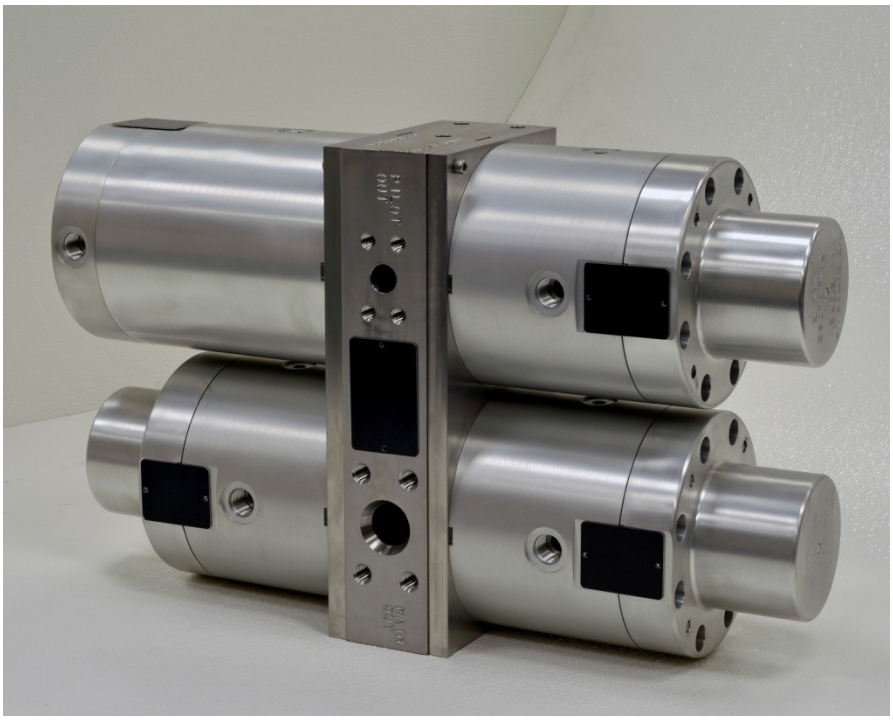
WOODWARD

Product Manual 26737
(Revision H, 1/2026)
Original Instructions



LXM Liquid Mixing Manifold

Installation and Operation Manual

Released

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. The latest version of most publications is available on the Woodward website.

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If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. The latest version of most publications is available on the Woodward website.

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Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26737

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Important Definitions

This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

Regulatory Compliance

European Compliance for CE Marking:

Pressure Equipment Directive:	Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to making pressure equipment available on the market. PED Category II PED Module H – Full Quality Assurance,

Other European and International Compliance:
Compliance with the following European Directives or standards does not qualify this product for application of the CE Marking:

Machinery Directive:	Compliant as partly completed machinery with Directive 2006/42/EC of the European Parliament and the Council of 17 May 2006 on machinery.
ATEX – Potentially Explosive Atmospheres Directive:	Exempt from the non-electrical portion of the ATEX Directive 2014/34/EU due to no potential ignition sources per EN ISO 80079-36:2016 for Zone 2 installations.

Special Conditions for Safe Use:

Compliance with the Machinery Directive 2006/42/EC noise measurement and mitigation requirements is the responsibility of the manufacturer of the machinery into which this product is incorporated.

The surface temperature of this valve approaches the maximum temperature of the applied process media. It is the responsibility of the user to ensure that the external environment contains no hazardous gases capable of ignition in the range of the process media temperatures.

Chapter 1.
General Information

Description

NOTICE

This product is designed for use with light distillate fuels. It is the customer's responsibility to confirm the product's suitability with any other fluids. Wetted internal parts include, but are not limited to, the following materials: perfluorinated elastomers, mineral filled PTFE, stainless steel, aluminum, and chrome nitride plating.

The Woodward Liquid Mixing Manifold (LXM) is a component of the liquid fuel metering system and NOx reduction system for an industrial gas turbine. It is designed for use with distillate fuel, demineralized water, and natural gas (to the primary liquid fuel circuit). The valve provides precisely controlled restrictions on both the primary and main liquid fuel and water injection circuits, which mitigate the effects of gravimetric head and ensure uniform flow delivery between combustors at different elevations. In addition, during liquid fuel operation, distillate fuel and water are mixed using counter-flow impingement within the manifold, to provide a uniform emulsion to the combustor nozzles.

The Liquid Mixing Manifold (LXM) is comprised of four pneumatically actuated, two-position poppet-style valves mounted to a multi-path manifold. The LXM provides the capability to direct flow from one or more of the three inlet ports (Pilot Inlet, Main Inlet, and Water Inlet) to one or more of the output ports (Pilot Discharge and Main Discharge). The device can be provided with either fail closed or fail open actuators. For the Main Fuel, Main Water, and Pilot water circuits, the typical default state is closed; therefore, the standard actuators supplied are a fail-closed configuration. However, in some cases, when the turbine is fueled on natural gas, the pilot liquid nozzles may require gas purge to provide protective cooling. For this critical function of providing un-interrupted flow capability even in the absence of actuation air, the pilot fuel actuator can be provided in a fail open configuration. For back-up shutdown capability, the pilot fuel actuator can be closed by pressurizing the actuator supply port.

The LXM is designed for ease of mounting and servicing. The valve assembly can be mounted to the fuel and water manifolds by its inlet flange connections in any orientation around the turbine. Threaded holes for an angle bracket are included on the manifold if additional support is desired.

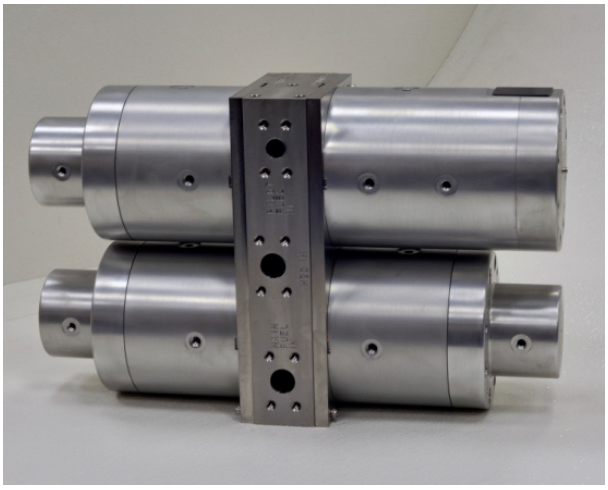


Figure 1-1. Front View of the LXM

Construction

The main components of the LXM include:

- Manifold
- Actuators
  - Normally closed (3x) for Main Fuel, Main Water, and Pilot Water. Pilot fuel (optional).
  - Normally open or normally closed for pilot fuel

Manifold

The LXM manifold is the common mounting block for the four actuators as well as the location for process fluid inlet and discharge connections. During liquid fuel operation, drilled cross channels within the manifold provide counterflow mixing of liquid fuel and water.

The manifold is a three-piece design constructed from austenitic stainless steel. The main block contains the process fluid passages, connects the actuator overboard drain passages to allow for common connections to drain, and serves as the interface for process fluid connections.

The inlet side of the manifold block has three ports, Pilot Fuel, Main Fuel, and a shared Water Inlet in the middle. The Pilot and Main discharge ports are located on the opposite side of the manifold. Fluid connection and actuator interface labels are engraved on the manifold for ease of identification during assembly, disassembly, and servicing.

The manifold plates serve as the location for orifice seat installation, as well as the interface between the manifold and actuators. The actuator and manifold interfaces have been designed to ensure that the correct actuator is assembled on each circuit.

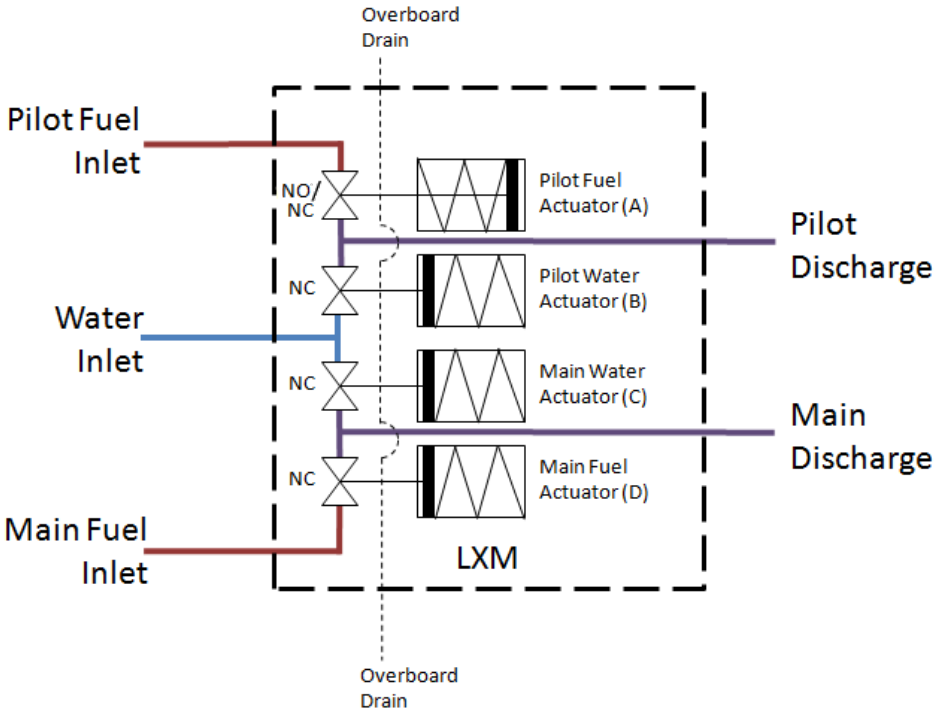


Figure 1-2. LXM Circuit Schematic

Actuators

The LXM uses four pneumatic actuators, which provide dependable open/close functionality. The actuators are integrated into the manifold design to control the isolation or combination of the process fluids within the manifold. Required connections to the actuators are SAE J514 ¾" -16 straight thread actuation supply ports and a SAE J514 7/16"-20 straight thread overboard vent ports.

The actuators and valves on the LXM are available in both a normally open and normally closed configuration. A normally open Pilot Fuel configuration allows natural gas to flow to purge the primary injectors during gas operation. The valve can close by pressurizing the unit during an emergency trip.

The actuators are comprised primarily of anodized aluminum to provide performance while reducing total valve weight. Primary wetted parts of the valve are stainless steel for additional corrosion resistance. For replacement of actuators or actuator parts, see Chapter 4 of this manual.

Visual Indicators

The position of the actuator can be verified by inspection of the visual indicator at the top of each actuator. When an actuator is open, the indicator rod protrudes from the actuator cover by approximately 6 mm / ¼ inch; when the actuator is closed, the indicator rod is flush with the actuator cover.

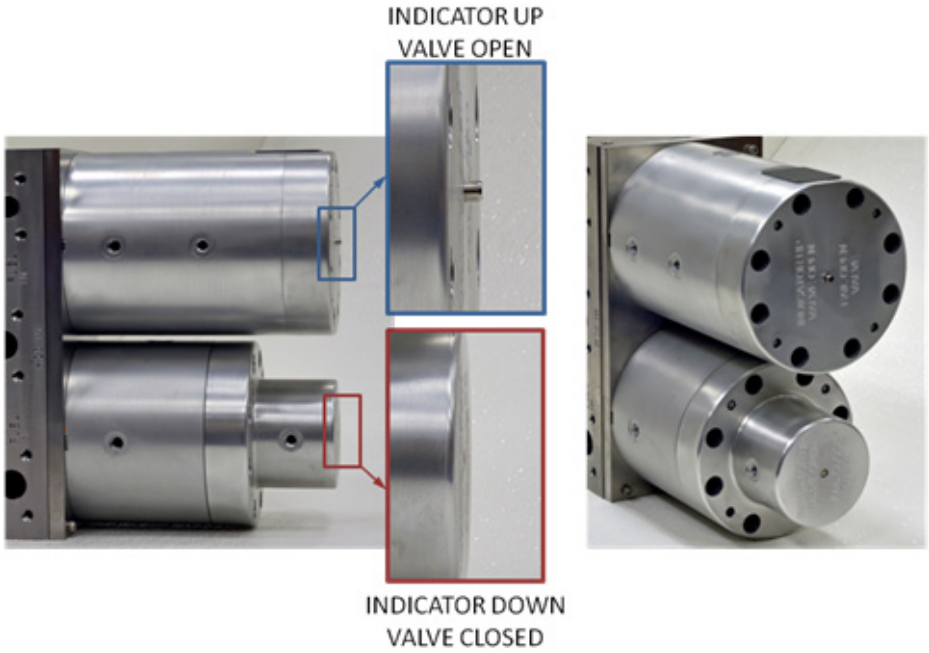


Figure 1-3. Visual Indicator of Actuator Position

Chapter 2. Specifications

Table 2-1. LXM Specifications Table

Valve Specifications	
Valve Type	Poppet Hybrid
Type of Operation	On/Off
Fluid Ports	SAE J518 Code 61, 4-Bolt Flange Pilot Fuel Inlet: 19.05 mm (3/4 inch) Water Inlet: 25.4 mm (1 inch) Main Fuel Inlet: 25.4 mm (1 inch) Pilot Discharge: 19.05 mm (3/4 inch) Main Discharge: 38.1 mm (1-1/2 inches)
OBVD Connection	SAE J514 .438-20 Straight Thread Port (-04)
Max OBVD Pressure	2.8 bar (40 psig), 5 second max duration
Allowable Process Fluid Leakage to OBVD	New: 5.88 cm³/min, 6.9 bar (100 psig) air or nitrogen (approx. Class V) Worn: 200 cm³/min, 6.9 bar (100 psig) air or nitrogen (approx. 7 % of Class IV)
Allowable Seat Leakage (Forward or Reverse)	New: 285 cm³/min, 6.9 bar (100 psig) air or nitrogen (approx. 10 % of Class IV) Worn: 2850 cm³/min, 6.9 bar (100 psig) air or nitrogen (approx. Class IV)
Flow Specifications (Cv)	
Pilot Fuel (A)	1.0 ± 3 % or 1.0 ± 3 % or 0.498 ± 5%
Pilot Water (B)	0.4 ± 3 % or 0.4 ± 3 % or 0.234 ± 5%
Main Water (C)	4.0 ± 3 % or 3.5 ± 3 % or 2.108 ± 3%
Main Fuel (D)	3.5 ± 3 % or 3.0 ± 3 % or 1.791 ± 3%
Process Fluid Specifications	
Process Fluids	Natural gas, demineralized water, Light True Distillate Fuel
Process Fluid Temperature	Liquid fuel & water: (0 to 93) °C [(32 to 200) °F] Gas Fuel: (–5 to +210) °C [(23 to 410) °F]
Recommended Process Fluid pH Range	pH 5–8
Recommended Process Fluid Filtration	$\beta_{5/10/20}$ = 2/75/1000 (20 µm absolute filtration)
Design Pressure	148 bar (2150 psig)
Max Continuous Differential Pressure	119 bar (1720 psid) (Forward or Reverse)
Proof Pressure	222 bar (3225 psig)
Minimum Burst Pressure	445 bar (6450 psig)
Maximum Service Conditions	
Liquid Fuel	Max Process Fluid Pressure: 118.6 bar (1720 psig) Max Process Fluid Temperature: 93 °C (200 °F)
Gas Purge Operation	Max Process Fluid Pressure: 34.5 bar (500 psig) Max Process Fluid Temperature: +210 °C (410 °F)

Actuator Specifications	
Actuator Type	Pneumatic
Actuation Supply Pressure	(6.2 to 7.6) bar [(90 to 110) psig]
Actuation Supply Temperature	(–31 to +49) °C [(–23 to +120) °F]
Recommended Actuation Supply Filtration	0.9 µm absolute
Actuation Supply Connection	0.750-16 Straight Thread Port (-08)
Allowable Air Leakage to Piston Vent	New: 41.1 cm³/min, 6.9 bar (100 psig) air or nitrogen (approx. Class V) Worn: 455.5 cm³/min, 6.9 bar (100 psig) air or nitrogen (approx. 16% Class IV)
Slew Time	Less than 0.5 second opening & closing from nominal cracking pressure to fully extended position, or nominal closing pressure to fully retracted position.

Environmental Specifications	
Design Ambient Temperature	(–5 to +218) °C [(23 to 425) °F]
Max Continuous Ambient Temperature	196 °C (385 °F)
Max Operating Ambient Temperature	210 °C (410 °F)
Vibration Test Level	2 G Sine sweep from 10 to 2000 Hz, resonance search. Random 0.04 G^2/Hz, from 10 to 2000 Hz for a period of 1-1/2 hours per axis. Equivalent to 8.2 G rms per MIL-STD 202F, M214A, TC(B).
Shock	40 G Peak, 11 ms duration sawtooth pulse per MIL-STD 810F, Method 516.5, Procedure 1.

Physical Specifications	
Height x Width x Depth	Approx. (546 x 336.3 x 170) mm [(21.5 x 13.24 x 6.7) inches]
Weight	Approx. 86 kg (190 lb) empty

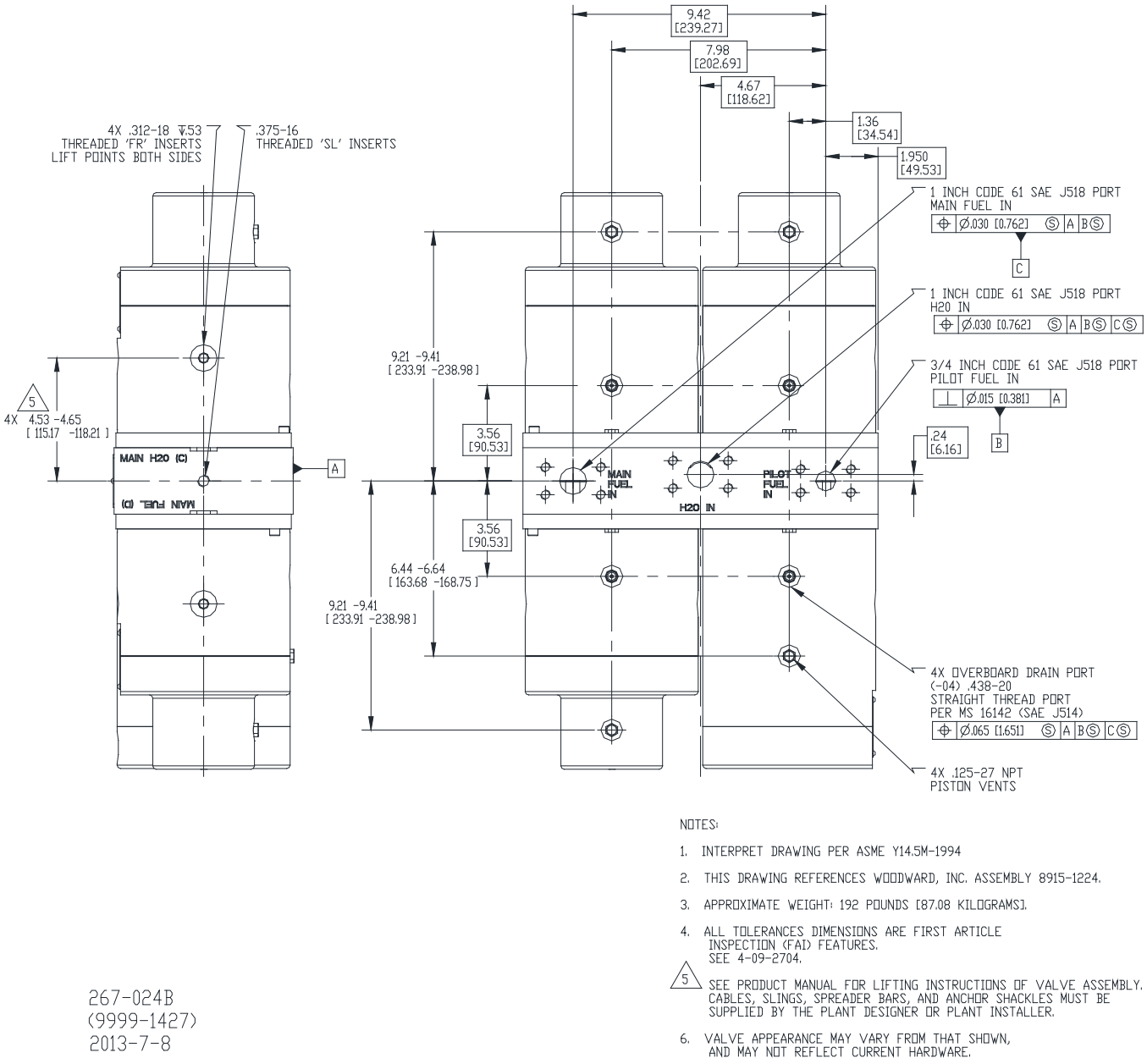


Figure 2-1a. LXM Outline Drawing (Fail Open (FO) Pilot Fuel Actuator)

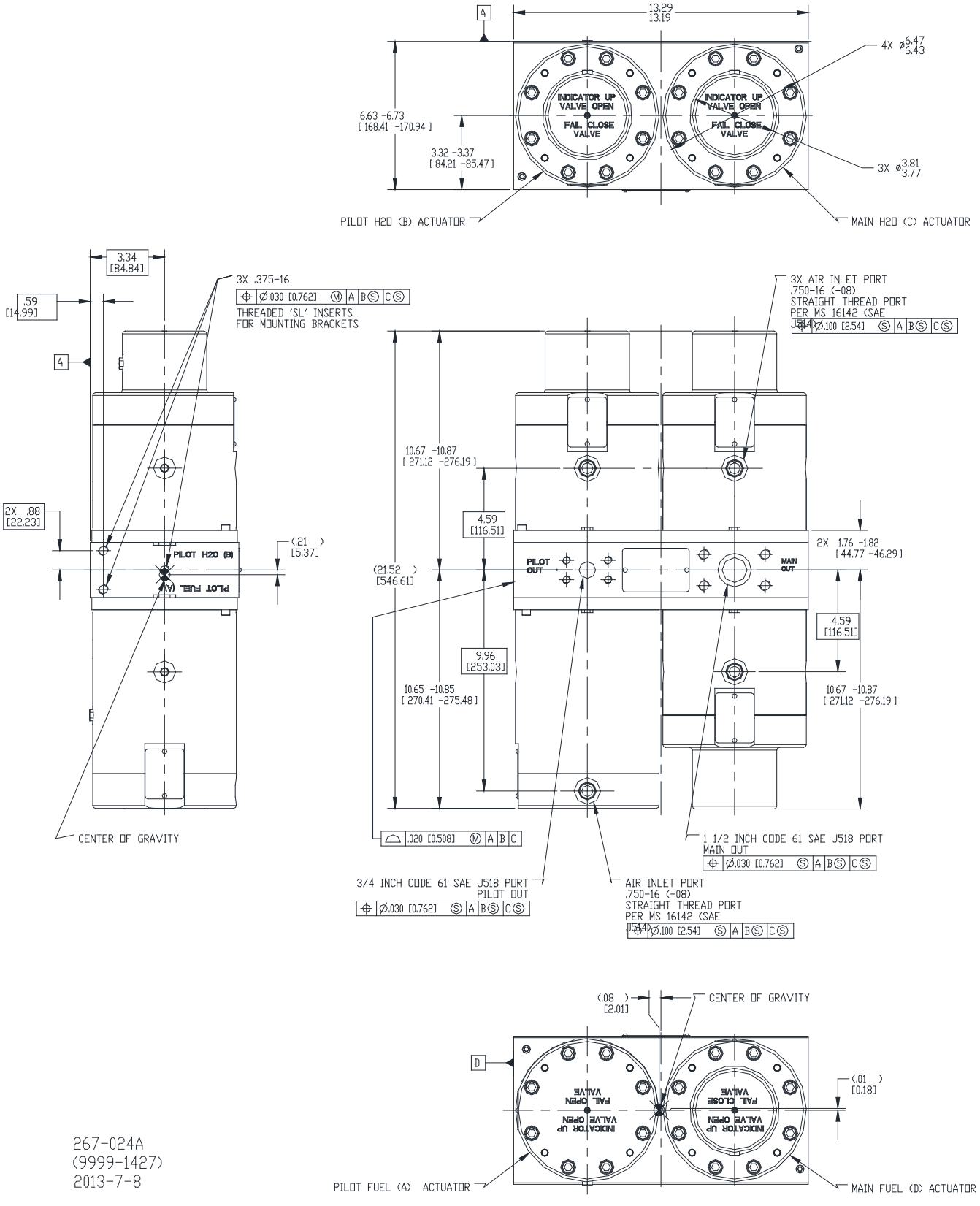


Figure 2-1b. LXM Outline Drawing (Fail Open (FO) Pilot Fuel Actuator)

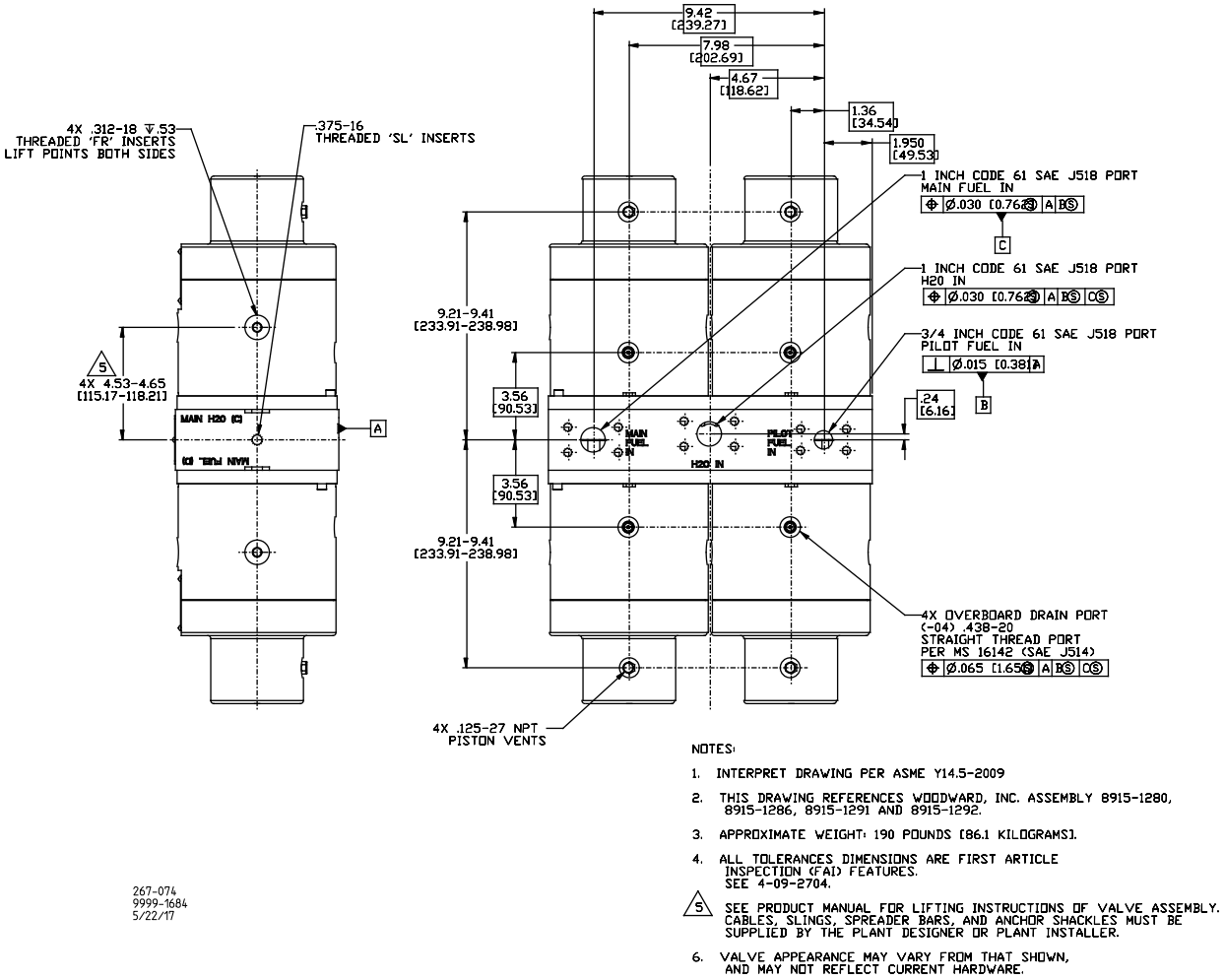


Figure 2-1c. LXM Outline Drawing (All Fail Close (FC) Actuators)

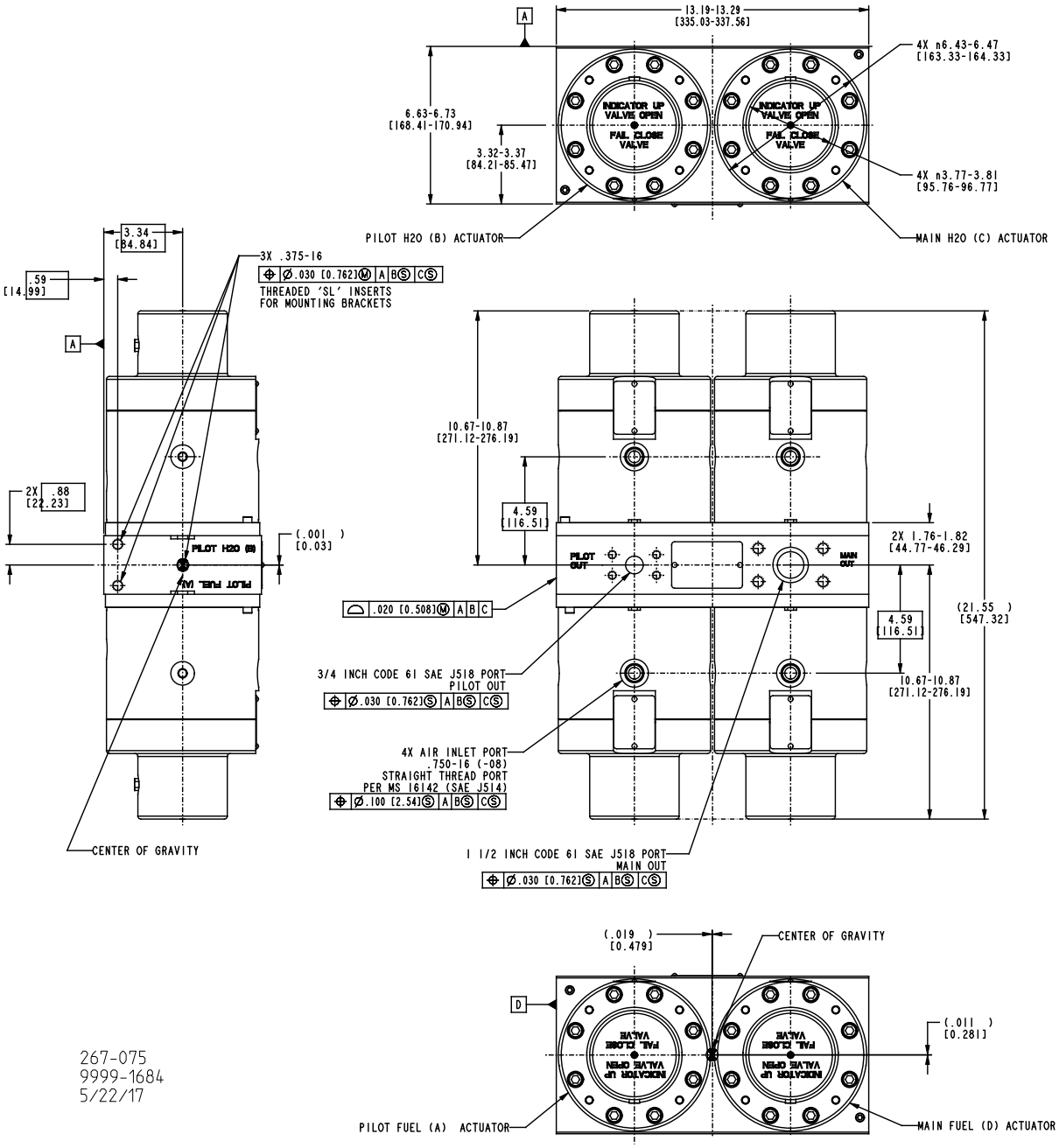


Figure 2-1d. LXM Outline Drawing (All Fail Close (FC) Actuators)

Chapter 3.
Installation

Receiving

The LXM is carefully packed at the factory to protect it from damage during shipping. It is recommended that the LXM be stored in its shipping container until installation. When unpacking the LXM, leave the port covers in place to protect the valve interior. Do not remove the port covers until just prior to valve installation.

NOTICE

Remove all shipping plugs and caps prior to installation. Failure to remove plastic overboard plugs may result in process fluid release through drains during operation.

Lifting

⚠WARNING

The LXM weighs approximately 86 kg / 190 pounds. Do not attempt to lift or move it without appropriate lifting equipment. Use caution when moving or lifting the LXM to prevent serious injury.

A 5/16-18 tapped hole with thread insert is provided on each actuator body as provision for using a lifting eye (Figure 3-1). This allows for flexibility of lifting configurations to match the various mounting orientations. Prior to lifting a valve, use at least two eye bolts in the actuators. Lifting hardware may be removed upon final installation.

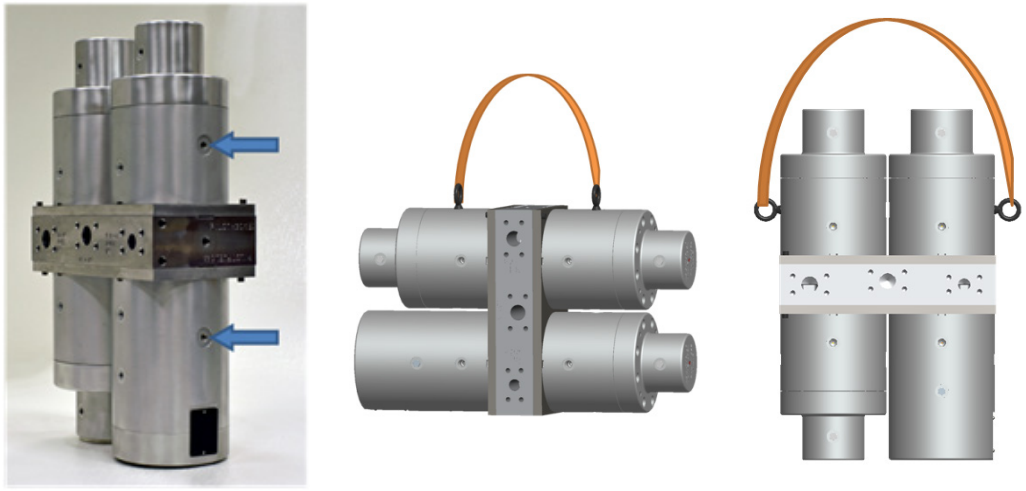


Figure 3-1. Lifting Eye Locations and Recommended Lifting Configurations

Fluid Connections and Mounting

⚠WARNING

Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the LXM Valve.

⚠WARNING

The surface temperature of this valve approaches the maximum temperature of the applied process media. It is the responsibility of the user to ensure that the external environment contains no hazardous gases capable of ignition in the range of the process media temperatures.

⚠WARNING

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

⚠WARNING

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

The Main Fuel, Pilot Fuel and Water inlets, as well as the Main and Pilot discharges are all SAE J518 code 61 four bolt -flange connections (Figure 2-1, LXM Outline Drawing). If expected fluid or ambient temperatures are in excess of 177 °C (350 °F), high temperature and explosive decompression resistant O-rings must be used in the connecting flanges. These O-rings are available as a kit, listed in Chapter 4. Inlet lines to the valve must be hard pipe of appropriate strength and wall thickness to support the valve.

Installation attitude does not affect actuator or valve performance. However, to promote the most effective flushing of the valve internals, it is recommended that the inlet face be mounted in a vertical arrangement perpendicular to the turbine axis.

The LXM can be supported by its three inlet flange connections. Three 3/8-16 holes are also included on the pilot side of the manifold as provisions for additional support. These holes are intended for connection to an angle support bracket to connect to the turbine manifold.

NOTICE

Fluid supply lines should be thoroughly flushed prior to LXM installation. Fluid filters are recommended upstream of the LXM supply lines.

⚠WARNING

Valve process fluids are irritants. Route vent lines away from operators and hazardous areas. Ensure that personal protective equipment and proper area ventilation are used.

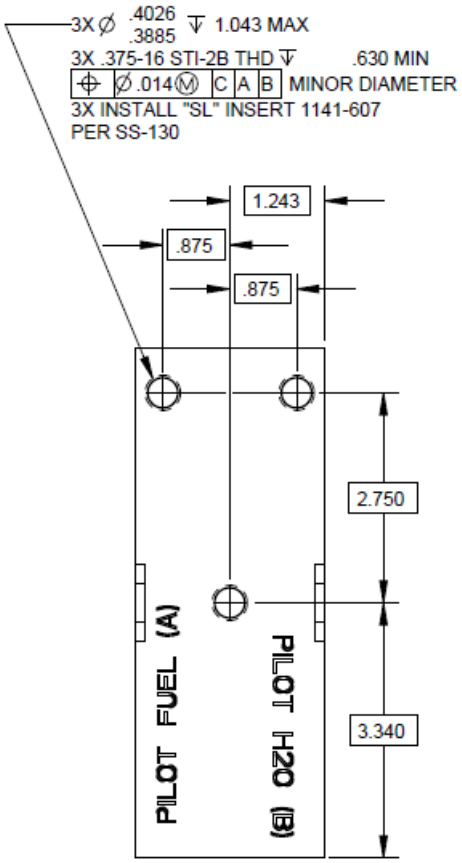


Figure 3-2. Support Bracket Provisions on Manifold
(Dimensions Shown in Inches)

Once the LXM is installed in its final orientation, overboard drain lines should be connected to the two lowest ports of each LXM to allow for effective fluid removal from the valve. The remaining two upper overboard ports must be closed with stainless steel straight thread plugs.

Actuation air supply lines must be connected to each individual actuator. It is imperative for accurate valve function that the normally open line is properly installed.

Recommend not connecting to the actuator piston vents during normal operation.

NOTICE

Removal of the piston vents could allow ingress and cause damage to actuator internals. Plugging of the piston vents traps pressure and may result in failure to actuate.

Allowable Flange Loads

Allowable flange loads are provided for each LXM port size (3/4”, 1”, 1½”). For each size, the allowable loads were resolved about the axes of a local coordinate system defined at each flange (Figure 2-1).The loads are considered as the combination of a tensile force along the specified axis and a moment about the same axis.

Coordinate axes are defined as follows. This local coordinate system can be utilized to determine if predicted flange loads are acceptable for use with the LXM.

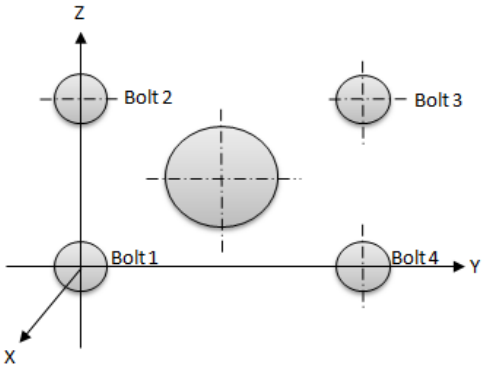


Figure 3-3. Local Coordinate System for Flange Load Calculations

It is the responsibility of the customer to ensure that the predicted and actual flange loads are within the specified limits.

For flange loads to be acceptable, the force and the moment when plotted must lie beneath the limiting force-moment line. This must be true for each axis of the flange.

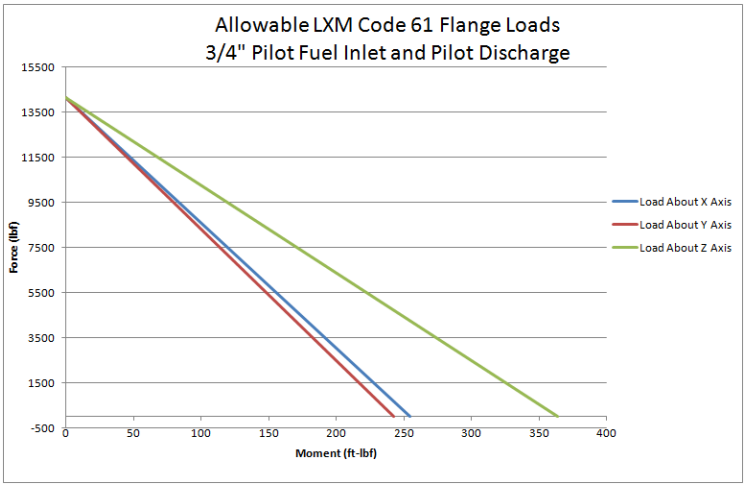


Figure 3-4. 3/4" Flange, Allowable Loads

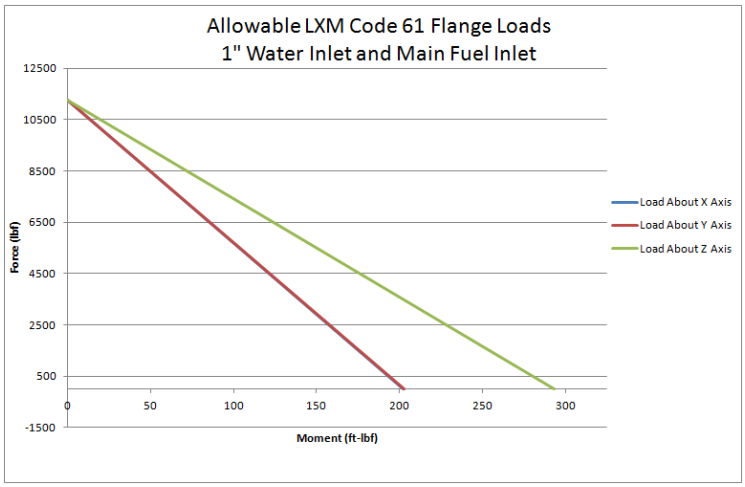


Figure 3-5. 1" Flange, Allowable Loads

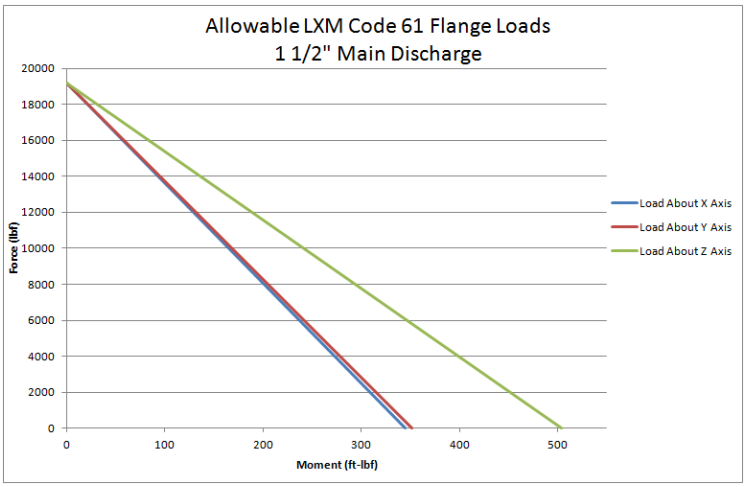


Figure 3-6. 11/2" Flange, Allowable Loads

$$L \geq F_{Axial} + A * M_{Bending}$$

Where:

F_{Axial} = Maximum axial force applied by piping (lbf)

$M_{Bending}$ = Maximum bending moment applied by piping (ft-lbf)

L & A = Constants according to Table 2 (Constants for flange load equation)

Table 3-1. Constants for Flange Load Equation

Flange Size	3/4"	1"	1 ½"
L	14160	11248	19200
A (x-axis)	55.65	55.65	55.65
A (y-axis)	58.48	55.5	54.59
A (z-axis)	38.91	38.34	38.15

It is the user's responsibility to determine the appropriately sized flange and to supply the flange connections. If the calculated flange loads exceed the limits described in this section, contact Woodward about possible redesign with larger flange connections.

Storage

To protect the valve from potential damage caused by freezing or corrosion, recommended storage procedures must be followed.

Prior to packing the valve for long term storage, the LXM should be drained of all fluids. It is recommended to purge the valve with pressurized air or nitrogen to aid in fluid removal.

Close off all external openings with appropriate plugs or caps to prevent contamination by solvents, cleaning agents, moisture, or other elements.

NOTICE

Fluid supply lines should be thoroughly flushed prior to LXM storage to prevent internal freezing damage.

⚠WARNING

When storing LXM in crates, do not stack crates more than two high to prevent tipping hazard that could result in death or serious injury.

Chapter 4.
Maintenance and Hardware Replacement

Inspections and Maintenance

⚠WARNING

Maintenance and replacement procedures detailed in this section will compromise the device's pressure containment if not followed with due care and attention. Operating the valve in this condition could result in a sudden release of pressure that could cause injury or death.

⚠WARNING

Disconnect all pressure from actuators and valve fluid connections before disassembly. Failure to do so could result in death or serious injury.

⚠WARNING

External fire protection is not provided in the scope of this product. It is the responsibility of the user to satisfy any applicable requirements for their system.

⚠WARNING

Due to typical noise levels in engine and turbine environments, hearing protection should be worn when working on or around the LXM.

⚠WARNING

The surface of this product can become hot enough or cold enough to be a hazard. Use protective gear for product handling in these circumstances. Temperature ratings are included in the specification section of this manual.

Woodward recommends the following maintenance and inspection schedule for the LXM.

Routine Inspections

1. Verify position of the valve by inspection of the position of the visual indicators. Ensure that they are in the proper position based on the commanded actuator state. Ensure that all the valves are open if the control state is open and closed if the control state is closed. Indicators will extend approximately 6 mm (¼ inch) from the end of each actuator when open, and will be flush with the top of the actuator when the actuator is in the closed (seated) position.
2. Routinely remotely monitor the ambient temperature within the enclosure during operation. Ensure that the ambient temperature does not exceed
   the design ambient temperature limits given in the specifications section.

Annual Inspections

1. Piston Seal Inspection: Pressurize the actuation supply ports of each actuator to 6.9 bar (100 psig) air. Remove the external breather and check for excessive piston seal leakage. Leakage should be less than 455.5 cm^3/min, as stated in the specifications section. Reinstall the external breather to protect valve internals from environmental contaminants.

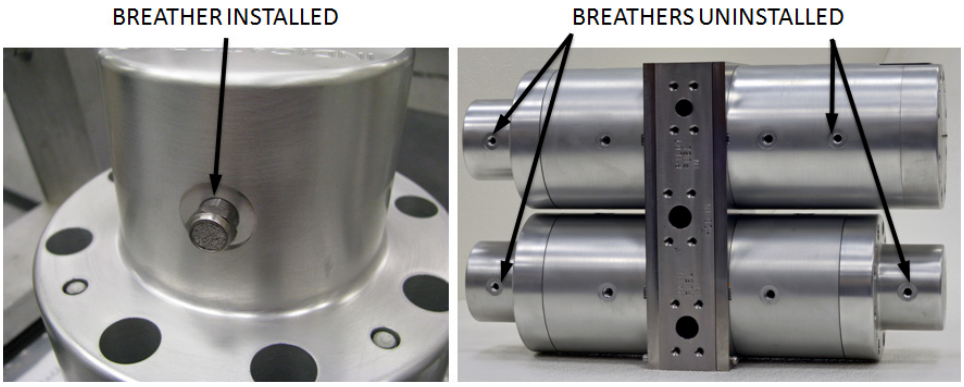


Figure 4-1. External Breather Locations

2. Pressurize the process fluid inlets to 6.9 bar (100 psig) with air or liquid and perform the following inspections:
   - Inspect all interfaces for external leakage.
   - Monitor the leakage from the two lowest overboard drain ports. Leakage should be less than 1.84 cm^3/min when tested with liquid or 345 cm^3/min when tested with gas.

Overhaul / Replace Valve

- If leakage from the overboard drain port or the piston seals exceed the limits stated above, the actuator assembly should be removed and returned to Woodward for overhaul.
- If an actuator becomes non-functional, or if replacement of the poppets or seats is required, field repair can be performed as described in the following section. See Table 4-2 for replacement kit part numbers.
  - Although signs and degrees of poppet wear may vary by site, Figure 4-2 can be used as a guideline for poppet inspection. Additionally, it is recommended to replace the poppets during periods of planned outages for maintenance or major inspections, no less than every three years.

- If there is external leakage between the manifold plates, contact Woodward to arrange for field repair by Woodward authorized Field Service Personnel.
- Woodward recommends removing valves from service and returning for factory overhaul every 48,000 hours of operation or at the major turbine overhaul closest to 48,000 hours, whichever comes first.

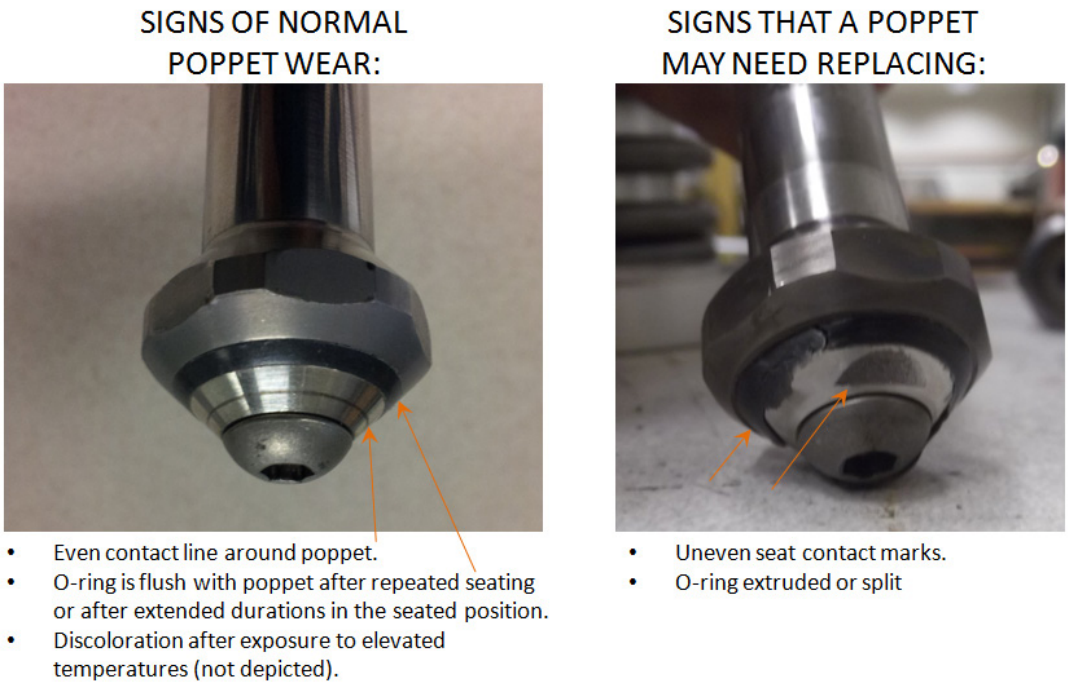


Figure 4-2. Poppet Inspection Guidelines

Hardware Replacement

Section 1: Actuator Replacement

Four actuators are mounted on a common manifold. Individual actuators may be removed from the manifold as complete subassemblies. Replacement kits are available for purchase (Table 4-2).

The following procedures are described in this section:
1. Removal of actuator from manifold
2. Replacement of actuator

Removal of Actuator from Manifold Procedure:

IMPORTANT

Verify that the proper tools are available before removing an actuator from the manifold. Removal of the fail open actuator requires a 5/16" hex driver at least 8" long. A custom hex adapter is available from Woodward (Part Number 8996-2269). The fail close actuator requires a 5/16" hex driver at least 6" long.

⚠WARNING

Verify that the manifold plate is held to the manifold with two ¼ -20 x1" SHCS (socket head cap screws). These are intended to keep the manifold plate and block securely fastened during disassembly. Use caution to avoid a dropping hazard.

⚠CAUTION

Actuators contain a return spring that could cause injury if disassembled incorrectly. Do not disassemble components except as instructed within these maintenance instructions.

1. From the actuator to be removed, remove the eight 0.375-16 x 2½" socket head cap screws.

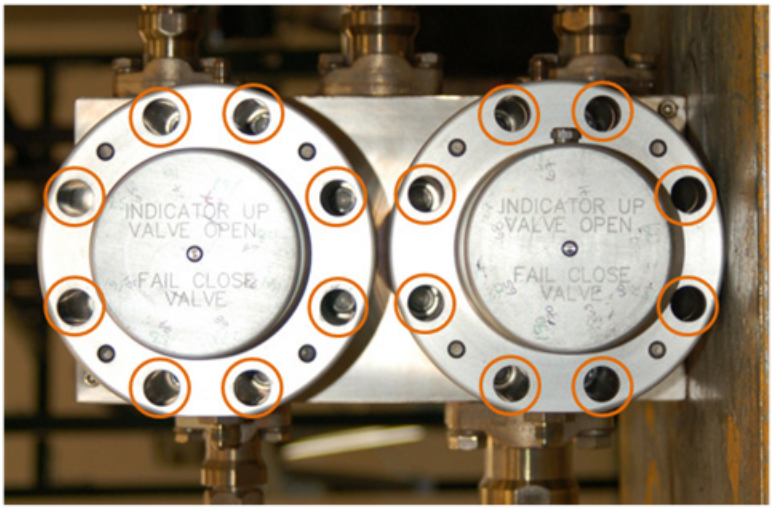


Figure 4-3. Top View of Actuator

⚠WARNING

Each actuator weighs between 11 kg and 14 kg (25 lb and 30 lb). Use caution when removing actuators to avoid a dropping hazard. Ensure that proper safety equipment and measures are utilized.
Prior to removing the final fastener, prepare for the actuator to be released from its position.

2. Remove the actuator by pulling straight away from manifold and alignment dowel pins. If the actuator does not easily pull away from the manifold, first verify that all eight screws are completely disengaged from the manifold, then use the pry grabs on the bottom of the actuator to aid in removal.
3. Verify that all O-rings and backup ring are removed from the interface between the actuator and the manifold.
4. Clean and inspect all the O-ring grooves on the top surface of the manifold. The grooves should be in good condition, absent of any significant corrosion or adhered material. If cleaning is necessary, only a medium grit abrasive cloth such as Bear-Tex 747 or 3M 7447 should be used.

Actuator Removal Procedure:
The LXM actuator assembly is not recommended for field repair. To replace the actuator assembly, purchase the appropriate replacement kit as listed in Table
4-2.

When removing a fail open actuator, use Woodward tool (part number 8996-2269) or similar. Standard tools required include a torque wrench with 20 N•m (177 lb-in) capability.

1. Remove the actuator from manifold in accordance with the procedure in this section.
2. Inspect the actuator and valve assembly. The valve poppet can be replaced if worn or damaged.
3. If the actuator does not function or leaks either process fluid or actuator air to the overboard drain port or vent breather order a replacement actuator kit from Woodward and replace the entire actuator.

Actuator Replacement Procedure:

1. Select the overboard port O-ring (smallest O-ring) and install into the Overboard Port O-ring counterbore in the manifold plate as shown in Figure 4-4.

NOTICE

No O-ring lubricants (i.e., Vaseline, O-Lube, etc.) should ever be used when replacing LXM O-rings. These lubricants will solidify into coke-like products at high temperatures, which could damage the combustion nozzles if flushed through the valve. LXM O-ring grooves have been designed to function without lubrication.

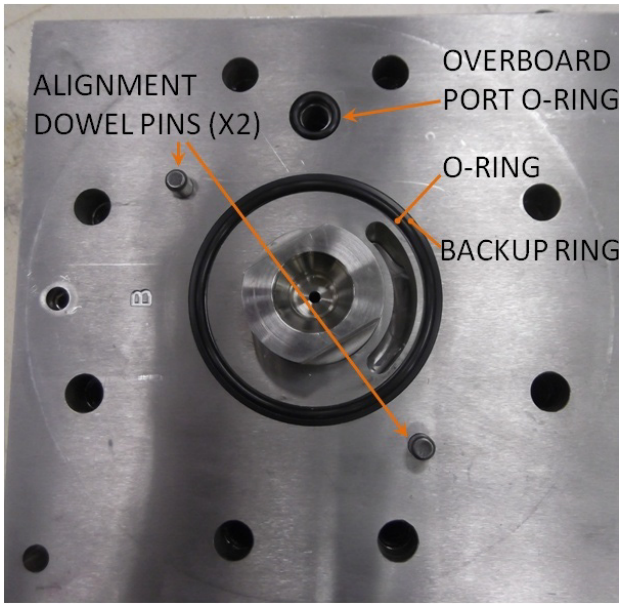


Figure 4-4. Identification of Components at Actuator-to-Manifold Interface

2. Select the backup ring from the actuator kit and install into the ring on the manifold plate concentric to the seat. LXM backup rings have a triangular cross section; they must be installed with the laser marked side (wider side) outboard and the thinner side directed toward the manifold as shown in Figure 4-5.

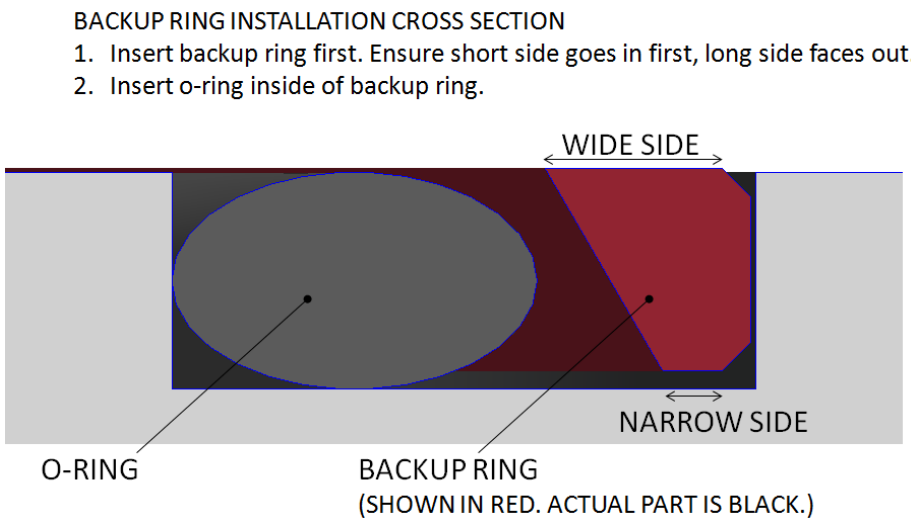


Figure 4-5. Proper Installation Orientation of Backup Ring

NOTICE

To ensure proper sealing at all temperature and pressure conditions listed in the specifications, the backup ring must be installed in the proper orientation. The proper orientation is shown in Figure 4-3.

3. With the backup ring installed, select the remaining O-ring from the kit and install into the manifold plate (Figure 4-4). The O-ring will fit within the inner diameter of the backup ring as shown in Figure 4-5. When properly installed, the O-ring should sit in the groove with the back-up ring on its exterior as shown in Figure 4-6.

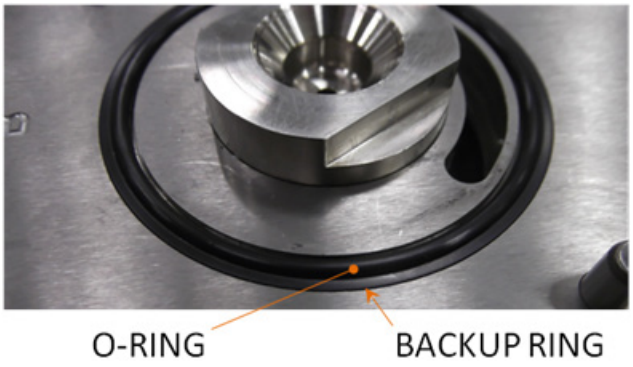


Figure 4-6. Identification O-ring and Backup Ring at Actuator-to-Manifold Interface

Actuator replacement kits include eighteen washers and nine bolts. Eight are required for the replacement actuator and one set is included as a spare.

4. Install two washers over each 0.375-16 socket head cap screw and lubricate the threads with Bostik Never-Seez® Regular Grade, Molykote® P-37 Antiseize paste or similar.
5. Place the actuator on the manifold by aligning the holes on the bottom of the actuator with the alignment dowel pins in the manifold plate (Figure 4-4).
6. Loosely install all the bolts 5-8 turn deep until all are installed. Tighten all the bolts in a crossing pattern to approximately 5 N•m (44.2 lb-in). Increase the torque setting and retighten to approximately 10 N•m (88 lb-in).
7. Torque each bolt to its finished torque of (17.6 to 19.3) N•m [(156 to 171) lb-in]. The final torque must be in a crossing pattern as shown in Figure 4-7.

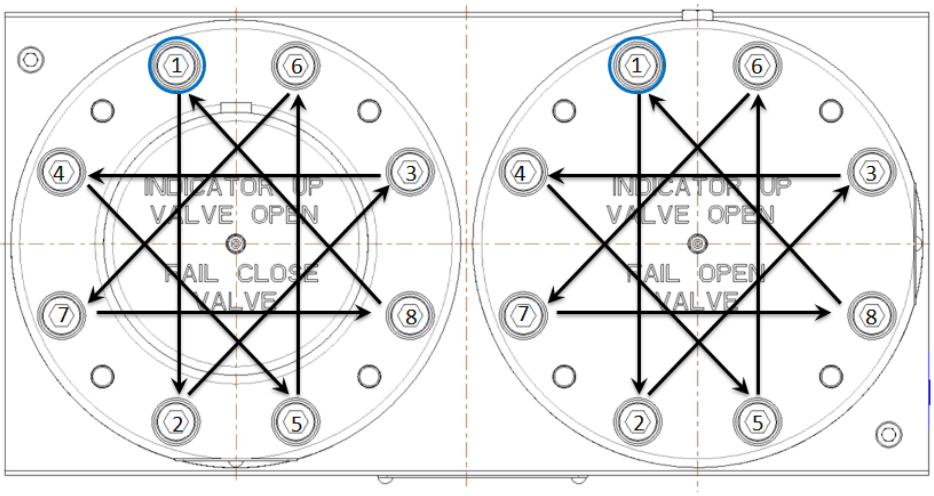


Figure 4-7. Torque Crossing Pattern Diagram

8. Check for external leakage upon pressurizing the system.

Section 2: Poppet & Seat Replacement

A replacement kit for poppet and seat replacement is available as shown in Table 4-2. This replacement option is appropriate if the actuators are functional and only the main poppets or seats require service.

The following procedures are described in this section:
1. Replacement of seats (manifold)
2. Replacement of poppets (actuator)

Seat Replacement Procedure:
This procedure requires tools for removing actuators plus the poppet and seat replacement kit (Table 4-2). Installation of the seats requires a 1 1/8" crows foot to torque the seat. Standard tools required are a torque wrench with 50 N•m (442 lb-in) capability.

1. Remove actuator from manifold according to the procedure in Section 1.
2. Remove and set aside visible O-rings and backup rings.
3. Remove one seat with socket.
4. Replace O-ring underneath seat with O-ring provided in replacement kit.

NOTICE

No O-ring lubricants (i.e. Vaseline, O-Lube, etc.) should ever be used when replacing LXM O-rings. These can solidify into coke-like products at high temperatures, which could damage the combustion nozzles if released from the valve. LXM O-ring grooves have been designed to retain O-rings without lubrication.

5. Select the corresponding new seat by matching the engraved letters on the wrench flats of the seat (Figure 4-8).

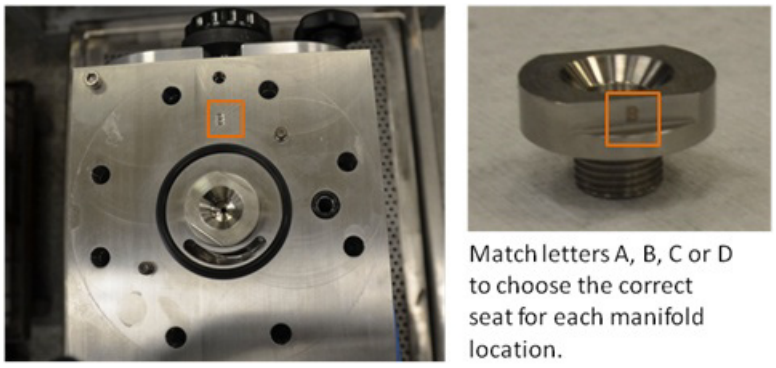


Figure 4-8. Match Engraved Letters on Manifold Plates and Seats

6. Screw new seat into manifold and torque to (40.7 to 47.5) N•m [(30 to 35) lb-ft].
7. Reinstall the actuator starting at step 2 of the "Replacement of Actuator" procedure in Section 1.
8. Repeat Steps three through seven for the remaining three seats.
9. Check for external leakage upon pressurizing the system.

Poppet Replacement Procedure:
Procedure requires tools for removing actuators plus the poppet and seat replacement kit (Table 4-2). Standard tools required are a 15/16” wrench and a 5/32” hex key/Allen wrench.

1. Remove actuator from manifold according to the “Actuator Removal” procedure in Section 1 of this chapter. Place actuator on its side on a clean, level workspace.
2. To remove the poppet from the actuator, place a 15/16” wrench on the hex head of the actuator shaft to prevent rotation. Use the 5/32” hex key to unscrew the button head poppet retaining screw (Figure 4-9).

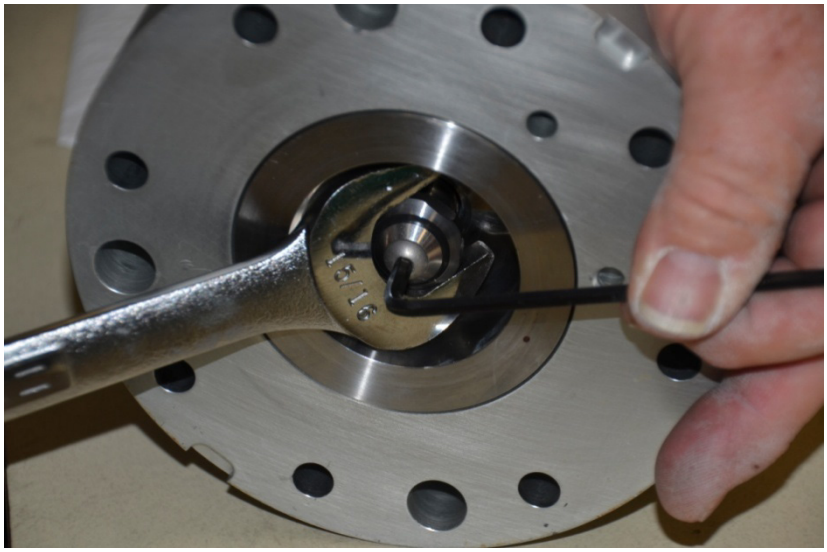


Figure 4-9. Hold Actuator Shaft with Wrench when Tightening or Loosening the Retaining Screw

3. Install a replacement poppet into the shaft counterbore. Ensure that the replacement poppet is completely seating inside the counterbore and does not rock or tip while tightening the retaining screw.
4. Hold the actuator shaft with the 15/16” wrench when tightening the poppet retaining screw (Figure 4-9). Use the 5/32 Allen hex key, torque the retaining screw to (8.6 to 9.9) N•m [(76 to 88) lb-in].
5. Check for seat leakage by applying air or liquid to the process fluid ports as described in the Annual Inspections section of this manual.

Spare and Replacement Parts

Spare and replacement parts are available from Woodward. To purchase any of the following parts or kits, please contact Woodward, and reference the part number provided.

To access the main actuator bolts, a long hex driver is necessary to reach inside the deep counterbores. Typically, an “extra-long” 6” hex driver socket will access the fail close actuator bolts however, the fail open design requires at least an 8” driver. Custom hex driver sockets are available for purchase through Woodward.

Table 4-1. LXM Tool List

Tool Name	Tool Purpose	Woodward Part Number
12” Long, 5/16” Hex Driver Socket (3/8” Square Drive)	Tool required to remove and install fail open actuator	8996-2269

Table 4-2. Spare and Replacement Parts

Kit Name	Kit Components	Woodward Part Number[1]	
Liquid Mixing Manifold Assembly	1 Complete LXM assembly	8915-1224	8915-1292
Fail Close Actuator Kit	1 Fail close actuator 1 Face seal O-ring 1 Face seal backup ring 1 Overboard port O-ring 9 Bolts & washers (includes 1 spare)	8935-1068	8935-1293
Fail Open Actuator Kit	1 Fail open actuator 1 Face seal O-ring 1 Face seal backup ring 1 Overboard port O-ring 9 Bolts & washers (includes 1 spare)	8935-1067	--
Poppet & Seat Replacement Kit	1 Pilot Fuel (A) Seal 1 Pilot Water (B) Seat 1 Main Water (C) Seat 1 Main Fuel (D) Seat 4 O-rings for under-seat seals 4 Poppets with seals 4 Poppet screws	8935-1066	8935-1294
O-ring Kit for SAE Flange Connections	1 O-ring for 1 ½" SAE J518 flange 2 O-rings for ¾" SAE J518 flange 2 O-rings for 1" SAE J518 flange	8935-1056	8935-1056

[1.] Contact Woodward to procure kits. Kit part numbers may vary depending on the Liquid Mixing Manifold Assembly part number for which the kit is being purchased.

Chapter 5. Troubleshooting

General

The following troubleshooting guide assist in troubleshooting the Liquid Mixing Valve, its connections, and system problems. Troubleshooting beyond this level is recommended ONLY when performed at a Woodward facility or by Woodward Field Service Personnel.

Troubleshooting Procedure

This table is a general guide for isolating system problems. Make sure that the input/output connections, controls, and contacts are correct and in good working order. Complete the checks in order. Each check assumes that the preceding checks have been completed, and any problems have been corrected.

⚠WARNING

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

Table 5-1. Troubleshooting Table

Symptom	Actuator	Possible Cause	Remedy
Valve will not open	Normally Closed Actuator	Actuation supply connected incorrectly.	Correct supply connection.
		Actuation supply pressure inadequate.	Actuation supply pressure must be greater than 6 bar (90 psig).
		Air supply is excessively contaminated, actuator piston seal degraded or wear ring is binding.	Check air supply for contamination. Increase actuator supply pressure to 7.6 bar (110 psig), note whether or not the actuator opens. Contact Woodward for replacement actuator.
		Actuator piston seal worn.	Replace actuator (See Replacement Kits in Table 4-2).
	Normally Open Actuator	Actuation supply port pressurized.	Verify there is no pressure on actuation supply.
		Actuator spring broken.	Replace actuator (See Replacement Kits in Table 4-2).

Symptom	Actuator	Possible Cause	Remedy
Valve will not close	Normally Closed Actuator	Actuation supply port pressurized.	Eliminate source of pressure on actuation supply.
		Visual indicator not coupled properly.	Push visual indicator end. Do not exceed 40 N (9 lb) of force. If no change, proceed to following actions.
		Actuator spring broken.	Replace actuator (See Replacement Kits in Table 4-2).
		Seat seal blocked.	Verify fluid supply contamination levels are within specifications of Table 2-1. Contact Woodward to return and replace actuator.
	Normally Open Actuator	Actuation supply insufficient or connected incorrectly.	Correct supply connection.
		Air supply is excessively contaminated, actuator piston seal degraded or wear ring is binding.	Check air supply for contamination. Increase actuator supply pressure to 7.6 bar (110 psig), note whether or not the actuator opens. Contact Woodward for replacement actuator.
		Visual indicator not coupled properly.	Push visual indicator end with 40 N (9 lb) of force. If no change, proceed to following actions
		Piston seal worn.	Replace actuator (See Replacement Kits in Table 4-2).
		Seat seal blocked.	Replace poppet & seat seals (See Replacement Kits in Table 4-2).

Chapter 6.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.

A current list of Woodward Business Partners is available at:
https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward North American Terms and Conditions of Sale 5-09-0690) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward North American Terms and Conditions of Sale 5-09-0690). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:
- Protective caps on any connectors
- Antistatic protective bags on all electronic modules
- Packing materials that will not damage the surface of the unit
- At least 100 mm (4 inches) of tightly packed, industry-approved packing material
- A packing carton with double walls
- A strong tape around the outside of the carton for increased strength

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:
- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.
- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will ensure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. Field engineers are experienced with Woodward products and much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at: **https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner**

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **https://www.woodward.com/support**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can receive information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 8818 5515
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+ 82 (51) 636-7080
Poland	+48 (12) 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Turbine Model Number _____

Type of Fuel (gas, steam, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Revision History

Changes in Revision H—
- Updated EU DoC

Changes in Revision G—
- Removed CE line in Pressure Equipment Directive
- Updated DoC

Changes in Revision F—
- Revised PED and ATEX Directives in Regulatory Compliance Section
- Replaced Declarations

Changes in Revision E—
- Updated O-ring Kit Components in Table 4-2

Changes in Revision D—
- Updated Flow Specifications in Table 2-1
- Replaced Drawings in Figures 2-1c and 2-1d
- Added additional part numbers to Table 4-2

Changes in Revision C—
- Updated PED and ATEX certifications in Compliance section
- Replaced Declarations

Changes in Revision B—
- On page 8, in Table 2-1, under Maximum Service Conditions, changed “Gas Operation” to “Gas Purge Operation”

Declarations

EU DECLARATION OF CONFORMITY

EU DoC No.:	00454-04-EU-02-02
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Contact Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Name(s)/Number(s):	LXM – Liquid Mixing Manifold
The object of the declaration described above is in conformity with the following relevant Union harmonization legislation:	Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment PED Category II
Applicable Standards:	ASME B31.1 Pressure Piping, 2007 ASME Boiler and Pressure Vessel Code VIII, Div. 2, 2007 ASME Boiler and Pressure Vessel Code II, Part D, 2007
Conformity Assessment:	PED Module H – Full Quality Assurance CE-0062-PED-H-WDI 001-22-USA Bureau Veritas SAS (0062) Tour ALTO, 4 Place des Saisons, 92400 COURBEVOIE, FRANCE

This declaration of conformity is issued under the sole responsibility of the manufacturer
We, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s).

MANUFACTURER

Annette Lynch
Signature

Annette Lynch
Full Name

Engineering Manager
Position

Woodward, Fort Collins, CO, USA
Place

25 August 2023
Date

5-09-1183 Rev 39

DECLARATION OF INCORPORATION
Of Partly Completed Machinery
2006/42/EC

File name: 00454-04-EU-02-01
Manufacturer's Name: WOODWARD INC.

Contact Address: 1041 Woodward Way
Fort Collins, CO 80524 USA

Model Names: LXM – Liquid Mixing Manifold

This product complies, where applicable, with the following Essential Requirements of Annex I: 1.1, 1.3, 1.5, 1.6, 1.7

The relevant technical documentation is compiled in accordance with part B of Annex VII. Woodward shall transmit relevant information if required by a reasoned request by the national authorities. The method of transmittal shall be agreed upon by the applicable parties.

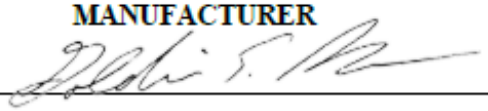
The person authorized to compile the technical documentation:

Name: Dominik Kania, Managing Director
Address: Woodward Poland Sp. z o.o., ul. Skarbowa 32, 32-005 Niepolomice, Poland

This product must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of this Directive, where appropriate.

The undersigned hereby declares, on behalf of Woodward Inc. of Loveland and Fort Collins, Colorado that the above referenced product is in conformity with Directive 2006/42/EC as partly completed machinery:

MANUFACTURER



Signature

Dino Alves
Full Name

Director of Engineering
Position

Woodward Inc., Fort Collins, CO, USA
Place

07/06/2021
Date

Document: 5-09-1182 (rev. 16)

Released

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 26737.

B 2 6 7 3 7 : H

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1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

Woodward has company-owned plants, subsidiaries, and branches, as well as authorized distributors and other authorized service and sales facilities throughout the world.

Complete address / phone / fax / email information for all locations is available on our website.