spring-end travel-stop (7) has been removed. Screw the special tool to the spring shaft and follow other detailed instructions provided with the special tool. Then remove pressure from the hydraulic cylinder.



**WARNING:** At this point the spring is compressed and the spring module contains a large quantity of stored energy. Failure to properly engage the specifically designed locking tool or failure to handle the spring carefully could result in release of the spring with potential damage to equipment or injury to personnel.

- 3.2.3.** Unscrew and remove the travel-stop of the hydraulic cylinder (25). For removing the stop, refer to paragraph 2.3. Feed the hydraulic cylinder from the port on the head flange (19) at minimum necessary pressure up to totally retract the piston rod (20).
- 3.2.4.** Remove the cover (46) from the Scotch yoke housing by unscrewing all of the locking components: hex screw (45), hex head shoulder bolts (44) and eyebolts (42) plus upper nuts (43). Leave the studs (41) screwed into the Scotch yoke housing (51).
- 3.2.5.** Remove the spring can, carefully following the instructions given in paragraph 4.5.
- 3.2.6.** Locate the studs (57) that connect the Scotch yoke housing to the cylinder. With the Scotch yoke (36) rotated 45°, it is possible to easily access these studs. Carefully unscrew the nuts (56). Pull out the whole hydraulic cylinder. The stem has to be fully retracted.



**NOTE:** Take care during removal, so as not to damage the piston rod or the stud threads.

- 3.2.7.** Change the adapter kit. Replace the adapters (54 and 55) designed for fail close (open) action, with the new ones designed for the opposite action. Take care to choose the adapter kit suitable for the Scotch yoke type in use (symmetric or canted).



The guide block (48) of the symmetric Scotch yoke is marked with the “S” letter on the top face, while the guide block of the canted Scotch yoke is marked with a “C” letter on the top face, as shown in the pictures at right.



**NOTE:** The spring can adapter (55) and cylinder adapter (54) can be inserted in the guide block in one way only, inserted on the Fail Close (CW) or Fail Open (CCW) configuration.

- 3.2.8.** Reassemble the spring can, as instructed in paragraph 4.5.
- 3.2.9.** Reassemble the hydraulic cylinder with adapter, following the reverse procedure as described in point 4.3.
- 3.2.10.** Apply the minimum pressure necessary to the hydraulic cylinder from the port on the end flange (27) until the piston rod moves the guide block (48) and partially compresses the spring. In this condition it will be possible to remove the special tool from the spring can.
- 3.2.11.** Remove the pressure, checking that the actuator goes in the correct new fail safe position.
- 3.2.12.** Reposition the cover, taking care to replace the cover gasket (47).
- 3.2.13.** Readjust the travel-stops, as instructed in paragraph 2.3.

# 4 MAINTENANCE INSTRUCTIONS

## 4.1. MAINTENANCE - INTRODUCTION

LHS/LHH actuators do not need maintenance for long periods, even when working in severe conditions. The LHS/LHH actuators features a 25-year design life, under proper conditions of service, installation, operation and recommended maintenance.

LHS/LHH actuators used for standard “ON-OFF” services do not need particular activities of periodic ordinary maintenance, with the exception of periodic visual inspections with functional tests, on the basis of which it is possible to establish replacements of components, which over time may be subject to wear ( if exceeding the guaranteed cycles in accordance with EN15714 ) or aging. For more details refer to paragraph 4.2.



**NOTE:** Information provided in present paragraph refers to LHS/LHH actuators used for standard “ON-OFF” services. Actuators intended to other services (for example, high-cycles, modulating or other) need dedicated Information. For details, contact your local Flowserve Limitorque Service representative.

For LHS/LHH actuators, extraordinary maintenance is necessary in case of malfunctions detected:

- a) during unexpected events occurring in normal operation;
- b) during periodic inspections / tests.

In the event of a detected malfunction, in order to identify the cause and activities to be performed, refer to Chapter 5 “Troubleshooting”. Depending on malfunction causes, Instructions on how to perform possible extraordinary maintenance on actuator modules are provided from paragraph 4.3 “Actuator Extraordinary Maintenance” onwards.


LHS/LHH Series actuators are designed to offer the greatest ease of operation during assembly, disassembly and maintenance. The maintenance and disassembly do not require special equipment, nor special or large wrenches. Furthermore, joints among the moving parts of the actuator are made exclusively through pins and screws.

For the maintenance of any installed accessory and/or control equipment installed on the actuator, follow the recommendation of individual Instruction Manuals.



**NOTE:** Operations of maintenance on LHS/LHH Actuators can be performed by qualified personnel ONLY.



 Limitorque Fluid Power Systems	<b>USER INSTRUCTIONS</b> <i>LHS/LHH SERIES HEAVY-DUTY ACTUATORS</i>	
	Doc. Number: FCD LFENIM0003-02-A4-05/21	Revision: 02 Date: 05 / 2021

## 4.2. ACTUATOR ORDINARY MAINTENANCE



**NOTE:** Information provided in present paragraph refers to LPS actuators used for standard “ON-OFF” services. Actuators intended to other services (for example, high-cycles, modulating or other) need dedicated Information. For details, contact your local Flowserve Limitorque Service representative.

For Actuators used in Standard ON/OFF applications it is recommended that they are periodically checked (at least every 5 years), through visual inspections and functional tests.

During Visual Inspections perform the following steps:

- Check that all signals (hydraulic and electric) correctly arrive to the actuator;
- Check that the pressure of the supply fluid is within the required range;
- Visually inspect all external surfaces and visible seals of the actuator;
- Carry out a few opening and closing operations, involving all the components of the control unit, checking that the actuator operates correctly, performing the complete strokes, and within required operating times, without increasing noise or jamming during the stroke;
- Check for the absence of leaks in the hydraulic connections. If necessary, tighten the fittings of the pipes;
- Check the functionality of the manual override (If present);
- Check the paint coating. If some areas are damaged due to accidental events, retouch them according to the painting specifications.



**NOTE:** Actuators intended to SIL certified systems must be subjected to additional diagnostic tests, with frequency and operational details established in accordance with SIS (Safety Instrumented System) requirements.



**NOTE:** In general, it is recommended a critical evaluation of the frequency of visual inspections, and, if necessary, to intensify them or to foresee a Scheduled Preventive Maintenance, depending on:

- Criticality of the service conditions;
- Criticality of the type of application.

In case of scheduled preventive maintenance, please refer to paragraph 4.3 “Actuator Extraordinary Maintenance” for instructions on how to perform the replacement of components contained in spare parts kits.

If during visual inspections a malfunction is detected, in order to identify the causes and the activities to be performed, refer to Chapter 5 “Troubleshooting”. Depending on malfunction causes, Instructions on how to perform possible extraordinary maintenance on actuator modules are provided from paragraph 4.3 “Actuator Extraordinary Maintenance” onwards.

### 4.3. ACTUATOR EXTRAORDINARY MAINTENANCE

In case of extraordinary maintenance, or in case of scheduled preventive maintenance, involving the lubrication and substitution of components (in table 1 Par. 4.8 the list of spare parts for ON/OFF applications to be replaced due to aging, also within guaranteed cycles of EN15714) by means of disassembling and reassembling activities on actuator, refer to instructions reported in following paragraphs, related to main actuator modules (Cylinder, Center body and Spring module). Always also refer to notes mentioned in paragraph 1.2 “GENERAL USAGE”.

LHS/LHH actuator is furnished pre-lubricated, with a sufficient amount of lubricants for its entire life cycle. However, during scheduled maintenance or in case of extraordinary maintenance, when necessary, it is possible to lubricate the components for which lubrication is foreseen, using greases having characteristics in accordance to Tables reported here below.

**For Temperature Conditions  
-29 °C to +100 °C**

Grease Characteristics*	
Worked Penetration [dmm]	280
Dropping Point ASTM [°C]	190
Base Oil Viscosity at 40 °C [mm <sup>2</sup> /s]	100
*Grease Suggested: AGIP MUP2 or equivalent	

**For low Temperature Conditions  
-60 °C to +100 °C**

Grease Characteristics*	
Worked Penetration [dmm]	296
Dropping Point ASTM [°C]	260+
Base Oil Viscosity at 40 °C [mm <sup>2</sup> /s]	1150
* Grease Suggested: AEROSHELL7 or equiv.	

**For high Temperature Conditions  
-29 °C to +160 °C**

Grease Characteristics*	
Worked Penetration [dmm]	280
Dropping Point ASTM [°C]	290
Base Oil Viscosity at 40 °C [mm <sup>2</sup> /s]	220
* Grease Suggested: ENI GREASE LCX2/220 or equivalent	

**For all Temperature Conditions  
-60 °C to +100 °C**

Oil for O-Rings and cylinder internal parts lubrication*	
Flashpoint [°C]	198
Density [kg/m <sup>3</sup> ] at 15°C	1074
Base Oil Viscosity at 40 °C [mm <sup>2</sup> /s]	222
* Oil Suggested: SHELL OMALA S4WE220 or equivalent	

For different conditions, contact your local Flowserve representative.



**NOTE:** If it is foreseen to exceed the minimum guaranteed cycle life in accordance to EN15714, a more detailed assessment is required, taking into consideration service conditions and actuator configuration, in order to define recommended spare parts list and intervals of maintenance. For further information, please contact your Flowserve representative.



**NOTE:** for the recommended hydraulic oils to be used as Supply fluids and other important recommendations, follow par. 1.2 of the present IOM.



**NOTE:** For maintenance of manual overrides (if installed) follow recommendations on the dedicated Manual Overrides IOM.

#### 4.4. GENERAL DISASSEMBLY INSTRUCTIONS

The LHS/LHH Series actuator is available in two different configurations, single acting and double acting, composed by the main parts shown in Figure 23. Before proceeding with other disassembling activities, perform the following preliminary steps.

- 4.4.1. Disconnect all hydraulic and electrical supplies from actuator;
- 4.4.2. Before dismounting the actuator remove control panel all accessories from actuator;
- 4.4.3. The reference drawings for the instructions reported in the following paragraphs are the exploded views of single acting and double acting actuators, included as Figures 24, 25, 26 and 27.

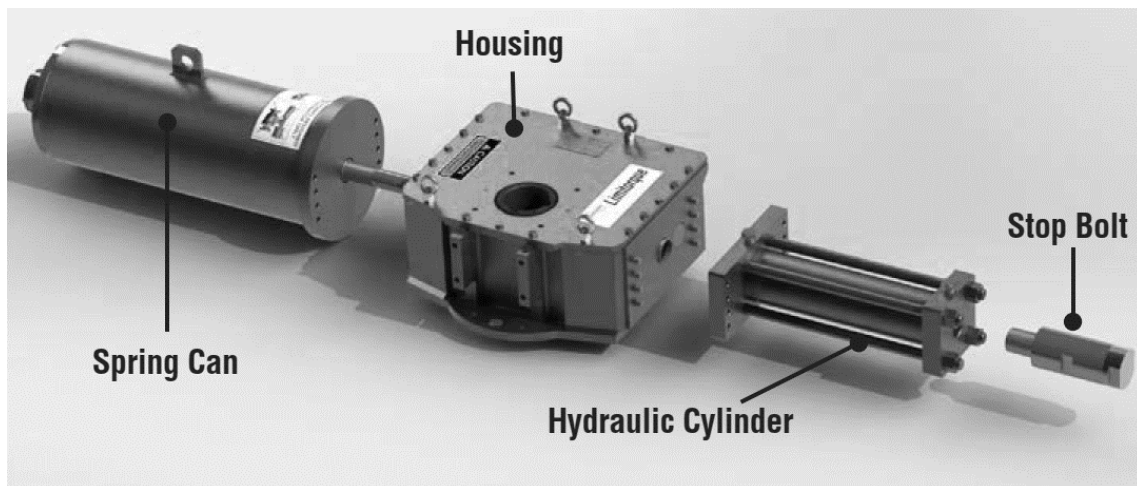


Figure 23: The Three Main Modules of LHS/LHH Actuators



**DANGER:** Do not attempt any maintenance operation with cylinder under pressure

#### 4.5. SPRING CONTAINER MAINTENANCE

The spring container does not require maintenance. Lubrication of internal parts is carried out during assembly and is not necessary to repeat it during the normal life of the actuator. The substitution of the spring container is not expected over the entire actuator life. However, accidental events may result in damage to this component. In these cases, proceed as described in the following steps.

The spring container is a single welded module. In case of damage, the whole container must be disassembled from the actuator and replaced with a new one equal to the original.

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The removal of the spring container from the actuator has to be performed through the following steps. The reference drawing are Figures 24, 25 and 26.

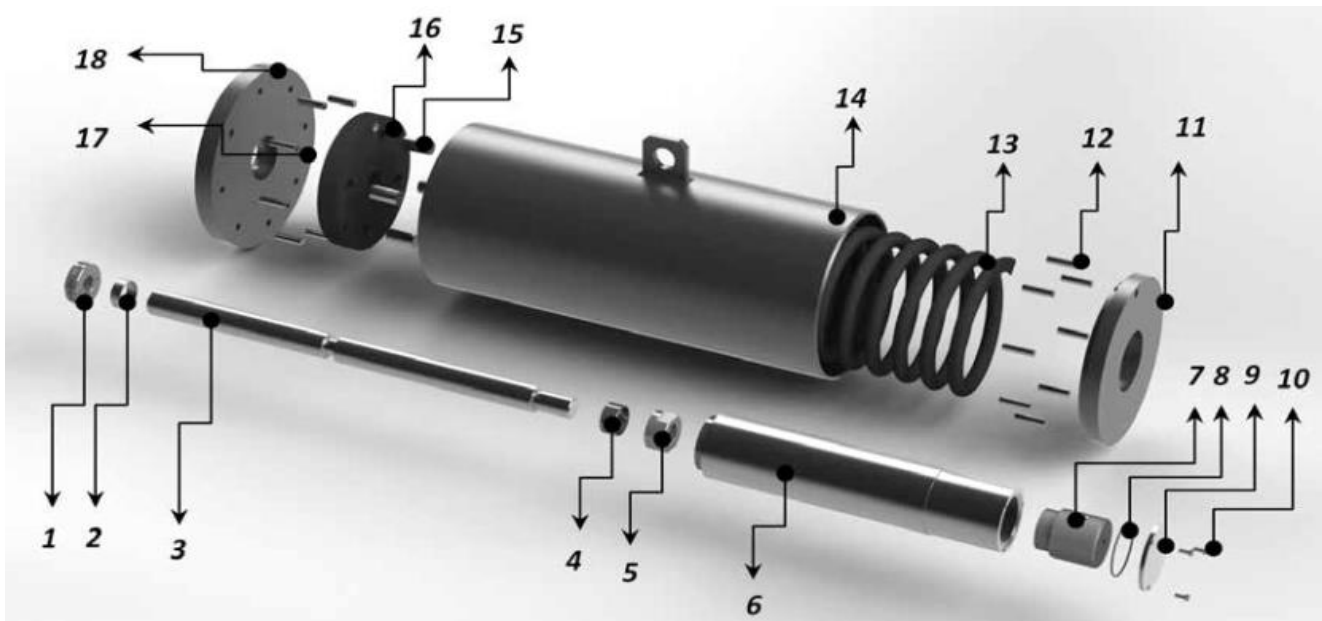


Figure 24: Spring Can Exploded View

Num	Description	Qt	Spare
1	Split Ring	1	
2	Bushing	1	
3	Spring Rod	1	
4	Bushing	1	
5	Spring Rod End Nut	1	
6	Spring Guide	1	
7	Spring Stop Bolt	1	
8	O-Ring	1	X •
9	Stop Bolt Cap	1	

Num	Description	Qt	Spare
10	Hex Screw	1	
11	Spring Can End Flange	1	
12	Bar Pin	8**	
13	Spring	1	
14	Spring Can	1	
15	Bar Pin	4**	
16	Spring Plate	1	
17	Bar Pin	8**	
18	Spring Can Head Flange	1	

X Maintenance spare parts for on/off applications (for aging within guaranteed cycles of EN15714)

• Spare parts that can be replaced without removing the actuator from the valve

\*\* Variable number depending on model



**DANGER:** Do not attempt any maintenance operation with cylinder under pressure



**WARNING:** Ensure that all hydraulic supplies to the control unit and all power supplies are disconnected. Finally, make sure that the actuator is in the failsafe position with the spring at its maximum released position.



**NOTE:** Operations of maintenance on Spring Module can be performed by qualified personnel ONLY.

- 4.5.1. Unscrew and remove the travel-stop of the hydraulic cylinder (25). For removing the stop, refer to paragraph 2.3. If necessary, feed the hydraulic cylinder from the port on the head flange (19) at minimum necessary pressure to facilitate the movement of the Scotch yoke and assure the total retraction of the piston rod (20). Remove the pressure. This way the spring is fully extended.
- 4.5.2. Remove the cover (46) from the housing by unscrewing all of the locking components: hex screw (45), hex head shoulder bolts (44) and eyebolts (42) plus upper nuts (43). Leave the studs (41) screwed into the Scotch yoke housing (51).
- 4.5.3. Hook and hold in tension the spring container using the specific lifting lug located on the top of the spring can (shown in the above picture). Care should be taken to choose lifting equipment. Locate the studs (57) that connect the Scotch yoke housing with the spring container. Carefully un-screw the nuts (56). Pull out the whole spring container with the studs (57) screwed inside.



**NOTE:** Take care to horizontally support the spring module during removal, so as not to damage the spring rod or the stud threads.

- 4.5.4. Before reassembling the new spring module to body, make sure stud threads are free of any dirt, shavings, or other debris. Clean threads with rag and solvent if necessary. Assemble the new spring can, following the reverse procedure as described in points 4.2.1 to 4.2.3. Readjust the travel stop (25) of the hydraulic cylinder and the travel stop (7) of the spring container, as instructed in paragraph 2.3.



**NOTE:** Take care to horizontally support the spring module during removal, so as not to damage the spring rod or the stud threads.



**NOTE:** After the maintenance steps described above, stroke the actuator a few times to check for proper operation.

## **4.6. HYDRAULIC CYLINDER MAINTENANCE**

The hydraulic cylinder maintenance mainly consists in the replacement of those parts that may degrade over time for aging (within guaranteed cycles of EN15714), even in the absence of faults. These components are the O-rings and the sliding elements of the piston.

The substitution of cylinder components not subjected to aging (or of the whole cylinder) is not expected over the entire actuator life (within guaranteed cycles of EN15714). However, accidental events may result in damage to these components. In these cases, proceed as described in the following steps.

The maintenance for replacing components degrading for aging can be performed in the field without

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the need to remove the whole cylinder from the actuator.



**DANGER:** Do not attempt this maintenance operation with cylinder under pressure.

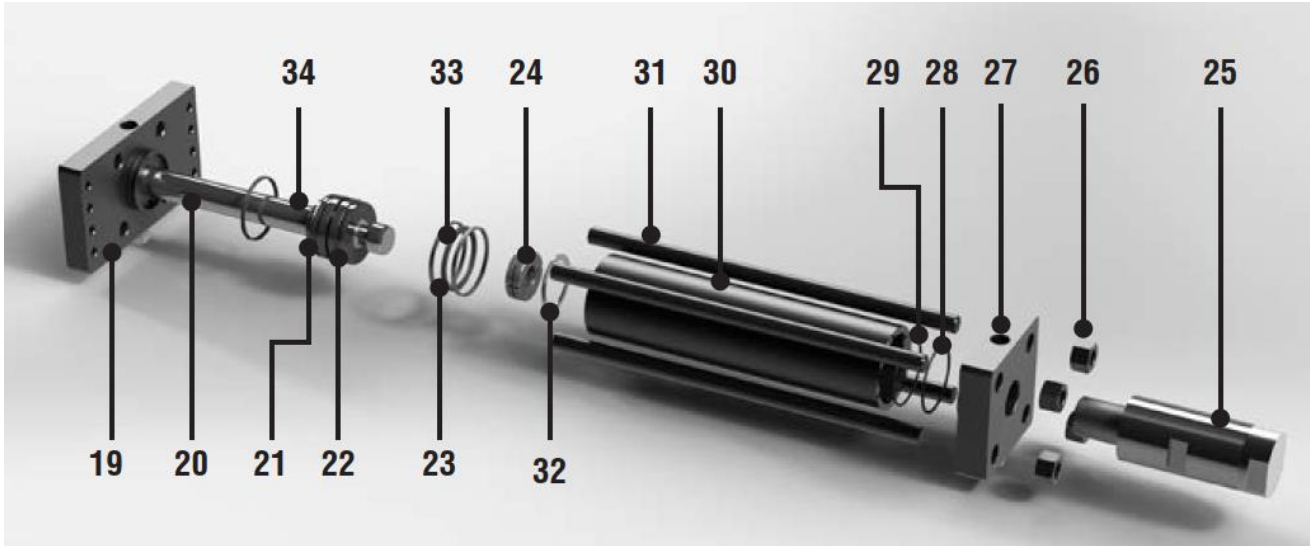


Figure 25: Exploded View of Hydraulic Cylinder

Num	Description	Qty	Spare
19	Cylinder Head Flange	1	
20	Piston Rod	1	
21	O-Ring	1	X •
22	Piston	1	
23	Tape Guide	2	X •
24	Split Ring	1	
25	Stop Bolt Assembly	1	
26	Hex Nut (High)	4**	

Num	Description	Qty	Spare
27	Cylinder End Flange	1	
28	O-Ring	2	X •
29	Anti-extrusion Ring	2	X •
30	Tube	1	
31	Tie Rod	4**	
32	Spiral Retaining	2	
33	Piston seal	1	X •
34	Split Ring	1	

X Maintenance spare parts for on/off applications (for aging within guaranteed cycles of EN15714)

• Spare parts that can be replaced without removing the actuator from the valve

\*\* Variable number depending on model



**WARNING:** Before performing any maintenance operation on the cylinder it's mandatory to remove the pressure inside the cylinder itself. Make sure that the hydraulic connection ports of the cylinder are disconnected. Also make sure that all hydraulic supplies to the control unit and all power supplies are disconnected. Make sure that the actuator is in the fail position.



**WARNING:** Use the hydraulic cylinder only for the intended function it has been designed for.



**WARNING:** In the case of PED cylinders, for any maintenance operations that involve the partial or total removal of the cylinder (not including adjustment operations of the end stopper) contact Flowserve to ensure the preservation of PED certification.



**NOTE:** During the maintenance operations inside the cylinder it's suggested to have a visual check of its internal parts, in order to guarantee their integrity.

Perform the following steps:

- 4.6.1.** Unscrew and remove the travel stop of the hydraulic cylinder. For removing the stop, refer to the indications given in paragraph 2.3.
- 4.6.2.** Remove at least two of the tie rods (31) positioned on the upper part of the cylinder by unscrewing the nuts on the sides of the end flange and of the head flange (or unscrewing the tie rods from the head flange if threaded into the flange.) This operation provides two free holes to be used for lifting the end flange (27). Screw two male eyebolts in these two holes and connect the end flange to a lifting system. Care should be taken to choose a lifting system suitable for the weight of the cylinder. Refer to the weight table shown in Figure 29 and 30. Remove all other tie rods (31), following the same procedure described herein. Then remove the end flange (27) from the tube (30).
- 4.6.3.** Finally, remove the tube (30). Take care not to scratch or dent the honed and plated inner surface of the tube. Remove the O-rings (28) from the head flanges; remove the O-ring of the piston (33) and finally the guide tapes (23) from the piston. Clean all surfaces of piston and flanges in contact with these components with rag and solvent. Brush the O-ring grooves with a light oil film and install the new O-rings. Spread a thin layer of grease on the bottom of the guide tape grooves and install the new guide tapes (23). Clean the internal surface of the tube (30) and lubricate with a protective oil film.
- 4.6.4.** Reassemble the parts of the cylinder with the reverse procedure as described from point 4.6.1 to 4.6.3. The tie rods should be tightened using a torque wrench, alternating between opposite holes, applying a torque according to Tables 3 and 4 included in Chapter 7. Readjust the stops as instructed in paragraph 2.3.



**NOTE:** After the maintenance steps described above, stroke the actuator a few times to check for proper operation.

### 4.7. SCOTCH YOKE HOUSING MAINTENANCE

Maintenance of the Scotch yoke housing may take place in the field, without the need to disassemble the spring container or the pneumatic cylinder. Perform the following steps. The reference drawings are Figures 26 and 27.

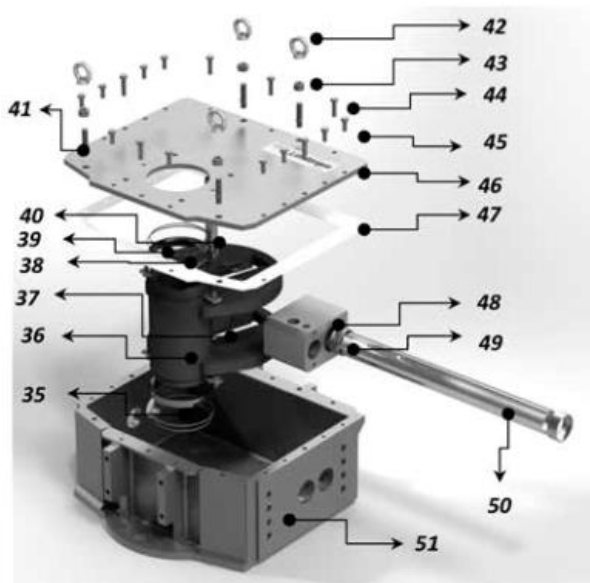


Figure 26: Exploded View of Housing

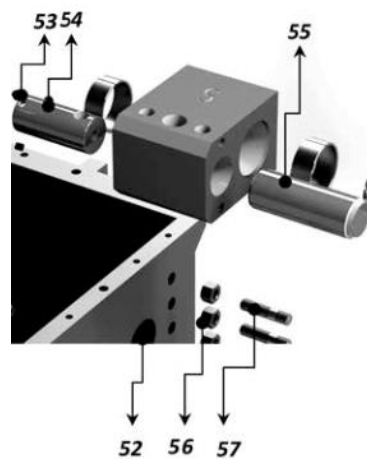


Figure 27: Exploded View of Assembling Kit

Num	Description	Qty	Spare
35	Bushing	2	
36	Scotch Yoke	1	
37	Slider Block	2	
38	O-Ring	2	X •
39	O-Ring	2	X •
40	Guide Pin	1	
41	Stud	4	
42	Eyebolt	4	
43	Hex Nut	4	
44	Hex Head Shoulder Bolt	11**	
45	Hex Head Screw	2**	
46	Cover	1	
47	Cover Gasket	1	X •

Num	Description	Qty	Spare
48	Guide Block	1	
49	Bushing	2	
50	Guide Cover	1	
51	Scotch Yoke Housing	1	
52	Center Ring	2	
53	Grub Screw	3	
54 <sup>(2)</sup>	Cylinder Adapter	1	
55 <sup>(2)</sup>	Spring Adapter	1	
56	Hex Nut (High)	8**	
57	Studs	8**	
58 <sup>(1)</sup>	Guide Adaptor Pin	1	
59 <sup>(1)</sup>	Hex Head Screw	1	

X Maintenance spare parts for on/off applications (for aging within guaranteed cycles of EN15714)

• Spare parts that can be replaced without removing the actuator from the valve

\*\* Variable number depending on model (1) Only in double acting actuators (2) from CW to CCW ( and vice versa ) Conversion kit parts





**DANGER:** Ensure that the hydraulic connection ports of the cylinder are disconnected. Also make sure that all hydraulic supplies to the control unit and all power supplies are disconnected. Finally, make sure that the actuator is in fail position.

- 4.7.1.** Remove the position indicators or other accessories, if fitted. Remove the cover (46) from the housing (51) by unscrewing all the locking components: hex screw (45), hex head shoulder bolts (44) and eyebolts (42) plus upper nuts (43). Leave the studs (41) screwed into the Scotch yoke housing (51). Remove the worn internal O-ring (39) of the bushing (35) inserted in the cover (46). Clean the O-ring groove and the sliding area of the bushing and after having brushed these surfaces with a light oil film, install the new internal O-ring (39).
- 4.7.2.** Apply a generous layer of grease on the sliding surfaces of the accessible moving parts inside the housing. In particular, grease the guide bar (50) and the surfaces of the slots of the wings of the Scotch yoke (36), in which the slider blocks (37) run. Reposition the cover, taking care to replace the cover gasket (47).

The LHS/LHH actuator is designed for easy on-site maintenance and increased actuator life cycle. For this reason, specific instructions and equipment were created to allow the replacement of all parts of the Scotch yoke housing without removing the actuator from the valve. For these instructions, contact Flowserve.



**NOTE:** The spring can and hydraulic cylinder must be removed before disassembling the components located in the Scotch yoke housing.

**4.8. SPARE PARTS**

Main spare parts for LHS/LHH actuators used in ON/OFF applications are listed in the table below. Depending on chosen actuator configuration and service conditions, other spare parts may be required. To obtain spare parts lists specific for each job/order, please contact your Flowserve Limitorque representative. Part numbers are referred to in Figures 24, 25 and 26.

Num	Description	Qty
21	O-Ring	1
23	Tape Guide	2
28	O-Ring	2
29	Anti-extrusion Ring	2
33	Piston seal	1

Num	Description	Qty
38	O-Ring	2
39	O-Ring	2
47	Cover Gasket	1

*Table 1: LHS/LHH Spare Parts List for ON/OFF applications  
(for aging within guaranteed cycles of EN15714).*

# 5 TROUBLESHOOTING

To prevent the actuator from not functioning properly or having a reduction in performances, first ensure that the installation and the adjustment operations are carried out completely in accordance with this manual and with all possible relevant additional instructions.



**WARNING:** When attempting to identify faults, it is very important to observe all the regulations and instructions about Safety and Health at Work. Read all the paragraphs of this manual concerning maintenance before opening the actuator for inspection or before starting to repair any of its components. If in doubt, choose **SAFETY FIRST**.

The following table lists potential problems along with corresponding causes and possible solutions. If a malfunction cannot be identified and eliminated using the table, please contact a Flowserve representative.

<b>Troubleshooting Table</b>		
<b>Problem</b>	<b>Possible cause</b>	<b>Solution</b>
The actuator does not move.	Actuator has not been properly installed.	Check that all the hydraulic connections and that all the hydraulic components have been installed correctly, and are in accordance with the actuator operating mode.
		Check that the actuator is properly connected to the valve and that there aren't problems in the mounting kit.
CONTINUE ...	Supply pressure problems.	Check that sufficient supply pressure is available at actuator inlet port. If possible, place a gauge in line and monitor the pressure level, in order to discover unexpected pressure drops.



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**USER INSTRUCTIONS**  
LHS/LHH SERIES HEAVY-DUTY ACTUATORS

Doc. Number: FCD LFENIM0003-02-A4-05/21

Revision: 02

Date: 05 / 2021

**Troubleshooting Table**

<b>Problem</b>	<b>Possible cause</b>	<b>Solution</b>
<p>... CONTINUE</p> <p>The actuator does not move.</p>	<p>Problems in the control panel (if present).</p>	<p>Check the correct functioning of the control panel. In particular, check all the hydraulic and electric connections</p>
		<p>Check the correct level of supply voltage for solenoid valves and for other electrical/electronic components.</p>
	<p>Inlet/Exhaust hydraulic circuits obstructed.</p>	<p>Ensure Inlet/Exhaust hydraulic circuits are free and not obstructed by residues due to improper oil filtration. If not, clean them of any obstructions.</p>
	<p>Leakage of the hydraulic cylinder.</p>	<p>A significant oil leak may prevent the actuator from operating. Ensure that there aren't any leaks in the hydraulic cylinder. Check also that there are not leaks across the piston. If possible, slightly pressurize the cylinder, then section the final part of hydraulic supply line and detect if pressure drops over time are present, by means of a pressure gauge. If possible, detect leakages towards the external environment. If leaks are present, follow the cylinder maintenance instructions given in paragraph 4.6.</p>
	<p>The valve is blocked.</p>	<p>Check that the valve moves freely. If necessary, disassemble the actuator from the valve.</p>
	<p>Spring problems (if actuator is a single acting version).</p>	<p>Check the proper functioning of the spring module. If problems are found, contact the Flowserve Service Department. In particular, perform the following test: disassemble the actuator from the valve and measure the minimum pressure values necessary to move and compress the spring. Compare the measured values with the ones reported on Testing Certificate. If there are significant differences, contact Flowserve Service Department.</p>
<p>CONTINUE ...</p>		

**In case of other problems not listed in this table, contact Flowserve Service Department.**



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**USER INSTRUCTIONS**

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Doc. Number: FCD LFENIM0003-02-A4-05/21

Revision: 02

Date: 05 / 2021

**Troubleshooting Table**

<b>Problem</b>	<b>Possible cause</b>	<b>Solution</b>
<p><b>... CONTINUE</b></p> <p>The actuator does not move.</p>	<p>A moving part is seized up.</p>	<p>If all the above causes can be excluded, please contact Flowserve Service Department.</p>
<p>The valve does not fully perform the stroke, in opening or closing direction, or, The valve does not shut off properly and leaks are found.</p>	<p>The actuator model is not the correct one or is not suitable for the plant environmental conditions.</p>	<p>Check the actuator nameplate and relevant documentation. Then check the order requirements and installation conditions. If there are mismatches, contact Flowserve Service Department.</p>
	<p>A lockout device has been inserted and forgotten in that position.</p>	<p>Disconnect the lockout module.</p>
	<p>The actuator is not properly adjusted.</p>	<p>Adjust the stopper bolt(s) of the hydraulic cylinder and of the spring can until the valve is leak-tight across the seat. Follow the instructions given in paragraph 2.3 about Travel-stopper bolts adjustment.</p>
	<p>Inlet/Exhaust hydraulic circuits partially obstructed.</p>	<p>Ensure Inlet/Exhaust hydraulic circuits are free and not obstructed by residues due to improper oil filtration. If not, clean them of any obstructions.</p>
	<p>Actuator torque lower than required.</p>	<p>In order to perform a check it is necessary to perform the following test: disassemble the actuator from the valve and measure the minimum pressure values necessary to move and compress the spring (if the actuator is a single acting model) or the minimum pressure values necessary to move the actuator and perform a full stroke (for double acting models). Compare the measured values with the values reported on the Testing Certificate. If significant differences are present, contact Flowserve Service Department.</p>
	<p>A moving part is seized up.</p>	<p>If all the above causes can be excluded, please contact Flowserve Service Department.</p>

**In case of other problems not listed in this table, contact Flowserve Service Department.**



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**Troubleshooting Table**

<b>Problem</b>	<b>Possible cause</b>	<b>Solution</b>
During the stroke the actuator exhibits excessive amounts of backlash.	Some components are excessively worn.	Identify and replace possible worn out components, according to the procedure described in the relevant paragraphs of this manual, or in any special maintenance operating instructions.
Abnormal Increase of maneuver time (in opening or closing direction)	Supply pressure problems / Decrease in hydraulic flow rate.	Check that a sufficient supply pressure level and flow rate are available at actuator inlet port. If possible, place a gauge in line and monitor the pressure values, in order to discover unexpected pressure drops.
	Problems in the control panel (if present).	See instructions at point "The actuator does not move".
	Inlet/Exhaust hydraulic circuits partially obstructed.	See instructions at point "The valve does not fully perform the stroke".
	Problems with lubricants.	Ensure that the actuator is properly lubricated, and that there is no solidified grease among sliding parts. If actuator lubrication is inadequate or improper, apply a new uniform lubricant layer. Follow the instructions for cylinder maintenance (par. 4.6 and 2.3 <b>Error! Reference source not found.</b> ). Contact Flowserve for further advices about proper oil and grease to be used.
	A moving part is (partially) seized up.	If all the above causes can be excluded, please contact Flowserve Service Department.
<b>In case of other problems not listed in this table, contact Flowserve Service Department.</b>		



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**USER INSTRUCTIONS**

*LHS/LHH SERIES HEAVY-DUTY ACTUATORS*

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**Troubleshooting Table**

<b>Problem</b>	<b>Possible cause</b>	<b>Solution</b>
Actuator movement jerky / not fluid / not linear	Supply pressure problems / Decrease in supply hydraulic fluid flow rate.	See above instructions at point "Abnormal Increase of maneuver time".
	Problems with lubricants.	See above instructions at point "Abnormal Increase of maneuver time".
	valve requiring irregular or excessively high torque	Check that jerky / not fluid / not linear movement is not due to valve problems. In particular, perform the following test: disassemble the actuator from the valve and measure the minimum pressure values necessary to move and compress the spring (if the actuator is a single acting model) or the minimum pressure values necessary to move the actuator and perform a full stroke (for double acting models). Compare the measured values with the values reported on the Testing Certificate. Furthermore, check that movement of the actuator disconnected from the valve is fluid and linear. If actuator functioning is as expected, the problem is reasonably due to the valve, requiring torques higher than stated ones.
	A moving part is (partially) seized up.	If all the above causes can be excluded, please contact Flowserve Service Department.

**In case of other problems not listed in this table, contact Flowserve Service Department.**

# 6 DISPOSAL OF DECOMMISSIONED ACTUATORS



**WARNING:** Before disassembling the actuator from the valve, and before any decommissioning activity, ensure that the hydraulic connection ports of the cylinder are disconnected and open to the ambient. Also make sure that power and hydraulic supplies are turned off, and bleed any pressurized parts of the actuator, control panel and hydraulic tubing (including hydraulic accumulator, if present). Verify that the actuator is in fail safe position, i.e., that it is not locked in a position with the spring compressed by means of locking devices.

Spring Return Actuators that have to be permanently decommissioned must have the energy stored in the spring neutralized. Spring module can be safely disassembled if the supply pressure has been removed and the actuator is in its fail-safe position: in fact, in this condition, any residual spring preload is avoided. To disassemble the spring module from the actuator, follow the instructions provided at Paragraph 4.5 of this manual.

Once the spring module is disassembled from the actuator, the spring inside can be neutralized in different ways depending on the equipment available on-site. Please contact your Flowserve Limitorque representative to receive a dedicated procedure for Spring Module disassembly and disposal, in order to safely perform all these operations, in the most appropriate way, according to available equipment and tools.



**DANGER:** Failure to neutralize the spring contained in the actuator's spring module or to follow these instructions could lead to injury to personnel or property damage.

No other specific actions need be taken on other portions/parts of the actuator for decommissioning. To disassemble hydraulic cylinder, follow the instructions provided in paragraph 4.6 of this manual.

All disassembled parts of the actuator shall be separated according to their material type (metal, rubber, plastic, oil and grease, electric and electronic equipment ...). Dispose them with support of differentiated waste collection sites, as provided for by the laws and provisions in force.



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# 7 ANNEXES

	Series	Body Size	Yoke	Cylinder	Temp. Range	Fail Action	Spring combination	Options		
<b>Example Model</b> →	LPS	20	A	535	B	FC	4 - 1	JL		
LPS - Limitorque Pneumatic Scotch-yoke actuators LHS - Limitorque Hydraulic Scotch-yoke actuators LHH - Limitorque High Hydraulic pressure scotch-yoke LDG - Limitorque Direct Gas scotch-yoke actuators										
15, 20, 25, 30, 35, 40, 50, 60										
A - Symmetric Scotch Yoke B - Custom Scotch Yoke C - Canted Scotch Yoke										
*50, 55, 60, 65 [...] 485, 535, 585, 635 [...] 1500, 1600, 1700, 1800										
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;"> <b>PNEUMATIC 12 BARG (175 PSIG) DIRECT GAS AND HYDRAULIC CYLINDERS</b>  <b>B - Buna Seals</b>            temp range: -20°C ; +100°C [-4°F;+212°F]  <b>S - Fluorosilicone Seals</b>            temp range: -40°C ; +100°C [-40°F;+212°F]  <b>F - Fluorosilicone Seals</b>            temp range: -40°C ; +100°C [-40°F;+212°F]            Required: EN-10204 3.1  <b>L - Fluorosilicone Seals</b>            temp range: -50°C ; + 100°C [-58°F;+212°F]  <b>Z - Fluorosilicone Seals</b>            temp range: -60°C ; + 100°C [-76°F;+212°F]  <b>V - Viton® Seals</b>            temp range: -29°C ; + 160°C [-20°F;+320°F]         </td> <td style="width: 50%; border: none; vertical-align: top;"> <b>PNEUMATIC 8.3 BARG (120 PSIG) CYLINDERS</b>  <b>A - Buna Seals</b>            temp range: -20°C ; +100°C [-4°F;+212°F]  <b>R - Fluorosilicone Seals</b>            temp range: -40°C ; +100°C [-40°F;+212°F]  <b>E - Fluorosilicone Seals</b>            temp range: -40°C ; +100°C [-40°F;+212°F]            Required: EN-10204 3.  <b>K - Fluorosilicone Seals</b>            temp range: -50°C ; + 100°C [-58°F;+212°F]  <b>Y - Fluorosilicone Seals</b>            temp range: -60°C ; + 100°C [-76°F;+212°F]  <b>U - Viton® Seals</b>            temp range: -29°C ; + 160°C [-20°F;+320°F]         </td> </tr> </table>									<b>PNEUMATIC 12 BARG (175 PSIG) DIRECT GAS AND HYDRAULIC CYLINDERS</b> <b>B - Buna Seals</b> temp range: -20°C ; +100°C [-4°F;+212°F] <b>S - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] <b>F - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] Required: EN-10204 3.1 <b>L - Fluorosilicone Seals</b> temp range: -50°C ; + 100°C [-58°F;+212°F] <b>Z - Fluorosilicone Seals</b> temp range: -60°C ; + 100°C [-76°F;+212°F] <b>V - Viton® Seals</b> temp range: -29°C ; + 160°C [-20°F;+320°F]	<b>PNEUMATIC 8.3 BARG (120 PSIG) CYLINDERS</b> <b>A - Buna Seals</b> temp range: -20°C ; +100°C [-4°F;+212°F] <b>R - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] <b>E - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] Required: EN-10204 3. <b>K - Fluorosilicone Seals</b> temp range: -50°C ; + 100°C [-58°F;+212°F] <b>Y - Fluorosilicone Seals</b> temp range: -60°C ; + 100°C [-76°F;+212°F] <b>U - Viton® Seals</b> temp range: -29°C ; + 160°C [-20°F;+320°F]
<b>PNEUMATIC 12 BARG (175 PSIG) DIRECT GAS AND HYDRAULIC CYLINDERS</b> <b>B - Buna Seals</b> temp range: -20°C ; +100°C [-4°F;+212°F] <b>S - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] <b>F - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] Required: EN-10204 3.1 <b>L - Fluorosilicone Seals</b> temp range: -50°C ; + 100°C [-58°F;+212°F] <b>Z - Fluorosilicone Seals</b> temp range: -60°C ; + 100°C [-76°F;+212°F] <b>V - Viton® Seals</b> temp range: -29°C ; + 160°C [-20°F;+320°F]	<b>PNEUMATIC 8.3 BARG (120 PSIG) CYLINDERS</b> <b>A - Buna Seals</b> temp range: -20°C ; +100°C [-4°F;+212°F] <b>R - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] <b>E - Fluorosilicone Seals</b> temp range: -40°C ; +100°C [-40°F;+212°F] Required: EN-10204 3. <b>K - Fluorosilicone Seals</b> temp range: -50°C ; + 100°C [-58°F;+212°F] <b>Y - Fluorosilicone Seals</b> temp range: -60°C ; + 100°C [-76°F;+212°F] <b>U - Viton® Seals</b> temp range: -29°C ; + 160°C [-20°F;+320°F]									
D1 - Double acting, Single Cylinder (STD) D2 - Double Acting Double Cylinders DD - Double Acting, Tandem Cylinders FC - Spring Fail Close FO - Spring Fail Open										
*1-1, 1-2, 1-3 [...] 2-1, 2-2, 2-3, 2-4 [...] 3-1, 3-2, 3-3 [...] 4-1, 4-2, 4-3, 4-4 [...] 5-1, 5-2, 5-3, 5-4 [...]										
JL - Jackscrew Light Handwheel JS - Enclosed Jackscrew Handwheel BG - Bevel Gear Handwheel HP - Hydraulic Manual Hand Pump [...]										

Figure 28: LHS/LHH Model Selection Table





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LHS	Assembling Kit		15X	100Y					FC 1-1	example model n°						
	SINGLE ACTING	DOUBLE ACTING		15	20	25	30	35			40	50				
15	50 (110)	9 (20)	10 (22)	12 (26)	-	-	-	-	54 (119)	98 (216)	124 (273)	228 (503)	-	722 (1592)	2139 (4716)	
20	90 (198)	12 (26)	14 (31)	-	-	-	-	-	56 (123)	-	133 (293)	252 (556)	517 (1140)	812 (1790)	-	
25	140 (309)	4 (7.7)	18 (40)	-	-	-	-	-	56 (123)	-	147 (324)	263 (580)	556 (1226)	833 (1836)	2620 (5776)	
30	295 (650)	8 (16.5)	21 (45)	26 (57)	-	-	-	-	1-4	-	138 (304)	-	652 (1437)	-	2647 (5836)	
35	561 (1237)	13 (28.7)	21 (46)	28 (61)	34 (75)	-	-	-	1-5	-	-	-	685 (1510)	-	-	
40	879 (1938)	26 (57.3)	23 (50)	27 (60)	37 (81)	41 (91)	-	-	2-1	90 (198)	112 (246)	183 (403)	277 (611)	778 (1715)	1010 (2227)	2506 (5525)
50	1984 (4374)	53 (116.8)	25 (54)	29 (63)	39 (85)	44 (97)	-	-	2-2	105 (231)	115 (254)	200 (441)	304 (670)	885 (1951)	1112 (2452)	2958 (6521)
			27 (59)	32 (70)	40 (89)	44 (98)	-	-	2-3	105 (231)	130 (287)	205 (452)	317 (699)	974 (2147)	1196 (2637)	-
			-	36 (79)	45 (100)	60 (133)	-	-	2-4	-	135 (298)	-	322 (710)	-	-	-
			-	38 (85)	48 (105)	68 (150)	121 (267)	-	3-1	91 (201)	162 (357)	182 (401)	306 (675)	1076 (2372)	1297 (2859)	3071 (6770)
			-	50 (111)	63 (139)	78 (172)	128 (283)	-	3-2	105 (231)	179 (394)	204 (450)	336 (741)	1260 (2778)	1475 (3252)	3607 (7952)
			-	-	89 (196)	88 (194)	143 (315)	138 (305)	3-3	105 (231)	184 (406)	227 (500)	350 (772)	1320 (2910)	1537 (3389)	3863 (8516)
			-	-	92 (204)	91 (201)	150 (330)	148 (327)	3-4	-	237 (522)	-	1305 (2877)	1537 (3389)	-	-
			-	-	96 (212)	93 (204)	155 (342)	154 (339)	4-1	-	266 (586)	253 (558)	400 (882)	956 (2108)	-	-
			-	-	-	95 (208)	161 (354)	159 (351)	4-2	-	266 (586)	279 (615)	432 (952)	1043 (2299)	-	-
			-	-	-	97 (214)	171 (376)	170 (374)	4-3	-	-	292 (644)	437 (963)	1387 (3058)	-	-
			-	-	-	101 (222)	180 (397)	230 (507)	4-4	-	-	298 (657)	447 (985)	1532 (3377)	-	-
			-	-	-	-	203 (448)	263 (579)	4-5	-	-	-	455 (1003)	-	-	-
			-	-	-	-	241 (530)	390 (860)	5-1	-	-	295 (650)	637 (1404)	2084 (4594)	-	-
			-	-	-	-	264 (582)	429 (946)	5-2	-	-	405 (893)	744 (1640)	2364 (5212)	-	-
			-	-	-	-	280 (617)	449 (990)	5-3	-	-	-	744 (1640)	2734 (6027)	-	-
			-	-	-	-	488 (1075)	501 (1105)								
			-	-	-	-	507 (1118)	551 (1215)								
			-	-	-	-	552 (1216)	585 (1290)								
			-	-	-	-	620 (1367)	655 (1444)								
			-	-	-	-	690 (1521)	725 (1598)								
			-	-	-	-	760 (1676)									

Figure 29: LHS Model Selection Table



Screws	Torque [Nm]
M3	1,1
M4	2,5
M5	5,0
M6	8,6
M8	21
M10	42
M12	72
M14	116
M16	180
M18	250
M20	354
M22	487
M24	609

Screws	Torque [Nm]
M27	901,0
M30	1222,0
M33	1660,0
M36	2131,0
M39	2766,0
M42	3414,0
M45	4273,0
M48	5161,0
M52	6646,0
M56	8277,0
M60	10283,0
M64	12373,0

Table 2: LHS/LHH Models. Tightening Torques for Screws Class 8.8 or ASTM A193 B7 /A320 L7 with metric coarse thread, without application of threads Lubricant, screwed in steel components (IMPORTANT: Tie Rods Excluded)



**CAUTION:** In case of screws made of materials differing from the ones indicated in caption (e.g. stainless steel) don't refer to Table 2. Please contact Flowserve for the correct tightening torques to be applied.

Tie Rods Diameter	Torque [Nm]
M16	135
M20	280
M24	470
M27	750
M30	1000
M33	1280
M36	1650

Table 3: Tightening Torque Table for LHS Standard Cylinder Tie Rods, without application of Threads Lubricant.

Tie Rods Diameter	Torque [Nm]
M16	145
M20	300
M24	530
M27	710
M30	1100
M33	1450
M36	1890
M39	2400

Table 4: Tightening Torque Table for LHH Standard Cylinder Tie Rods, without application of Threads Lubricant.

\* other versions are available verify your Job Order documentation or contact your Flowserve representative if required in case of doubts

**LHS/LHH Series Coupling Dimensions \***

Model	ISO 5211 Flange Interface (reference)	ØA	B	C	No of holes n	Hole Diameter ØD	P.C.D. [mm(inch)] ØE	F	ØG	ØH	I	L	P
LHS/LHH 15	F16	65	10	70,6	4	M20	165 (6,50)	18	86	78	161	8	155
LHS/LHH 20	F25	86	12	91,6	8	M16	254 (10)	16	130	112	178	4.5	205
LHS/LHH 25	F30	100	18	108,8	8	M20	298 (11,73)	18	150	133	201	6	230
LHS/LHH 30	F35	130	28	138,6	8	M30	356 (14,02)	28	168	152	261	10	305
LHS/LHH 35	F40	150	36	166,8	8	M36	406 (15,98)	33	199	185	323	9	405
LHS/LHH 40	F48	185	45	205,8	12	M36	483 (19,02)	38	244	230	338	10	450
LHS/LHH 50	F60	230	50	252,8	20	M36	603 (23,74)	48	292	275	500	18	550
LHS/LHH 60	n.a.	270	45	290,8	20	M42	800 (31,49)	58	372	350	620	16	650

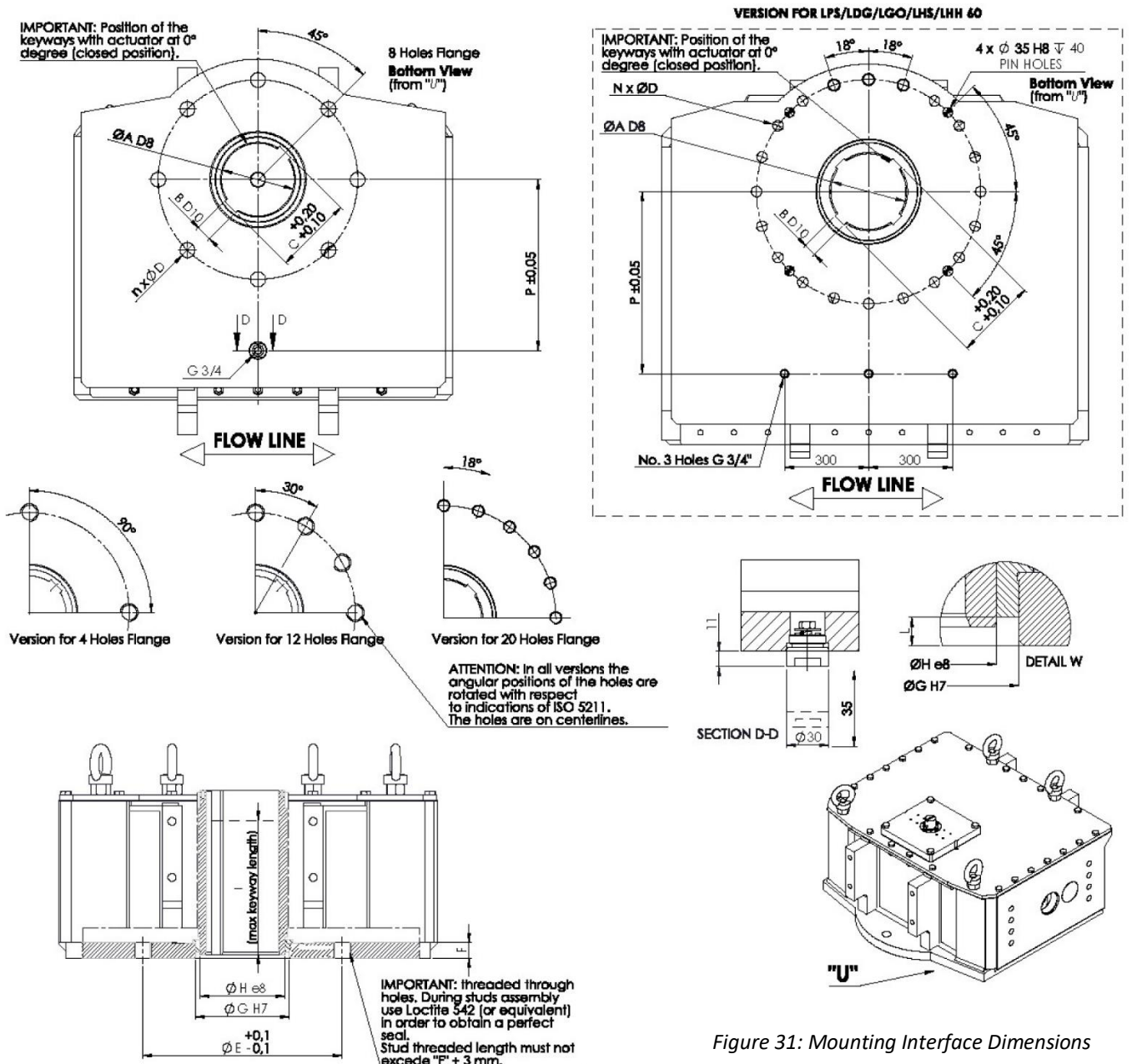


Figure 31: Mounting Interface Dimensions

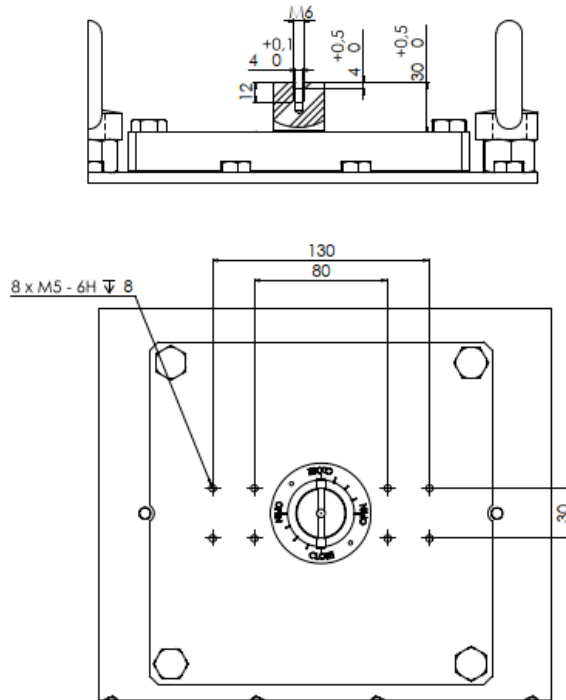
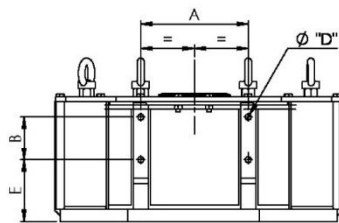
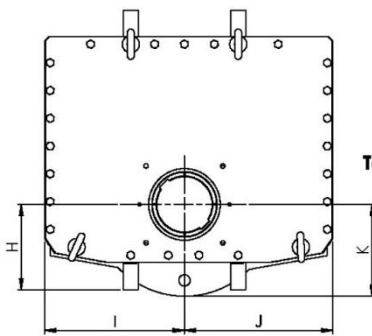


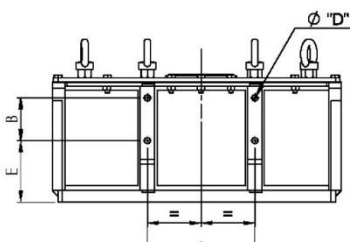
Figure 32: Details of Namur VDE/VDI 3845 Adaptor Kit, Available Upon Request



Front View  
(From "U")



Top View



Back View  
(From "W")

LPS/LDG/LGO/LHS/LHH Series Center Body Mounting Holes									
Model	A	B	D		E	H	I	J	K
			Ø	Thread length					
LPS/LDG/LGO/LHS/LHH 15	104	55	M10	12	85	113	164	174	120
LPS/LDG/LGO/LHS/LHH 20	131	70	M12	18	90	135	219	222	150
LPS/LDG/LGO/LHS/LHH 25	211	73	M12	15	105	179	249	267	188
LPS/LDG/LGO/LHS/LHH 30	252	100	M16	20	144	200	328	348	215
LPS/LDG/LGO/LHS/LHH 35	270	110	M20	25	190	269	413	433	260
LPS/LDG/LGO/LHS/LHH 40	345	140	M24	30	200	285	519	543	290
LPS/LDG/LGO/LHS/LHH 50	355	220	M33	40	250	369	633	649	343
LPS/LDG/LGO/LHS/LHH 60	500	220	M24	48	417	396	738	783	455

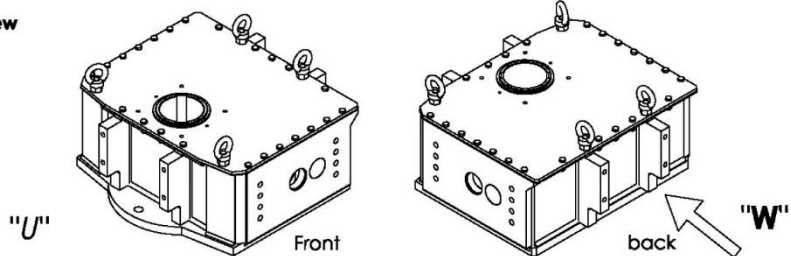


Figure 33: Control Panel Mounting Holes





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