WOODWARD

Product Manual 26504
(Revision F, 7/2021)
Original Instructions

Variable Bleed Valve (VBV)
for GE LMS100

Instruction Manual

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. To verify that you have the latest revision, check manual *26311*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

www.woodward.com/publications

The latest version of most publications is available on the *publications page*. 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. Be sure to check manual *26311*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions—Changes in this publication since the last revision are indicated by a black line alongside the text.

Manual 26504

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Warnings and Notices

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.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

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*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Regulatory Compliance

European Compliance for CE Marking:
This listing is limited only to those units bearing the CE Marking

Pressure Equipment Directive DeZurik valve: Certified to Pressure Equipment Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment, Category III Bureau Veritas UK. LTD, Certificate CE-0041-PED-H-SVI-001-09-USAModule H.

Pressure Equipment Directive Parker Accumulator: Certified to Pressure Equipment Directive 97/23/EC of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment, Category IV Bureau Veritas Inspection Limited Certificate CD-0041-PED-H1-PAR 01-07-USA, Module H1.

Other European and International Compliance:
Compliance with the following European Directive 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.

North American Compliance:
This listing is limited only to those units bearing the CSA Marking.

CSA: CSA Certified for Class I, Div. 2, Groups B, C & D, T2 at 49°C Ambient
For use in Canada and the United States
Certificate 70099049

Special Conditions for Safe Use:
Refer to the manufacturer's installation and application manuals for safe installation practices for the valve and accumulators in addition to instructions provided in this manual.

For valves with magnetic angle sensor, wiring must be in accordance with North American Class I, Division 2, or European or other international Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.
For valves without magnetic angle sensor, wiring must be in accordance with intrinsically safe ia wiring methods as applicable, and in accordance with the authority having jurisdiction.
Field wiring must be suitable for at least 59°C.

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

⚠WARNING

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

⚠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

Do not connect/disconnect/substitute components
WARNING - Explosion Hazard—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

Substitution of components may impair suitability for Class I, Division 2 or Zone 2 applications.

Field Wiring must be suitable for at least 59 Degrees C

AVERTISSEMENT - Risque d'explosion— Ne pas enlever les couvercles, ni raccorder / débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous situez bien dans une zone non explosive.

La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, applications Division 2 ou Zone 2.

⚠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.

NOTICE

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.

Chapter 1.
General Information

Introduction

The Woodward Variable Bleed Valve (VBV) controls the pressure from the low-pressure compressor on the GE LMS100 gas turbine. It is a modulating valve and actuator assembly that bleeds off excess air to the atmosphere as necessary to prevent turbine surge. Each turbine is equipped with two VBVs.

Optimum control of the gas turbine requires that each actuator and valve accurately and quickly track the demand signals transmitted by the control. The valve is a 36 inch (914 mm) single-offset high-performance butterfly type with a soft seat. To prevent surge, the actuator is capable of moving the valve from full closed to 95% open in less than 0.200 second and can do this under servo valve control conditions or emergency trip conditions. The actuator is fully self-contained, including integral dual-redundant hydraulic accumulators and hydraulic supply pressure reducing valves. The redundant accumulators work in conjunction with hydraulic supply pressure sensing valves to trip the VBV to the failsafe open position in the event of loss of hydraulic supply pressure. Other components include an on-board hydraulic filter, supply relief valve, triple-coil servo valve, electric emergency trip solenoid valve, and dual acting hydraulic cylinder with custom profiled hydraulic end-of-stroke cushions. The VBV has been designed to provide output forces that exceed the opening and closing requirements with some margin. The additional margin helps ensure that the system moves rapidly even under service conditions where the valve has been contaminated or worn.

The valve actuation lever is keyed and clamped to the valve shaft, preventing any relative motion, fretting or galling to the valve shaft. Live loading of the valve shaft packing seals precludes the need for packing adjustments during the normal life of the valve. The long actuation rod between the hydraulic cylinder and the valve actuation lever reduces side loads on the actuator, increasing the life of its seals and bearings. Redundant actuator seals and bearings ensure long, trouble-free life.

LMS100 LP Compressor Variable Bleed Valve—Functional Characteristics

Parameter or Feature	Characteristic
Number of Valves/Turbine	2 per turbine
Application	LMS100 Low Pressure Compressor Variable Bleed Valve
Ingress Protection Rating	IP 54
Ambient Temperature Range	–4 to +120 °F (–20 to +49 °C)
Valve/Actuator Trip Time (fully closed to 95% open)	Less than 0.200 seconds
Valve/Actuator Slew Time from receipt of signal (fully closed to 95% open)	Less than 0.200 seconds
Valve Type	DeZurik HP Butterfly valve, Class 150 wafer, CF8M material
Minimum Design Pressure Rating	75 psig (5.2 bar)
Modulating Valve Inlet Pressure	53 psia (3.65 bar) maximum
Valve Inlet Temperature Range	–20 to +450 °F (–7 to +232 °C)
Allowable Valve Air Leakage (in closed position)	Class IV, PTFE Soft Seal (Valve is Class VI)
Nominal Diameter	36 inches (914 mm)
Actuator	Electro-hydraulic with N-spring Failsafe
Actuation Type	Hydraulic, Dual Acting, 6 inch (152 mm) stroke
Valve Travel Stops	Actuator piston travel serves as stop for open and closed positions. External stops on transfer case for backup.
Hydraulic Supply Pressure	2500–3600 psig (172–248 bar)
Actuator/Accumulator Operating Pressure	2200 ±25 psig (152 ±1.72 bar) nominal
Hydraulic Fluid Temperature Range	30 to 150 °F (–1 to +66 °C)
Accumulator Precharge Pressure	1500 ±25 psig (103 ±1.72 bar)
Accumulator Volume	2.5 US gallons (9.5 liters)
Hydraulic Return Pressure	30 psig (2.1 bar) max.
Hydraulic Trip Solenoid	24 Vdc
Actuator Accessories	Last chance filtration with visual ΔP switch Hydraulic Cushion at fully open position Hydraulic Cushion at fully closed position N-Spring accumulators to support fail open function with integral supply check valve. Accumulator capacity to dual redundantly supply two full strokes of the actuator 2x pressure reducing valves and 1x pressure relief valve on hydraulic supply 2x dual element (dual RTD) temperature transmitters in manifold 1x pressure transmitter, downstream of filter and inlet check valve 1x pressure monitor port, upstream of filter
Hydraulic Cleanliness Level	ISO DIS 4406 code 16/13
Failsafe Trip to Open	Upon loss of hydraulic supply or removal of trip solenoid voltage
Servo Valve	Triple-coil, 60 US gal/min (227 L/min) rated
Torque Motor Null Current	+5 mA
Torque Motor Rated Current Range	Null current ±48 mA shared across three coils
Loss of Input Current Result	Valve opens
Position Feedback	Triple 6 inch (152 mm) range LVDTs on actuator (±1% FS accuracy) and redundant output rotary 4–20 mA (105° range) on valve shaft (not available on CE marked units)

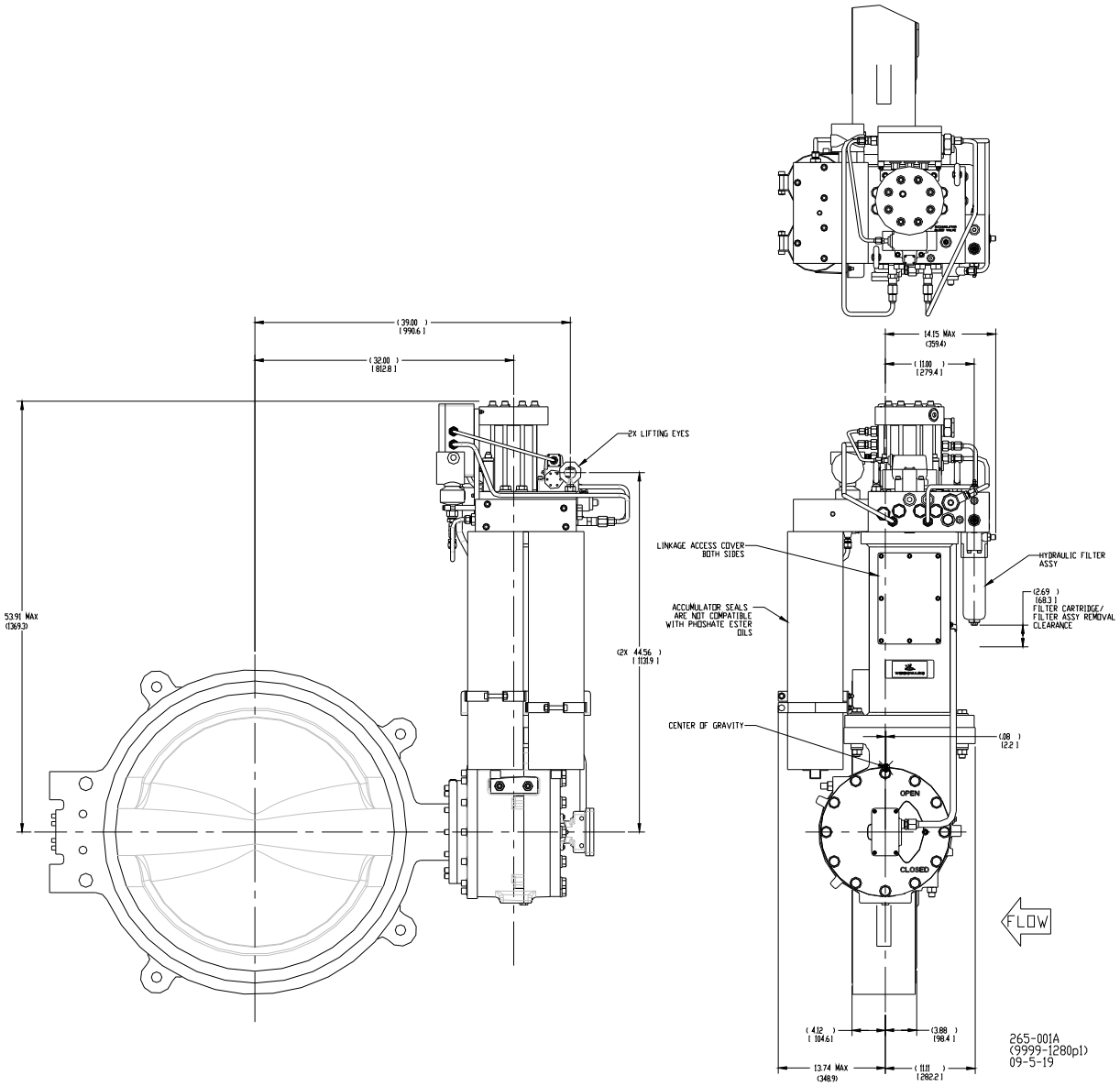


Figure 1-1a. VBV 1 Outline Drawing (furthest from turbine)

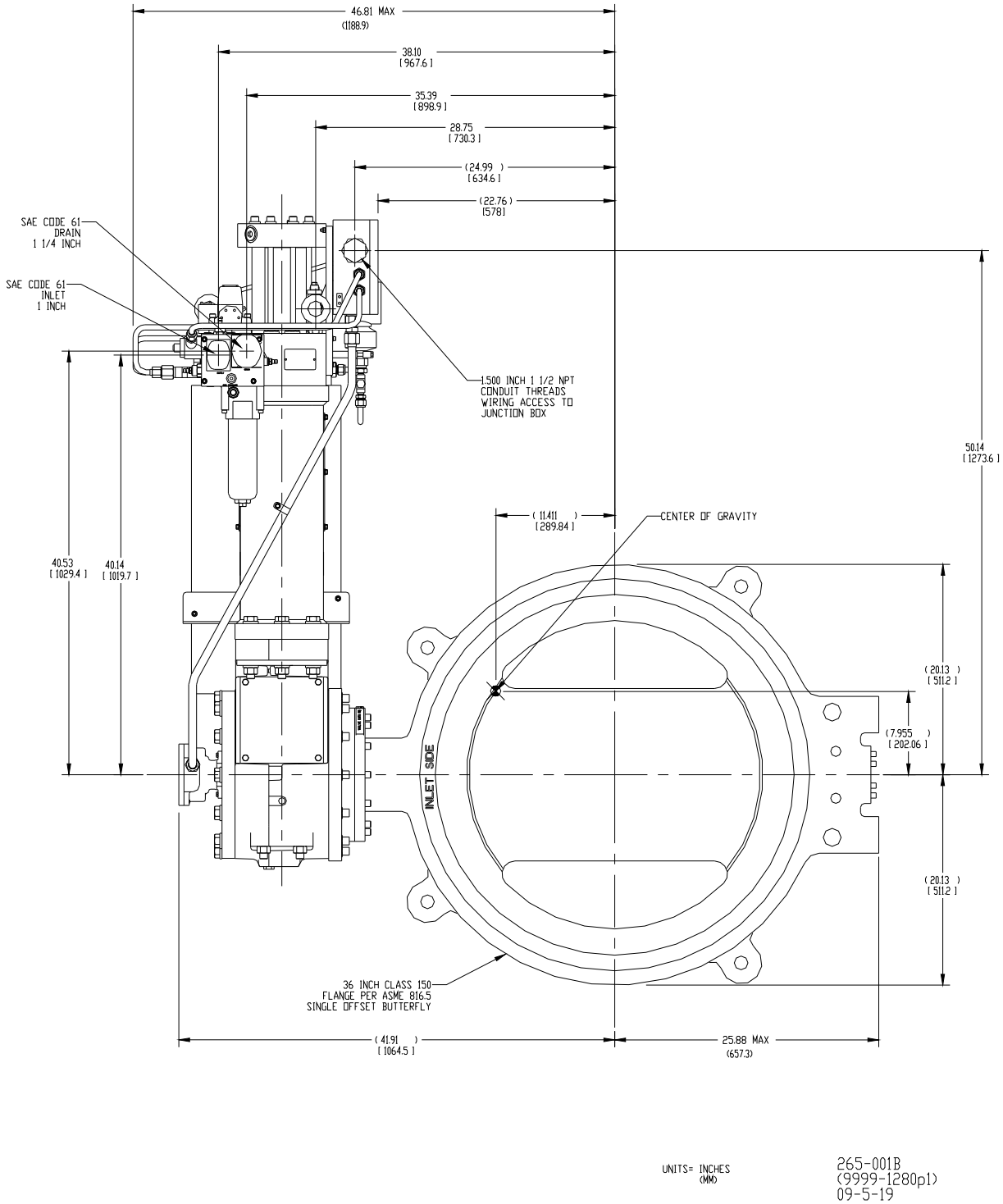


Figure 1-1b. VBV 1 Outline Drawing (furthest from turbine)

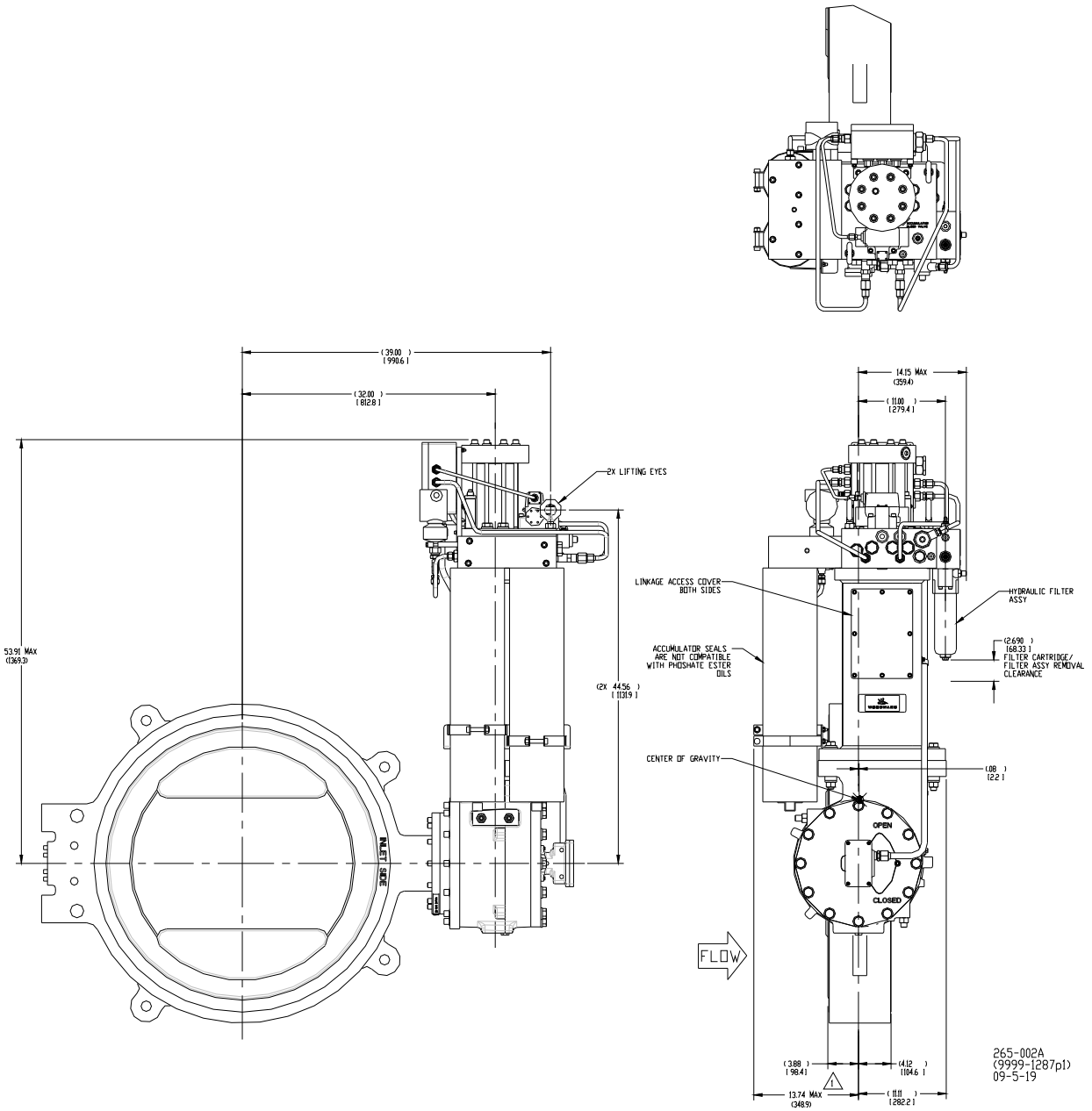


Figure 1-2a. VBV 2 Outline Drawing (closest to turbine)

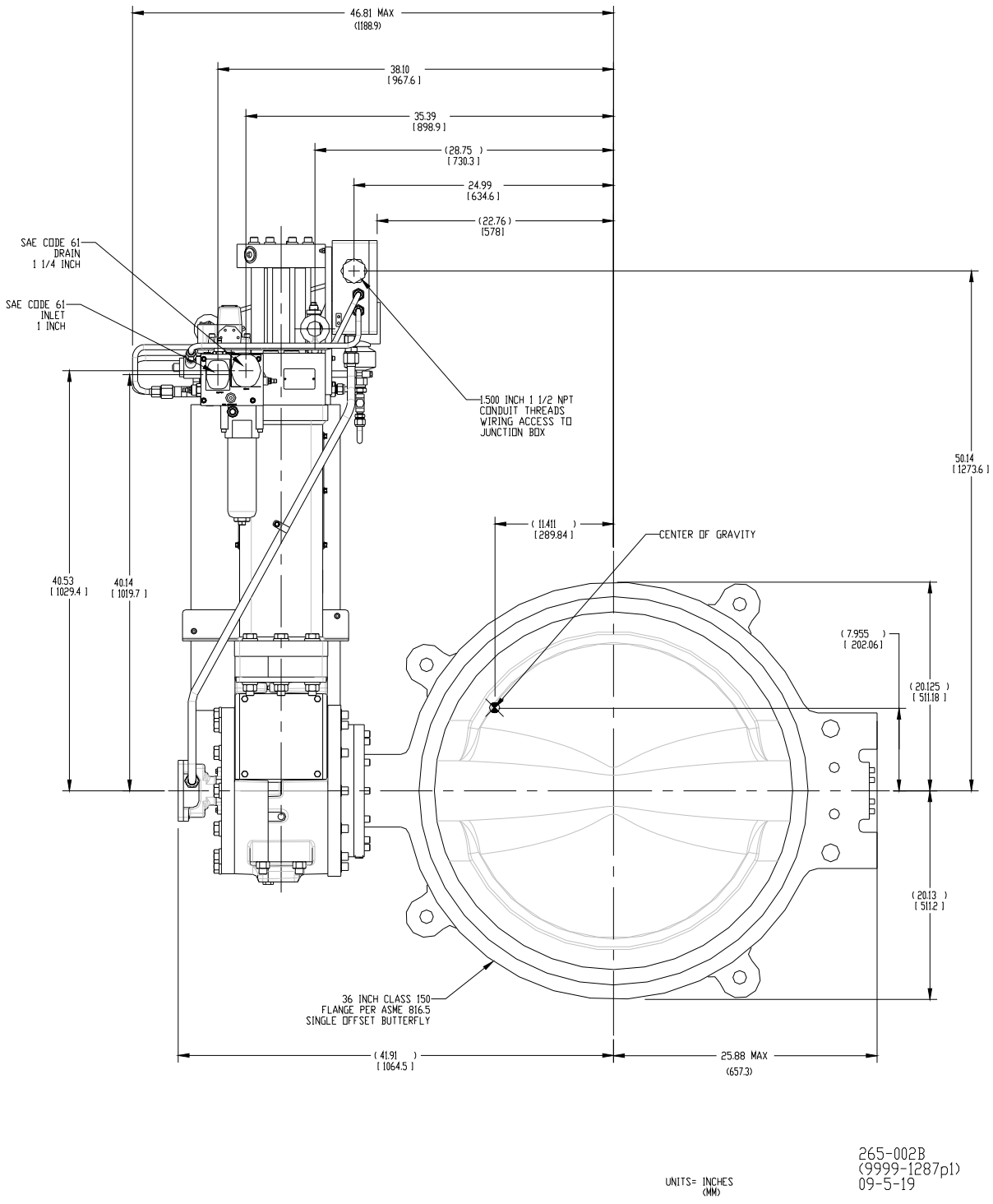


Figure 1-2b. VBV 2 Outline Drawing (closest to turbine)

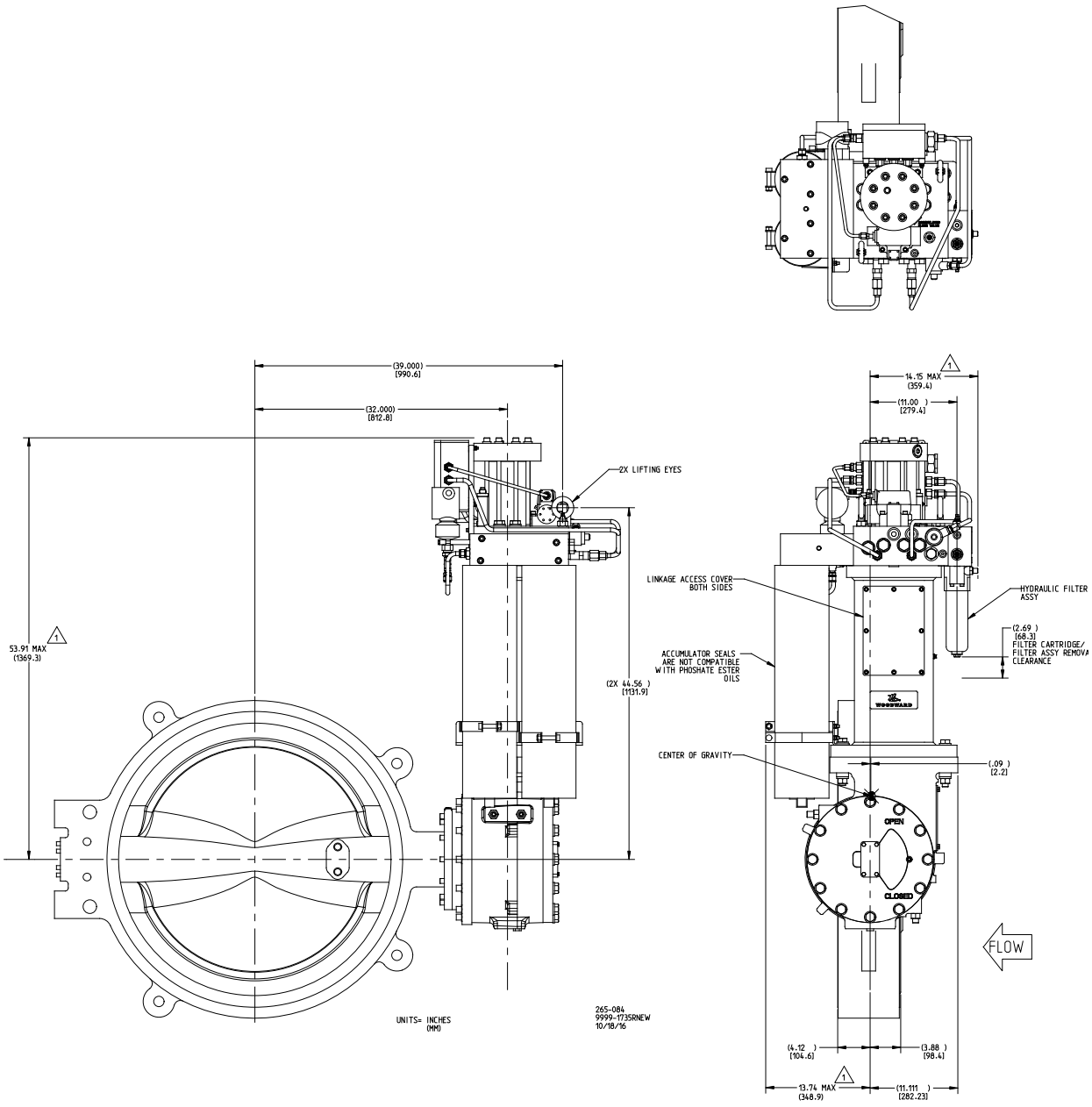


Figure 1-3a. VBV 1 Outline Drawing (furthest from turbine) without Rotary Position Sensor

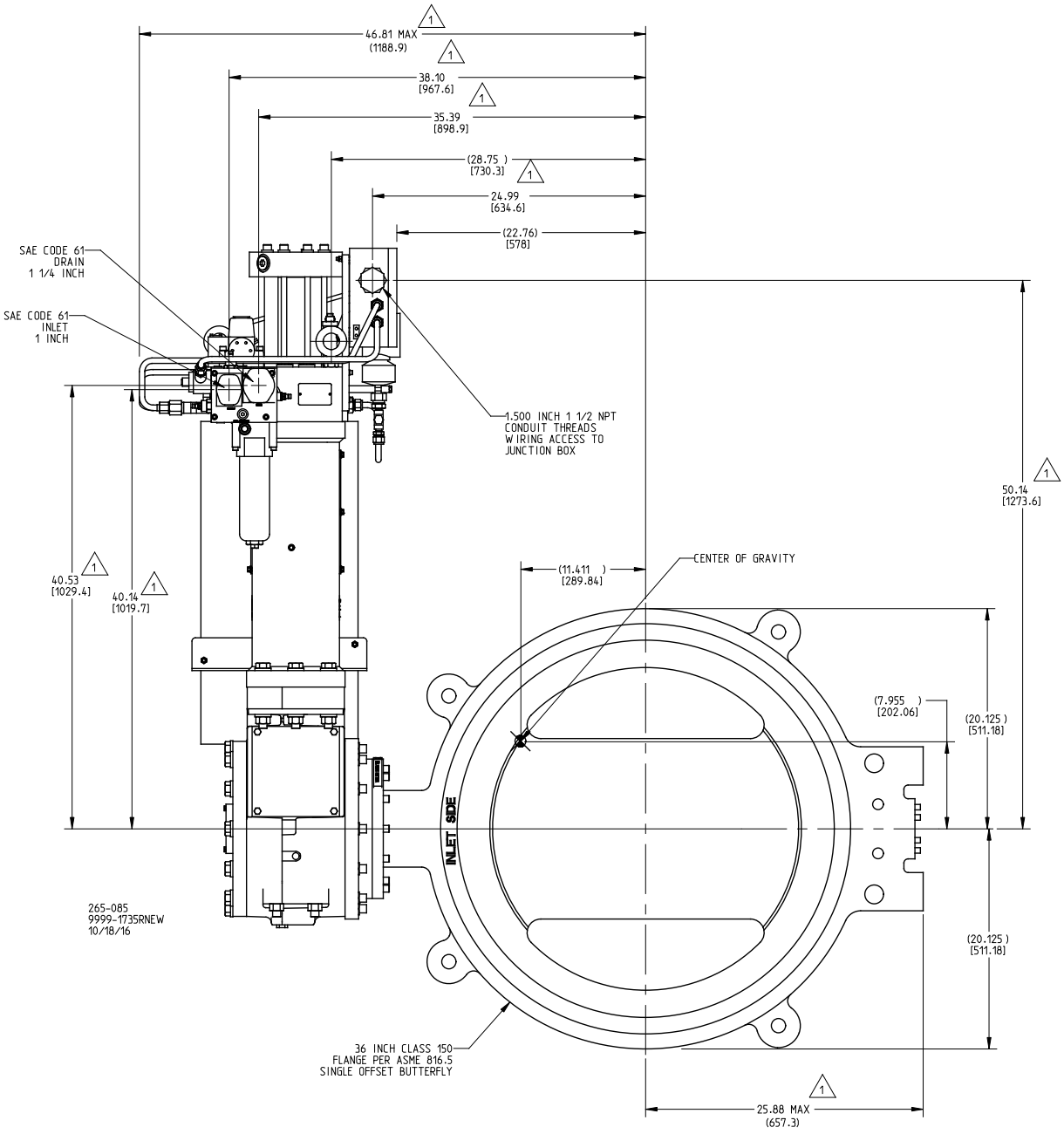


Figure 1-3b. VBV 1 Outline Drawing (furthest from turbine) without Rotary Position Sensor

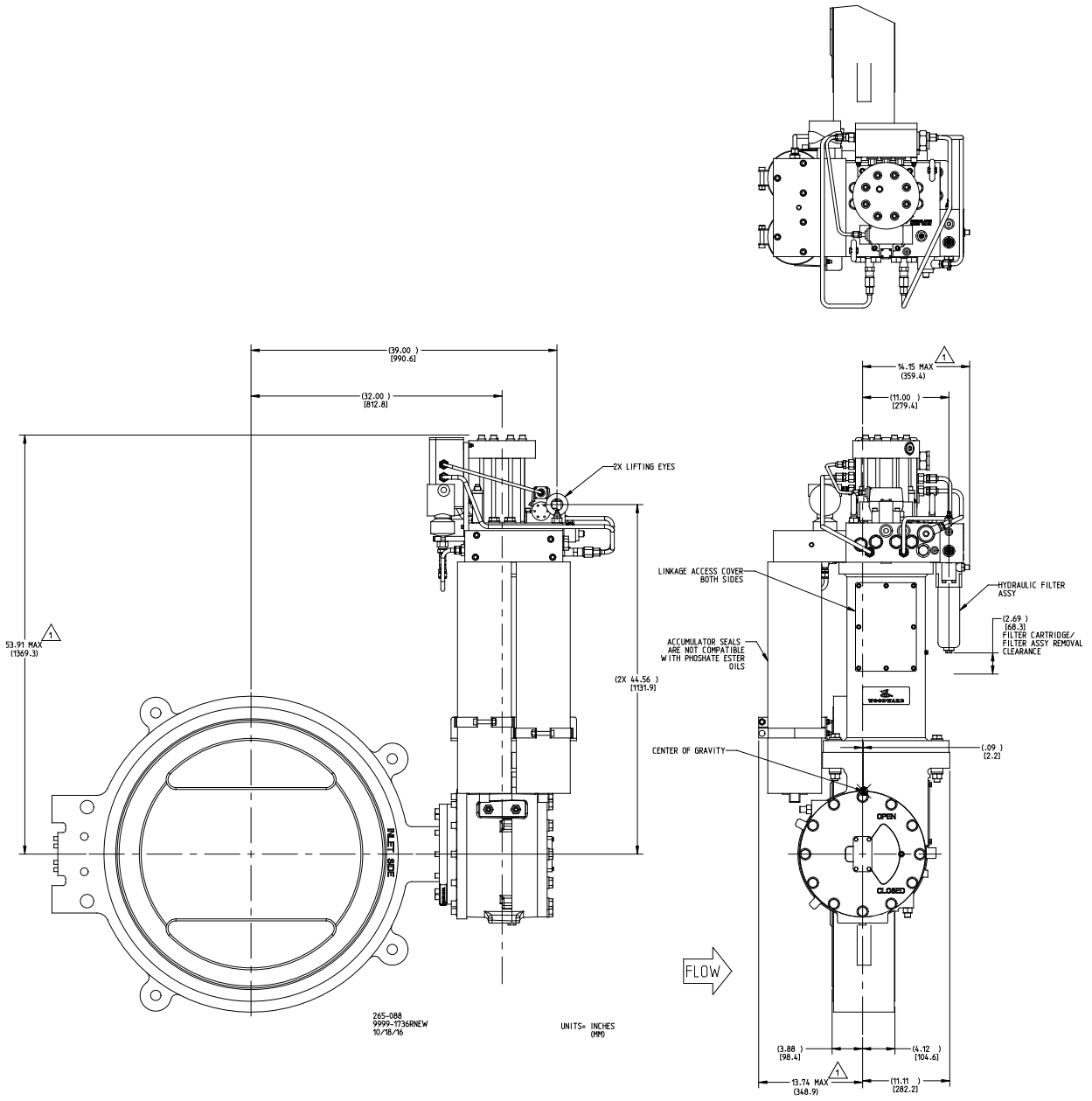


Figure 1-4a. VBV 2 Outline Drawing (closest to turbine) without Rotary Position Sensor

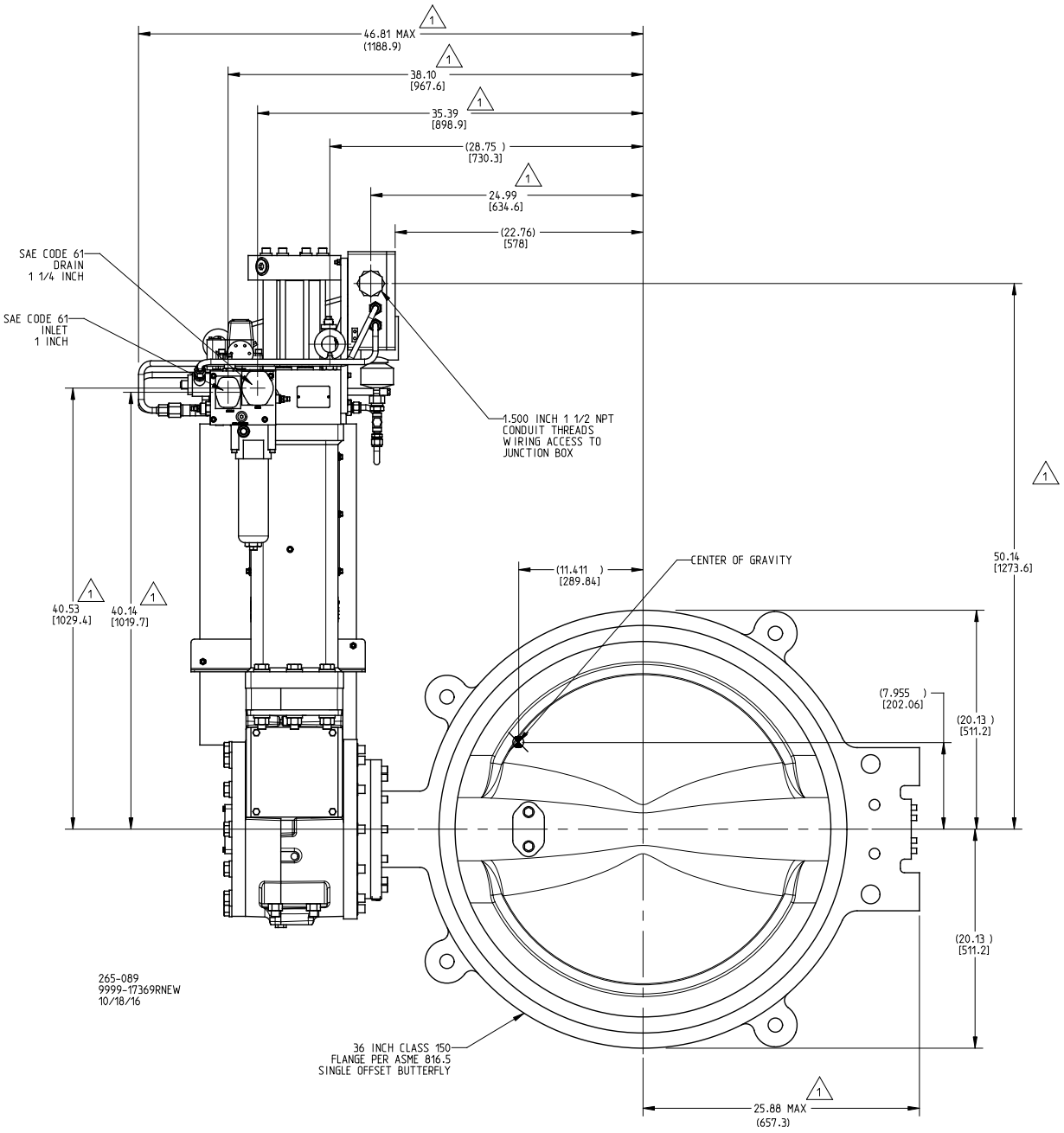


Figure 1-4b. VBV 2 Outline Drawing (closest to turbine) without Rotary Position Sensor

Notes for Figures 1-1 & 1-2

1. Installation Orientation:
   Actuator must be oriented vertically, above pipe. See elsewhere in this manual for other installation recommendations

2. Replacement Parts *see Notes for Figures 1-3 & 1-4
   Servo Valve - Woodward part number 1886-5039
   O-rings for servo valve - Woodward part number 13558-1164 (4x)
   Filter element (media) - Woodward part number 1326-8002
   LVDT - Woodward part number 1886-7034
   Solenoid - Woodward part number 1886-557
   O-rings for Solenoid – 1355-217 (1x), 1355-107 (1x)
   Rotary valve position sensor – 1689-1126 *see Notes for Figures 1-3 & 1-4
   Temperature sensor – 1689-1112
   Pressure sensor – 1689-1106 *see Notes for Figures 1-3 & 1-4
   Accumulator – 5299-1008 (without CE Mark)
   5299-1009 (with CE Mark)

Notes for Figures 1-3 & 1-4

*Replacement Parts are the same as this for Figures 1-1 & 1-2, except valves without rotary valve position sensor use pressure sensor 1689-1322.

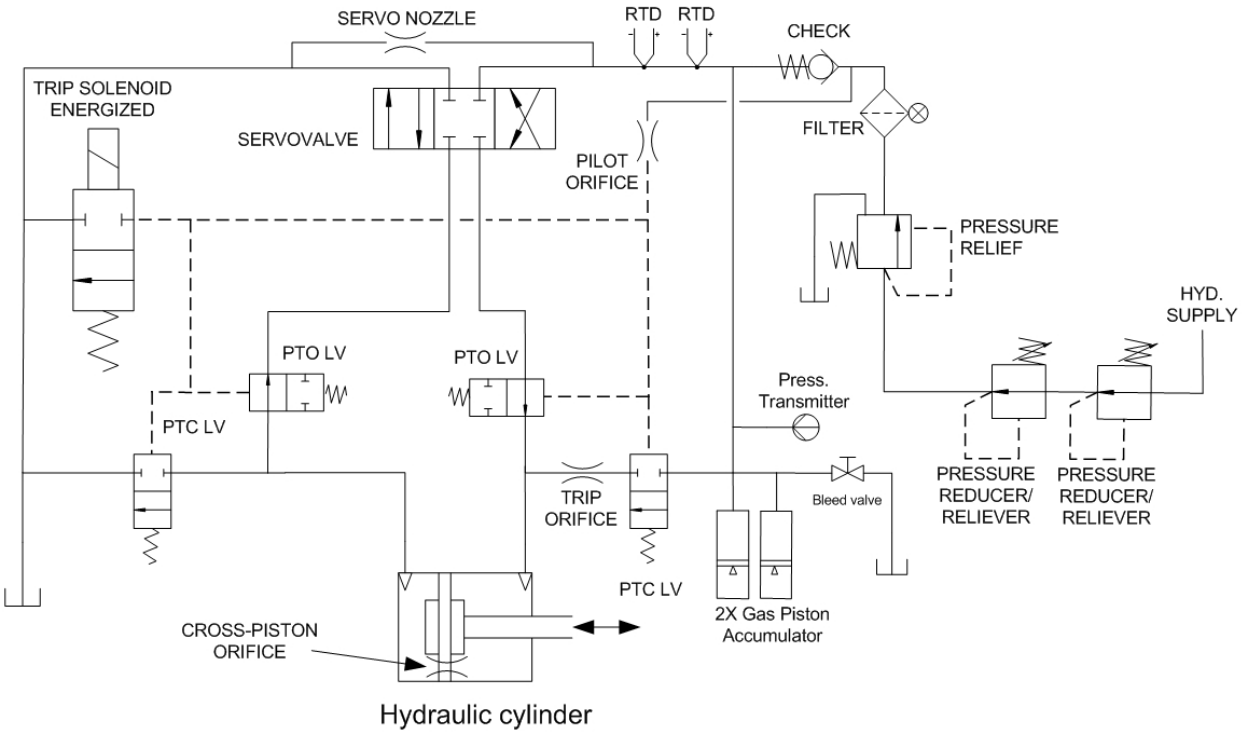


Figure 1-5. VBV Actuator Hydraulic Schematic

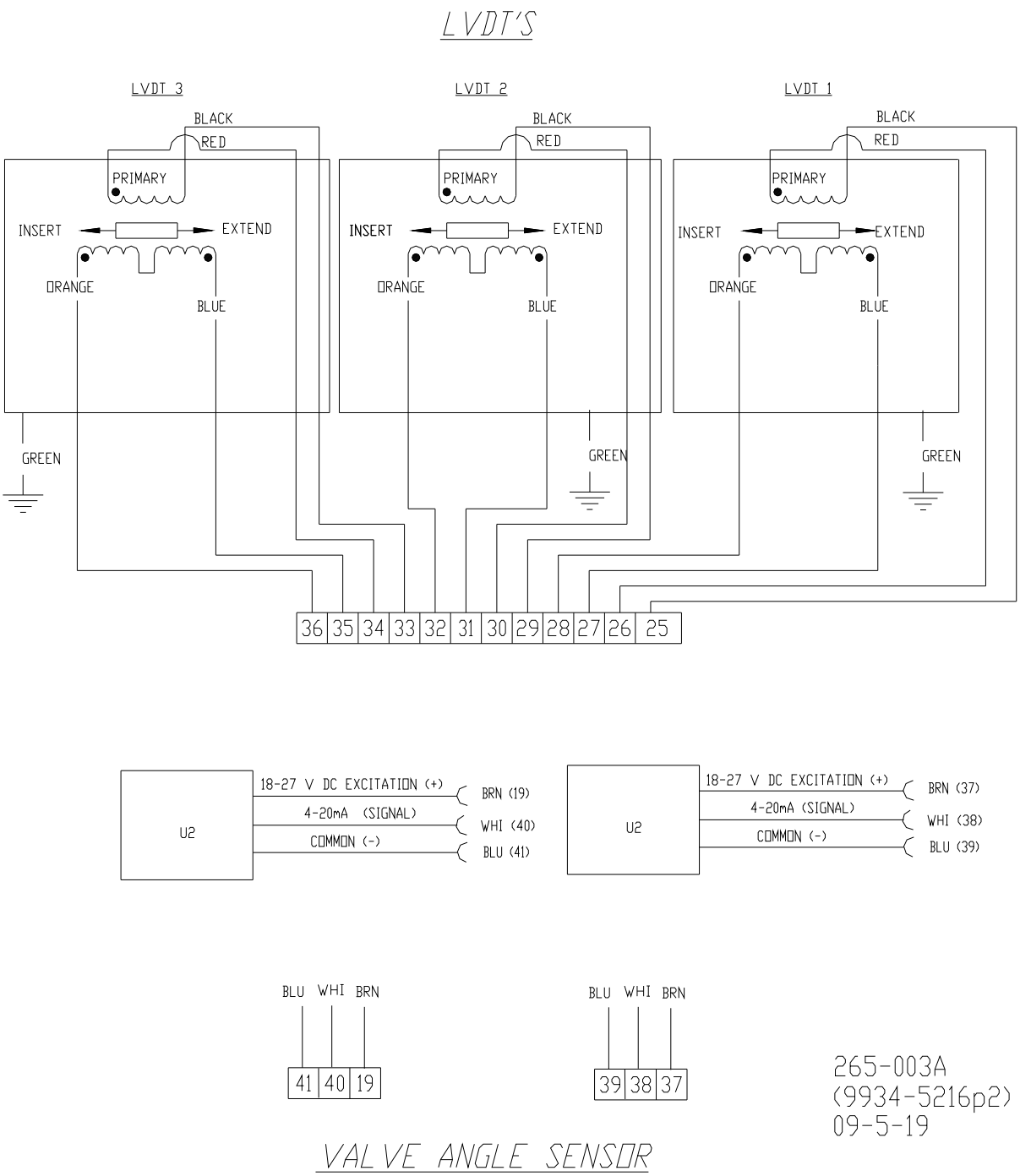


Figure 1-6a. VBV 1 & 2 Actuator Electrical Schematic and Wiring Diagram (Triple LVDT)

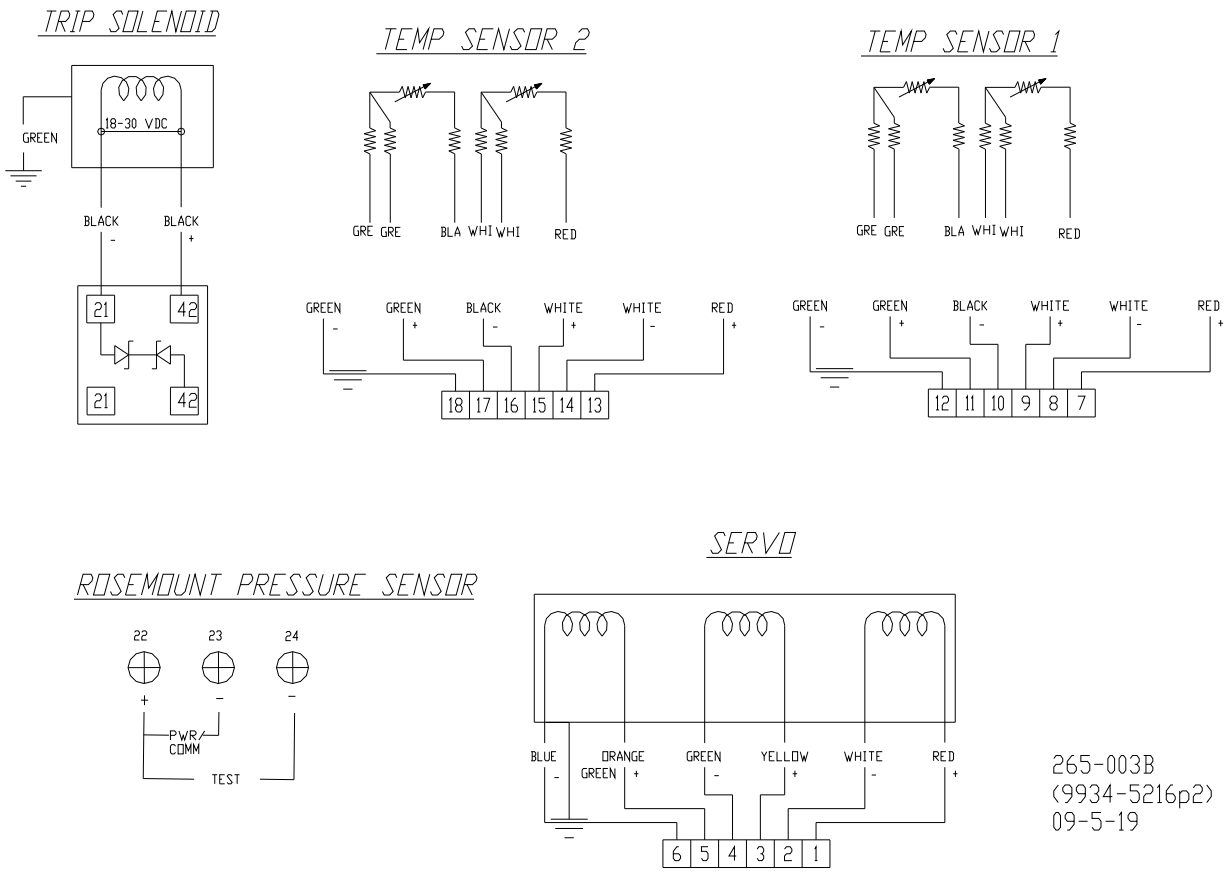


Figure 1-6b. VBV 1 & 2 Actuator Electrical Schematic and Wiring Diagram (Triple LVDT)

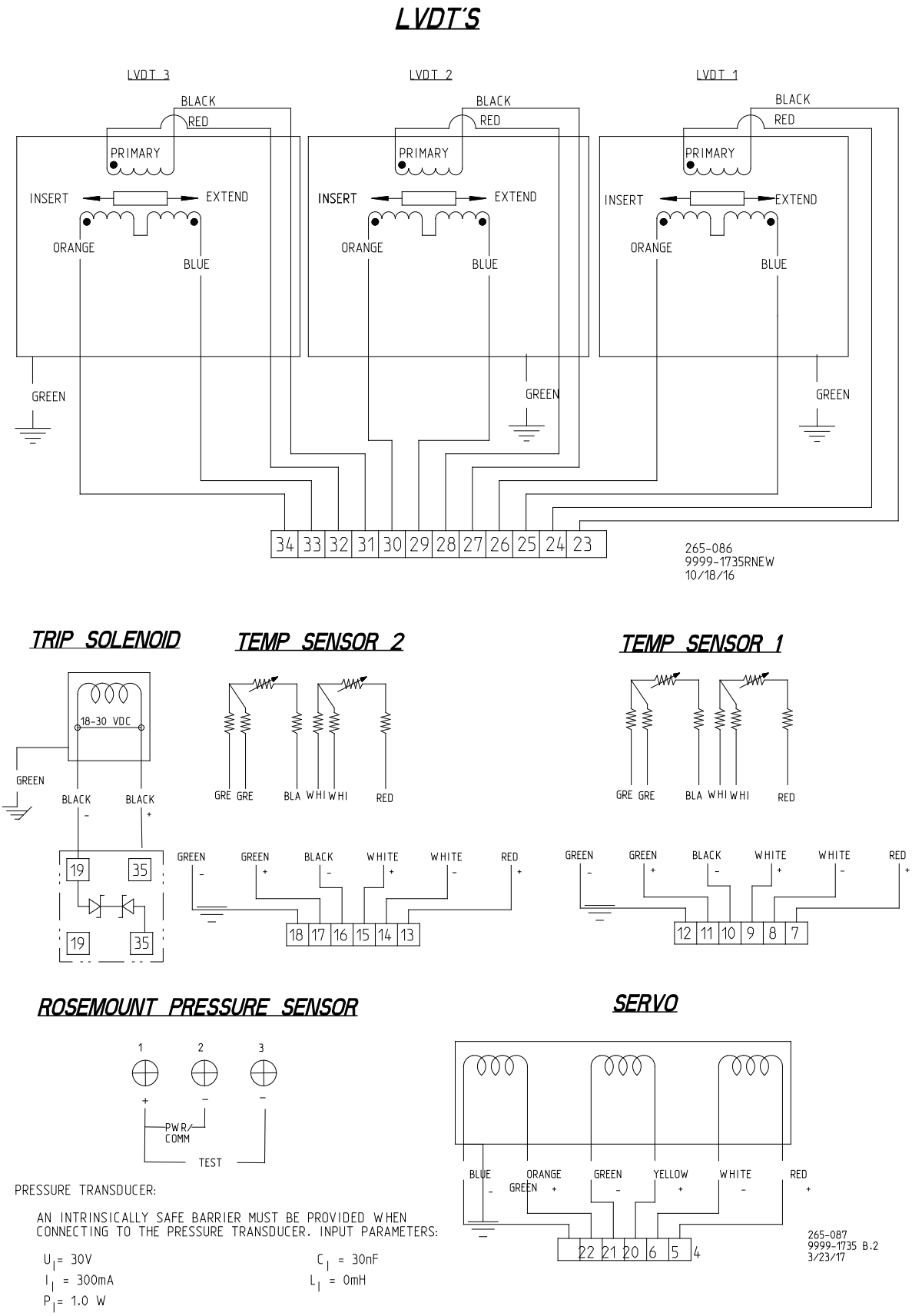


Figure 1-7. VBV 1 & 2 Actuator Electrical Schematic and Wiring Diagram (Triple LVDT) without Rotary Valve Position Sensor

Chapter 2.
VBV Actuator Operation

The VBV actuator is controlled by an electronic servo-control system (not included), which compares the commanded and actual valve positions. The control system modulates the input current signal to the electrohydraulic servo valve to minimize the positioning system error. See Figure 1-5 for a functional schematic of the double-acting actuator.

Hydraulic oil enters the actuator via a 1-inch (25.4 mm) SAE code 61 port. After passing through redundant pressure reducing/relieving valves, it passes through a replaceable element filter with integral high ΔP indicator. Additional overpressure safety protection is provided by a pressure relief valve. The dual hydraulic accumulators are downstream of the inlet check valve, supplying oil to the actuator for large transient movements and also in the event of pump loss. A four-way, electro-hydraulic servo valve controls the flow of the oil into and out of the power cylinder, controlling its position, and thereby valve position. A bleed valve is incorporated into the actuator to bleed off hydraulic pressure stored in the accumulators so that maintenance can be safely conducted.

The emergency trip relay circuit utilizes a solenoid operated valve that closes two pilot-operated logic valves (normally closed) to block the servo valve control ports. Two more pilot-operated logic valves (normally open) are activated by the trip circuit to connect the accumulator oil to the rod side of the hydraulic cylinder and the drain circuit to the cap side of the cylinder. When the trip solenoid is de-energized, these valves act in concert to retract the cylinder output rod and move the bleed valve to its full open position. Loss of hydraulic supply pressure also activates the trip system.

Actuator linear position is measured with triple redundant LVDT position feedback transducers mounted within each actuator. The LVDT sensor cores and support rods are connected to the main actuator output rod by a guided coupling arrangement that maintains LVDT core/coil alignment. Valve shaft position is measured with a redundant-output, contactless (no mechanical coupling to the shaft) rotary position sensor (applies only to units with this feature). Two redundant-output temperature sensors measure manifold oil temperature, and a pressure transmitter measures internal hydraulic supply pressure.

Chapter 3.
Standard Component Details

Triple Coil Electrohydraulic Servo Valve Assembly

The VBV actuator utilizes a two-stage hydraulic servo valve to modulate the position of the output shaft and thereby control the 36-inch (914 mm) butterfly valves. The first stage torque motor utilizes a triple-wound coil, which controls the position of the first and second stage valves in proportion to the total electrical current applied to the three coils. See the Functional Characteristics Table for actuation current details.

If the control system requires a closing movement of the valve to increase low-pressure compressor pressure, the servo valve current is increased above the null current. In such a condition, supply oil is admitted to the cavity above the actuator piston (cap side), and the cavity below the piston (rod side) is connected to the hydraulic drain. The oil flow rate is proportional to the total current applied to the three coils. Thus, the actuator stroke velocity and the valve opening are also proportional to the current (above null) supplied to the torque motor above the null point.

If the control system requires an opening movement to reduce low-pressure compressor pressure, the servo valve current is reduced well below the null current. In such a condition, supply oil is admitted to the rod side, and the cap side is connected to the hydraulic drain circuit. The oil flow rate is proportional to the magnitude of the total current below the null value. The flow rate and closing velocity of the valve are proportional to the total current below the null point.

Near the null current, the servo valve essentially isolates the power cylinder from the hydraulic supply and drain, and the upper and lower piston pressures are balanced to maintain a constant position. The control system, which regulates the amount of current delivered to the coils, modulates the current supplied to the coils to obtain proper closed loop operation of the system.

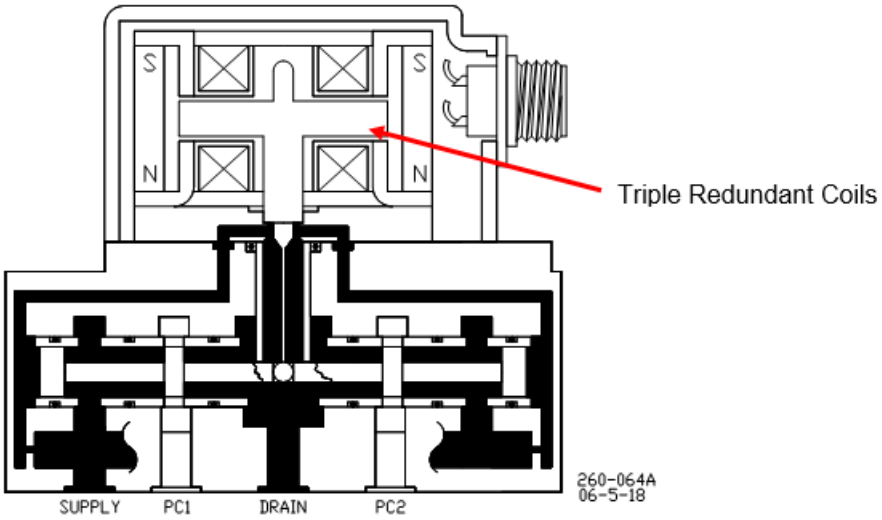


Figure 3-1. Servo valve Cutaway

Emergency Shutdown Trip Assembly

The VBV actuator electric emergency trip circuit utilizes a 2-way, two position, 24 Vdc solenoid-operated valve to control “pilot” pressure to four pilot-operated 2-way logic valves that override the servo-valve-commanded actuator position, and open the VBV in response to a removal of solenoid coil voltage (see Figures 1-5,1-6, and 1-7). Two pilot-to-open (PTO) logic valves are interposed between the servo valve control ports PC1 and PC2 and the hydraulic cylinder. One pilot-to-close (PTC) logic valve is interposed between the cap side of the hydraulic cylinder and drain and another PTC logic valve between the hydraulic accumulators and the rod side of the cylinder.

When the trip valve solenoid is energized, pilot pressure is high. The PTO logic valves are held open and allow the servo valve control pressure to communicate directly with the hydraulic cylinder while the PTC valves are closed and isolate the cylinder from the accumulators and drain. When the trip valve solenoid is de-energized, pilot pressure is low, causing the PTC and PTO valves to shift. The PTO valves close, blocking the servo valve control ports. The PTC valves open to connect the pressurized accumulator oil to the rod side of the power cylinder and the drain circuit to the cap side of the cylinder. These valves act together to retract the cylinder output rod and move the bleed valve rapidly to its full open position. Loss of hydraulic supply pressure also activates the trip system.

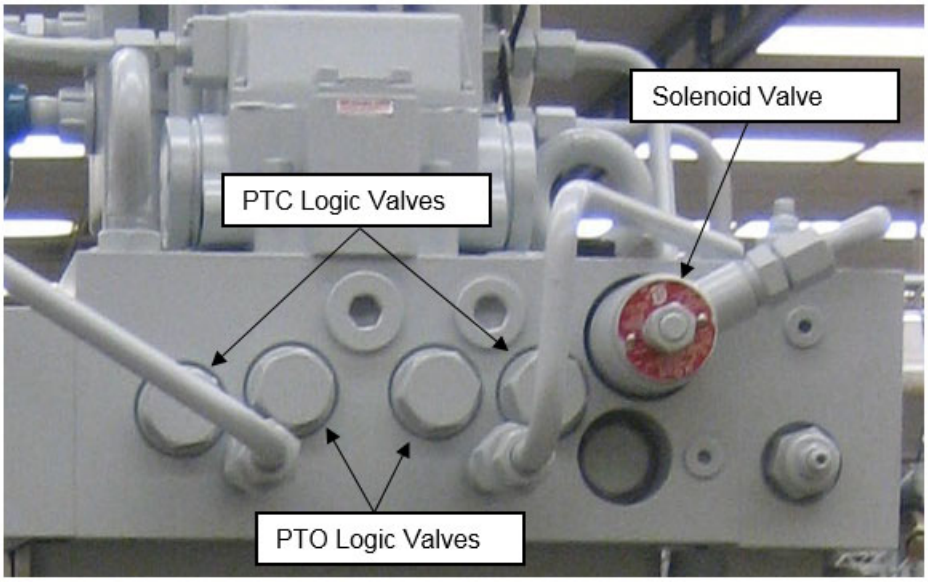


Figure 3-2. Electric Trip

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. During the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, *the following procedure to purge air* must be completed before the unit is commanded to “trip”.

Command the actuator to stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at least 5 cycles to purge entrapped air from the actuator.

Hydraulic Filter Assembly

The VBV actuator is supplied with an integrated, high-capacity filter. This broad-range filter protects the internal hydraulic control components from large oil-borne contaminants that might cause the hydraulic components to stick or operate erratically. The filter is supplied with a visual indicator which indicates when the pressure differential exceeds the recommended value, indicating that replacement of the element is necessary.

Hydraulic Accumulators

The VBV actuator uses dual-redundant, five-gallon piston-style accumulators for supplemental hydraulic flow for large transient valve movements. The seals in the accumulators are specified for low temperature (–40 °F/–40 °C) service and are suitable for most mineral-based hydraulic and lube oils. They are NOT suitable for use with Phosphate Ester fluids. The accumulators are pre-charged with nitrogen to 1500 ±25 psi at 70 °F (10 342 ±172 kPa at 21 °C).

IMPORTANT

The seals used in the hydraulic accumulators are NOT compatible with PHOSPHATE ESTER type fluids. Use only mineral based hydraulic or lube type fluids.

Hydraulic Pressure Reducers/Reliever Valve

The VBV actuator uses dual-redundant pressure reducer/reliever cartridge valves for reducing the supply pressure to the normal operating pressure used by the actuator. The primary valve is set at 2200 psi (15 169 kPa), with the backup valve set at 2400 psi (16 548 kPa).

IMPORTANT

The VBV must use 2200 psi (15 169 kPa) operating pressure setting for proper performance and to prevent damage to the actuator or valve.

Hydraulic Pressure Relief Valve

If both pressure reducer/reliever valves fail, a pressure relief valve will open to drain at 2600 psi (17 927 kPa). See Figure 1-5 for hydraulic schematic.

LVDT Position Feedback Sensors

The VBV actuator uses triple redundant LVDTs for position feedback. The LVDTs are factory set to give 0.7 ±0.1 Vrms feedback at the valve-closed position and 3.25 ±0.5 Vrms feedback at the valve-open position. The actual voltage values for each LVDT are provided inside the junction box with each VBV unit for reference during field calibration.

Valve shaft Rotary Position Sensors

This section does not apply to valves that exclude the valve shaft rotary position sensor.

The VBV actuator uses a dual-redundant Hall Effect array sensor for valve position feedback. The sensors work without mechanical coupling between the sensors and the valve shaft (contactless). A magnet is mounted on the end of the valve shaft and the sensors work across an air gap. They require a 24 Vdc power supply. Output signal is 4–20 mA over a range of 105 degrees. Nominal output with the valve closed is 5.1 mA, and with the valve open, it is 18.8 mA.

Transfer Case Vent/Drain

A screened vent/drain is installed in the bottom of the transfer case to prevent the buildup of moisture within the transfer case/yoke assembly. Do not plug this vent/drain.

Chapter 4.
Installation

General

Woodward recommends that the valve and actuator assembly be adequately supported by a structural support system designed and fabricated to meet the size, weight and local code requirements. Each valve and actuator assembly has been designed to be supported during operation by the piping system that the valve is installed in. The correct orientation for the actuator is vertical, above the valve stem. See the installation drawings for details.

See the outline drawings for:

- Overall dimensions
- Hydraulic fitting sizes and locations
- Electrical connections
- Lift points and center of gravity
- Weight of the valve

The Woodward valve rotates clockwise to close.

⚠WARNING

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

⚠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.

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a "trip" command. During the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, *the following procedure to purge air* must be completed before the unit is commanded to "trip".

Command the actuator to stroke (but do not command it to "trip") between its fully retracted and fully extended positions at least 5 cycles to purge entrapped air from the actuator.

⚠WARNING

Do not pass any lifting devices, including straps or slings, through the valve port when rigging the valve for installation or removal. Seat and/or seal damage may result.

The assembly should never be lifted solely by the actuator lifting eyes or by a sling only around the actuator. By themselves, these areas are for removal and installation of the actuator to the valve. A combination of actuator lifting eyes and valve lifting lugs must be used in unison for lifting and installing the assembly.

Tool Requirements

No special tools are required for VBV installations that are not commercially available. Lifting devices used to move the valve into a desired position must be of sufficient size to support the weight of the valve/actuator assembly. Use the actuator lifting eyes and the valve body lifting lugs in combination to lift the VBV assembly. The actuator alone may be lifted by the actuator lifting eyes, but the VBV assembly should **never** be lifted by the actuator lifting eyes alone or by a sling only around the actuator.

Unpacking

The valve is shipped in an airtight bag with desiccant to ensure a non-corrosive environment. We recommend that the valve be kept in its shipping container until installation. If the valve is to be stored for extended periods of time, encase the valve in an airtight container with desiccant.

Valve and Actuator Installation

General Considerations Prior to Installation

- The valve and actuator are preassembled and calibrated at the factory. They should be installed as a unit in the pipeline. Before installation of the valve into the piping system, the body seat and disc seal must be checked for dirt accumulation or damage due to transit or storage. For proper operation of the valve, the seat and disc seal must be undamaged and free of foreign material. Any rust preventative on the valve body faces should be removed prior to installation.

- The valve must be installed with the shaft in a horizontal plane and the actuator above the shaft axis. This reduces the axial load and prevents debris build-up in the bearing area and self-cleaning action on the seat.

- The flat side of the disc (seat side) is the high-pressure inlet side of the valve (see Figure 4-1). The valves must be installed in this orientation. Failure to do so may cause excessive dynamic torque and damage to the valve and actuator.

NOTICE

"VBV 1" MUST NEVER BE INSTALLED IN THE "VBV 2" LOCATION, AND "VBV 2" MUST NEVER BE INSTALLED IN THE "VBV 1" LOCATION. The flat side of the disc (seat side) is the high-pressure inlet side of the valve (see Figure 4-1). The valves must always be installed in this orientation. Failure to do so may cause excessive dynamic torque and damage to the valve and actuator.

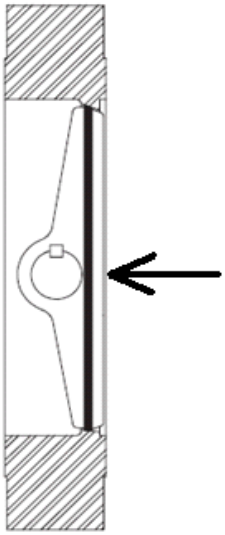


Figure 4-1. Required Flow Direction

- ASTM/ASME grade bolts or studs should be used to install the valve into the process piping. Refer to ASME B16.47 for details of flange, gasket, and bolt types and dimensions.
- Use self-centering flat ring flange gaskets. Flange gasket materials should conform to ANSI B16.20. The user should select a gasket material that is suitable for the service conditions and that can withstand the expected bolt loading without injurious crushing.
- All valves must be in the full closed position during installation or removal to prevent the valve disc from hitting the pipe flanges and damaging the disc seat.

Installing Valve

⚠WARNING

Do not pass any lifting devices, including straps or slings, through the valve port when rigging the valve for installation or removal. Seat and/or seal damage may result.

The assembly should never be lifted solely by the actuator lifting eyes or by a sling only around the actuator. By themselves, these areas are for removal and installation of the actuator to the valve. A combination of actuator lifting eyes and valve lifting lugs must be used in unison for lifting and installing the assembly.

Figure 4-2. Proper Rigging for Lifting

Figure 4-2 shows the proper method of lifting the VBV assembly in the vertical orientation for installation in the piping. Note how the load is shared between actuator and valve lift points.

Woodward recommends that installation of the valve and actuator into the piping be done according to GE installation procedures using flange gaskets and bolting materials specified by GE. The valve installation chock (Figure 4-3) holds the valve disc closed so that the valve will fit between the pipeline flanges. Remove the chock **AFTER** the valve is bolted into the pipeline. The chock **MUST** be removed prior to operation of the VBV. After removal of the chock, install the inspection cover that is supplied with the actuator. Torque screws to 23 lb-in (2.6 N·m).

NOTICE

The VBV valve is shipped with a chock that holds the actuator in the "valve closed" position for installation. VBV 2 will open due to the weight of the valve disc without the chock in place, making it impossible to install. AFTER the valve is installed in the pipeline, the chock MUST be removed prior to operation of the VBV. Failure to do so may cause damage to the actuator and/or turbine.

Figure 4-3. Valve Installation Chock

Additional considerations are as follows, but in no way should supersede installation procedures or materials specified by GE.

WARNING **The following is intended to assist the end user in developing procedures for installation. Woodward recommends that all common safety practices be followed during installation of the valve.**

Verify that the process piping flange-to-flange dimensions meet the requirements of the outline drawings (located at the end of Chapter 1) within standard piping tolerances. The valve and gaskets should mount between the piping interfaces such that the flange bolts can be installed with only manual pressure applied to align the flanges. Mechanical devices such as hydraulic or mechanical jacks, pulleys, chain-falls, or similar should never be used to force the piping system into alignment.

When installing the valve into the process piping, it is important to properly torque the studs/bolts in the appropriate sequence to keep the flanges of the mating hardware parallel to each other. A two-step torque method is recommended. Once the studs/bolts are hand-tightened, torque the studs/bolts in a crossing pattern to half the torque value. Once all studs/bolts have been torqued to half the appropriate value, repeat the pattern until the rated torque value is obtained.

Hydraulic Connections

There are two hydraulic connections that must be made to each valve: supply and return. The tubing up to the valve must be constructed to eliminate any transfer of vibration or other forces into the actuator (see Figures 1-1 through 1-4).

The hydraulic **supply connection** to the actuator is a 1.00-inch SAE Code 61 port. The supply tubing should be 1.00 inch (25.4 mm) or larger. Torque bolts to 27–35 lb-ft (37–47 N·m).

The hydraulic **drain connection** to the actuator is a 1.25-inch SAE Code 61 port. The drain tubing should be 1.25-inch (31.75 mm) or larger tubing and must not restrict the flow of fluid from the valve. The drain pressure must not exceed 30 psig (207 kPa) under any condition. Torque bolts to 35–46 lb-ft (47–62 N·m).

Make provisions for proper filtration of the hydraulic fluid that will supply the actuator. The system filtration should be designed to assure a supply of hydraulic oil with a maximum ISO 4406 contamination level of 18/16/13 and a preferred level of 16/14/11. The filter element included with the actuator is not intended to provide adequate filtration over the entire life of the actuator.

Electrical Connections

NOTICE

Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagram (Figures 1-6 and 1-7).

All customer connections should be made according to the wiring diagrams in Figures 1-6 and 1-7. All customer connections are on the upper terminals of the contact blocks. Component connections (made by Woodward) are on the lower contacts. It is recommended to secure wires to limit wire movement that may be caused by vibrations. Wire ties or other means may be used for this purpose.

The use of cable with individually shielded twisted pairs is recommended. All signal lines should be shielded to prevent picking up stray signals from nearby equipment. Installations with severe electromagnetic interference (EMI) may require shielded cable run in conduit, double-shielded wire, or other precautions. Connect the shields at the control system side or as indicated by the control system wiring practices, but never at both ends of the shield such that a ground loop is created. Wires exposed beyond the shield must be less than 2 inches (51 mm). The wiring should provide signal attenuation to greater than 60 dB.

Servo valve cable must consist of three individually shielded twisted pairs. Each pair should be connected to one coil of the servo valve as indicated in Figures 1-6 and 1-7 (wiring diagram).

The LVDT cable must consist of six individually shielded twisted pairs. Separate pairs should be used for each of the excitation voltages to the LVDT, and separate pairs should be used for each of the feedback voltages from the LVDT.

Servo Valve Null Current

Servo valve null current is measured by Woodward during final test. The null current specification is +3.36 to +6.24 mA (total current across all coils). The actual null current for each unit is recorded in documentation that is shipped with each VBV. Please use this data when setting up the control system.

The positive null current bias ensures that the valve will move to the failsafe open position if there is a loss of all servo valve control current.

LVDT Voltage

The LVDTs are calibrated during final test at Woodward. Actual LVDT calibration documentation is shipped with each VBV (inside junction box). Please use this calibration data when setting up the control system. With 7.0 Vrms excitation at 3000 Hz, the LVDT calibration specifications are:

- Valve closed, 0% position = 0.7 ± 0.10 Vrms
- Valve open, 100% position = 3.25 ± 0.50 Vrms

Chapter 5.
Maintenance and Hardware Replacement

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure, and air pressure have been removed from the valve and actuator before beginning any maintenance or repairs. Drain accumulators by opening the bleed valve on top of the actuator.

Maintenance

1. **Butterfly Valve:** The butterfly valve requires no maintenance or adjustment in preparation for, or during, normal operation. The stem packing is live-loaded so that periodic packing nut adjustments are not necessary. If for any reason the live loading adjustment is disturbed, it can be reset. The proper adjustment is one additional turn of the packing nut after play between the spring washers is eliminated.
2. **Hydraulic oil filter:** Woodward recommends **once a month checks** of the DP indicator on the filter assembly to verify that the filter is not partially clogged. If the DP indicator shows red, the filter element needs to be replaced. See below for replacement procedure.
3. **Hydraulic Accumulators:** Woodward recommends checking the pre-charge 1 week after installation and thereafter **once a month. Recharge** to 1500 ±25 psi (@ 70 °F) [10 342 ±172 kPa (@ 21 °C)] when pressure goes below 1350 psig (9308 kPa). If pressure loss exceeds 50 psi (345 kPa) per month, replacement of the accumulator is recommended.

IMPORTANT

Refer to Parker Hannifin catalog HY10-1630/US prior to performing any additional maintenance, repair or component replacement on the hydraulic accumulators.

4. See below for instructions for removal and replacement of the accumulator. The V-O-ring seal on the accumulator piston is generally the only maintenance required and can be replaced per instructions in Parker Hannifin catalog HY10-1630/US. Periodic checking of pre-charge pressure will detect whether V-O-ring wear is sufficient to begin reducing sealing performance. If pre-charge is low, also check for gas valve and/or end seal leakage. Allowing for temperature difference, if any, from time of its previous pressure checking, pre-charge pressure will rise if oil gathers in the gas side and will fall if gas leaks into the oil side or out past gas end seals.

Pre-charge Checking Procedure

Turn off the hydraulic supply and using the bleed valve on top of the actuator, discharge all oil from the accumulators. Alternatively, the pressure will slowly bleed off through the actuator, but will take at least 10 minutes after the hydraulic supply is turned off. Use gauging assembly Parker part #085122XX00 or similar assembly.

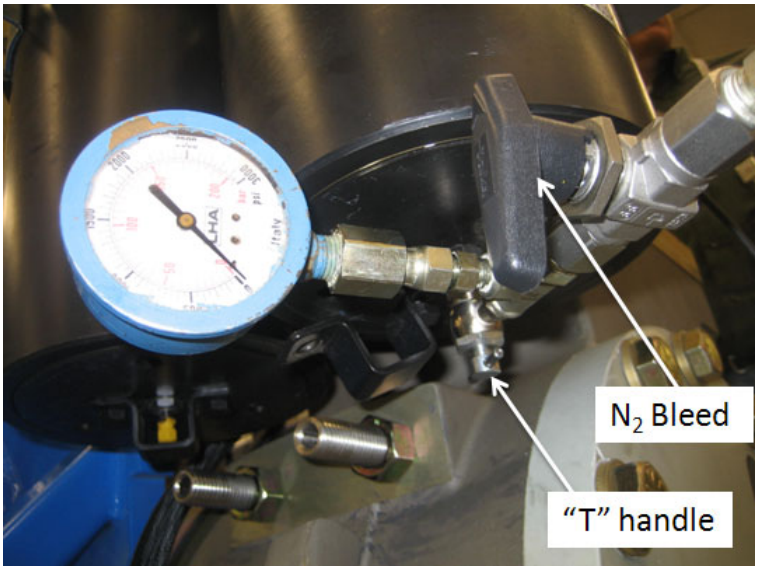


Figure 5-1. Bleed Valve

1. Remove gas valve guard and gas valve cap.
2. Back gas chuck "T" handle all the way out.
3. Close gas bleed valve.
4. Attach swivel nut to gas valve and tighten (10–15 lb-in / 1.1–1.7 N·m).
5. Turn gas chuck "T" handle all the way in. This will depress the core in gas valve and check pressure.
6. To remove the gauging assembly, turn "T" handle all the way out, then open the gas bleed valve.
7. Hold gas valve from turning, loosen gauge swivel nut, and remove assembly.
8. Replace gas valve cap (10–15 lb-in / 1.1–1.7 N·m) and valve guard.

Hardware Replacement

In the event that any of the standard components of the valve become inoperative, field replacement of certain components is possible. Contact a Woodward representative for assistance. Some replacement operations will require the use of Woodward tool number 1013-2567.

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure, and air pressure have been removed from the valve and actuator before beginning any maintenance or repairs. Drain accumulators by opening the bleed valve on top of the actuator.

⚠WARNING

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

⚠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

Do not pass any lifting devices, including straps or slings, through the valve port when rigging the valve for installation or removal. Seat and/or seal damage may result. Do not lift or handle the actuator by any conduit.

The assembly should never be lifted solely by the actuator lifting eyes or by a sling only around the actuator. By themselves, these areas are for removal and installation of the actuator to the valve. A combination of actuator lifting eyes and valve lifting lugs must be used in unison for lifting and installing the assembly.

IMPORTANT

Disassembly of this actuator without a Woodward Technician present will void the Woodward warranty.

See the outline drawing (Figures 1-1 thru 1-4) for the location of items.

Table 5-1. Replacement Parts

Servo Valve	1886-5039
O-rings for servo valve	1355-1164 (4x)
Filter Assembly	1326-1014
Filter Assembly O-rings	1355-1282 (2x)
Filter element (media)	1326-8002
LVDT	1886-7034
Shutdown Solenoid	1886-557
O-rings for Solenoid	1355-217 (1x), 1355-107 (1x)
Rotary valve position sensor	1689-1126*, see note below
Temperature sensor	1689-1112
Pressure sensor	1689-1106 or 1699-1322
Accumulator	5299-1008 (without CE Mark) 5299-1009 (with CE Mark)
O-ring for accumulator	1355-1001

*CE marked units do not include this feature.

Hydraulic Filter Assembly/Cartridge

The hydraulic filter is located on the right side of the hydraulic manifold.

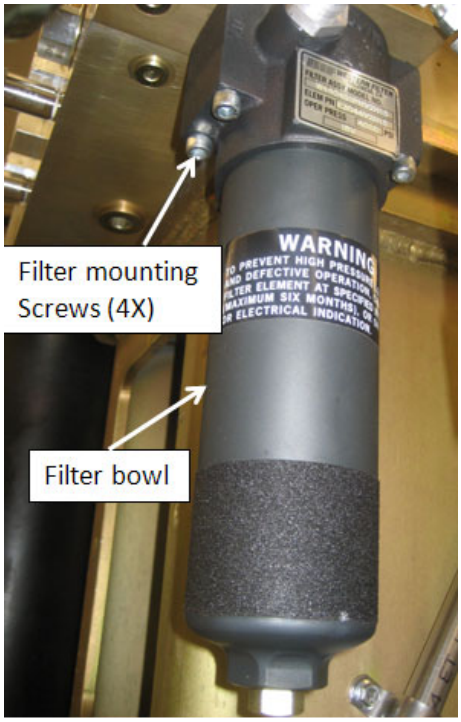


Figure 5-2. Hydraulic Filter Assembly/Cartridge

Replacement of Filter Assembly

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Remove four 0.312-18 UNC socket head cap screws.
3. Remove the filter assembly from manifold block.

IMPORTANT **The filter contains a large amount of hydraulic fluid that may be spilled during filter removal.**

4. Remove the two O-rings present in the interface between the filter and the manifold.
5. Obtain a new filter assembly.
6. Place two new O-rings (1355-1282) in the new filter assembly.
7. Install filter onto manifold assembly. Be sure to place the filter in the correct orientation. See the outline drawing (Figures 1-1 thru 1-4).
8. Install four 0.312-18 cap screws through filter and torque into manifold to 135-165 lb-in (15–19 N·m).

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a "trip" command. During the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to "trip".

- **Command the actuator to stroke (but do not command it to "trip") between its fully retracted and fully extended positions at least 5 cycles to purge entrapped air from the actuator.**

Replacement of Filter Cartridge

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Using a 1-5/16-inch (~33+ mm) wrench, loosen the bowl from the filter assembly.

IMPORTANT

The filter contains a large amount of hydraulic fluid that may be spilled during filter element removal.

3. Remove the filter element by pulling it downward.
4. Obtain a new filter element, Woodward P/N 1326-8002.
5. Lubricate the O-ring on the ID of the cartridge with hydraulic fluid.
6. Install the cartridge into the assembly by sliding the open end of the cartridge upward onto the nipple.
7. Install the filter bowl. Tighten only by hand.

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a "trip" command. During the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to "trip".

- **Command the actuator to stroke (but do not command it to "trip") between its fully retracted and fully extended positions at least 5 cycles to purge entrapped air from the actuator.**

Emergency Trip Solenoid Valve

The trip solenoid valve is located on the right, front of the manifold, on the opposite side as the LVDTs.

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Open accumulator bleed valve on top of the actuator.
3. Remove the cover to the electrical junction box.
4. Disconnect the solenoid wires from the connector blocks as shown in the wiring diagram (Figures 1-6 and 1-7).
5. Loosen the conduit fittings from the electrical box and the solenoid.
6. Carefully remove the conduit from the solenoid and pull the wiring out of the conduit.
7. Loosen the ¾ inch jam nut on top of the solenoid coil (see Figure 5-3).
8. Loosen the coil retention nut (see Figure 5-3).
9. Remove the solenoid coil from the cartridge valve.
10. Using 1-inch deep well socket, loosen and remove the cartridge valve from the actuator.

IMPORTANT

Hydraulic fluid may spill during cartridge valve removal.

11. Obtain a replacement solenoid from Woodward and verify part number and revision with the existing unit. Woodward P/N 1886-557.
12. Verify that the O-rings on the replacement solenoid are undamaged and present as compared to the old solenoid. Replace if damaged.
13. Lubricate the O-rings with a light oil or petroleum jelly.
14. Install replacement cartridge valve into actuator and tighten to 260 lb-in (30 N·m).
15. Install solenoid coil and hand tighten coil retention nut.
16. Install and torque jam nut to 95 lb-in (11 N·m)
17. Install wiring through the conduit and into the electrical box.
18. Connect the conduit to the solenoid and torque to 240 lb-in (27 N·m).
19. Torque the conduit to the electrical box to 240 lb-in (27 N·m).
20. Install wires into the solenoid connector blocks as shown in Figure 1-4 (wiring diagram). If it is necessary to cut wires for installation, be sure to retain at least one service loop of wiring.
21. Replace the cover onto the junction box and tighten the screws.
22. Close the accumulator bleed needle valve and tighten jam nut.

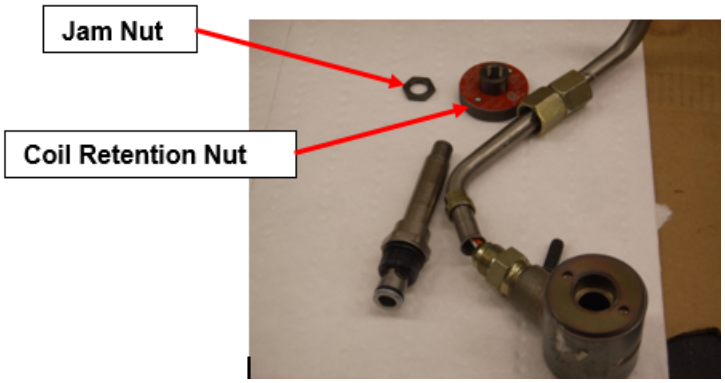


Figure 5-3 Trip Solenoid Assembly

Servo Valve

The servo valve is located on the top of the hydraulic manifold directly in front of the hydraulic power cylinder Refer to the outline drawing (Figures 1-1 thru 1-4).

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Loosen jam nut and open accumulator bleed valve on top of actuator.
3. Remove the cover to the electrical junction box.
4. Disconnect the servo valve wires from the connector blocks.
5. Loosen the conduit fittings from the electrical box and the servo valve.
6. Carefully remove the conduit from the servo valve and pull the wiring out of the conduit.
7. Remove the four 0.375-16 UNC socket head cap screws holding the servo valve to the manifold.
8. Discard the four O-rings between the servo valve and the manifold.

9. Obtain replacement servo valve and verify part number and revision with existing unit.
10. Remove protective plate from replacement servo valve and verify that all O-rings are in place in the counter bores of the servo valve. Lubricate with Vaseline or O-ring lube.
11. Place the servo valve onto the hydraulic manifold. Be sure to orient the servo valve to match the original orientation. Be sure that all the O-rings remain in their proper location during assembly.
12. Install four 0.375-16 UNC socket head cap screws and torque to 225–275 lb-in (25–31 N·m).
13. Install the servo valve wiring through conduit and into electrical box.
14. Connect conduit to servo valve and torque to 100–125 lb-in (11–14 N·m).
15. Torque conduit to electrical box to 100–125 lb-in (11–14 N·m).
16. Install wires into servo valve connector blocks as shown in the wiring diagram (Figure 1-6 and 1-7). If it is necessary to cut wires for installation, be sure to retain at least one service loop of wiring.
17. Replace cover onto junction box and tighten screws.

18. Close the accumulator bleed needle valve and tighten jam nut.

LVDT Replacement

The LVDTs are located between the junction box (back of) and the hydraulic power cylinder. Refer to the outline drawing (Figures 1-1 thru 1-4). The core rod connections can be accessed through the rear yoke cover below the junction box.

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Loosen jam nut and open accumulator bleed valve on top of actuator.

⚠WARNING

The failsafe emergency trip system will suddenly and rapidly move the valve to the full open position upon loss of hydraulic supply or loss of trip solenoid voltage. DO NOT do any work on the actuator unless the hydraulic supply is turned off, locked out and accumulator bleed valve opened, and all accumulator pressure bled off. Failure to do so could result in severe personal injury.

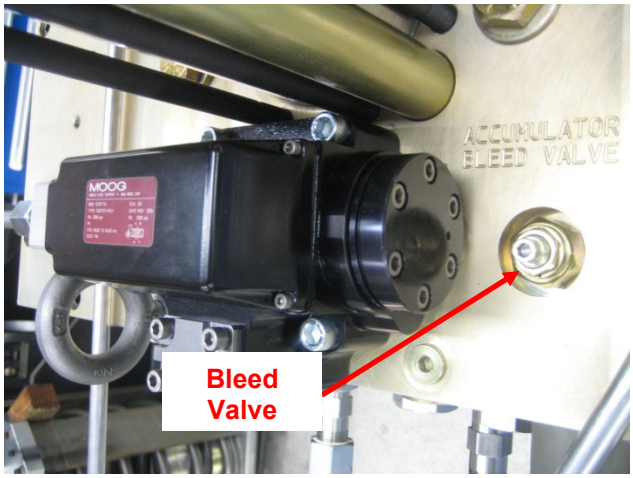


Figure 5-4. Bleed Valve

3. Remove access covers from the front and back of the yoke.
4. If the LVDT core rods are not accessible through the window, the actuator piston rod must be extended to make them accessible. Either of two methods may be used to accomplish this. Woodward Tool number 1013-2567 can be used as shown in Figure 5-5a. Turn the jack screw nuts evenly until the rods are accessible. Alternatively, a pry bar between the top of the window opening and the top of the clevis may be used to move the clevis downward. DO NOT pry against the top of the LVDT core rod plate. Place a 4.5” long block between the top of the clevis and the bottom of the actuator to hold this position. See Figure 5-5b. Both methods require that the bleed valve be open for the clevis to move down.

Figure 5-5a. Tool 1013-2567 to Move Clevis Down

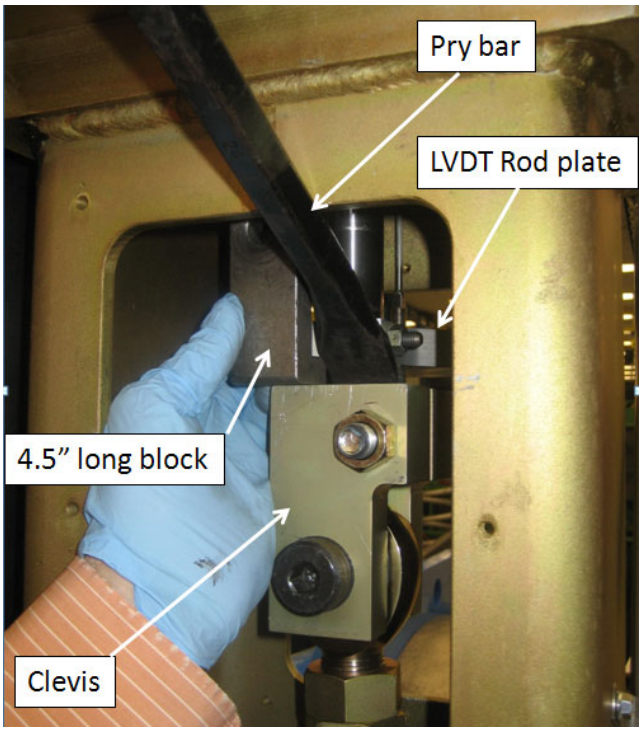


Figure 5-5b. Prying Clevis Down and Blocking

5. Remove the cover to the electrical junction box.
6. Remove applicable LVDT wires from terminal block.
7. Remove ¾" hex nuts on all of the LVDTs from inside the junction box with a 1-1/8" wrench (29– mm). A notched socket (for wire clearance) also works well for this.
8. Loosen conduits on both ends and enough to pull them clear of the conduit box (except Rosemount pressure transmitter). Some of the wire ties in the conduit box may need to be removed to get enough slack to swing the junction box clear of the LVDTs.
9. Remove Rosemount pressure transmitter mount saddle clamp. Loosen the tubing fitting nut (mark nut location with permanent marker for retightening) below the Rosemount just enough so that the Rosemount and junction box can be swiveled.
10. Remove socket head cap screws that attach the junction box mounting bars to the actuator manifold (Figure 5-6a).
11. Carefully remove junction box from LVDTs and swing to the side enough to clear the LVDT that is being replaced.
12. Remove locking nut from top of applicable LVDT.
13. Remove the two socket head cap screws that hold the LVDT mounting bracket to the actuator manifold.
14. Remove LVDT from bracket and set aside.
15. Loosen jam nut and using a wrench remove the mating core rod from the retaining plate (Figure 5-6b).

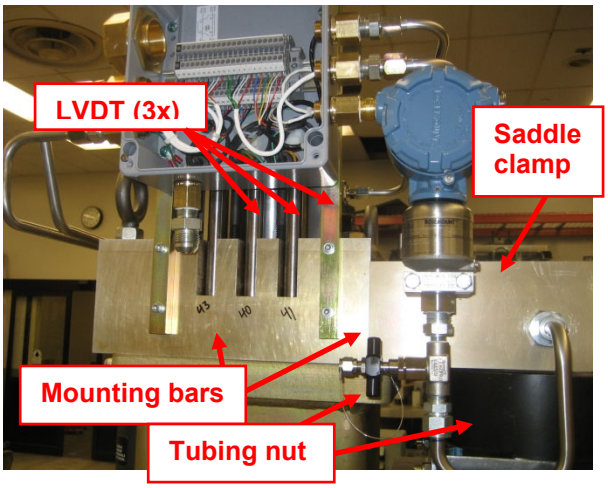


Figure 5-6a. Disassembled LVDT

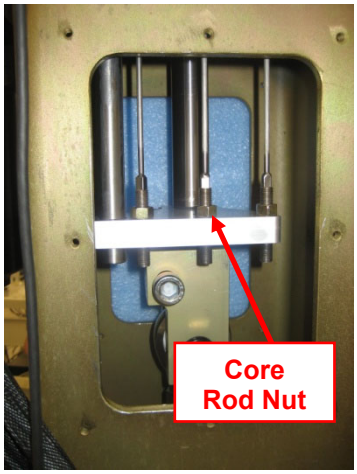


Figure 5-6b. Retaining Plate

NOTICE **These units are matching sets. Mixing and matching may cause LVDT to not function properly.**

16. Remove jam nut and install on new core rod.
17. Install new core rod, reusing the jam nut from the old unit.
18. Pre-adjust core rod visually to approximately the same height as the other core rods and tighten jam nut to 15 lb-ft (20 N·m).
19. Install LVDT Housing into retaining plate, align, and tighten nut to 25 lb-ft (34 N·m).
20. Carefully install retaining plate and LVDTs into actuator, aligning with the core rods. Using standoffs and socket head cap screws, torque to 45 lb-ft (61 N·m).

NOTICE **Bending LVDT core rods will damage them beyond repair.**

21. Reinstall junction box over LVDTs.
22. Install nuts on LVDT bodies and torque to 15 lb-ft (20 N·m).

23. Replace all conduits, replace saddle clamp and torque to 15-18 lb-ft (20–24 N·m), tighten Rosemount tubing nut 1/8 turn beyond where it was before loosening.
24. Reinstall electrical wiring as shown in Figure 1-4 (wiring diagram). Note that new wiring may need to be cut for proper fit, with service loop.
25. Replace junction box mounting bar socket head cap screws and tighten to 70 lb-in (95 N·m).
26. Remove Tool 1013-2567, or the 4.5” long stop block, depending on method used to position clevis for LVDT rod access. VBV 2 (closest to the turbine) butterfly valve disc weight will act to open the valve when the tool is removed from the top of the clevis. USE CAUTION when removing the tool and be aware that the valve and linkage may move to the valve open position.

⚠CAUTION

The weight of the butterfly valve on VBV 2 acts in the direction to open the butterfly valve. In some cases when the valve is new, the friction of the valve seal will hold the disc closed, but this cannot be depended upon. Working on the linkage in this position could apply enough force for the valve to start moving suddenly and cause a pinch point. Always move the VBV 2 butterfly valve to the open position using Tool 1013-2567 before working on the linkage.

27. Close the accumulator bleed needle valve and tighten jam nut.
28. CALIBRATE LVDT
    a. Turn on hydraulic system and check for leaks.
    b. In Calibration Mode, Command the actuator to 0% (valve slew min)
    c. Apply 7 Vrms at 3000 Hz to the excitation side of the LVDT (see wiring diagram, Figures 1-6 and 1-7).
    d. Measure feedback voltage and adjust the core rod so the feedback is V = 0.7 ±0.1 Vrms when the valve is fully closed.
    e. If adjustment is needed, turn off the hydraulic supply. Lock out-tag out pump or shutoff valve. Open accumulator bleed valve. Do not attempt to adjust the rod while the pumps are on and the actuator is pressurized.
    f. Adjust the core rod as needed. Tighten jam nut on the core rod.
    g. Repeat steps 27-28 as necessary to achieve calibration.
29. Replace the access covers for the junction box, and access covers on the yoke.
30. Recalibrate the control system with new LVDT values if necessary.

Accumulator Replacement

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Loosen jam nut and open accumulator bleed valve on top of actuator.
3. Loosen and remove the accumulator bracket clamp bolts.
4. While supporting the weight of the accumulator, remove the three accumulator mounting bolts from the top side of the accumulator manifold. Remove the accumulator.
5. Install a new O-ring (1355-1001) in the O-ring groove and retain with Vaseline or O-ring lubricant.
6. Slide the new accumulator into the bracket and support while installing the three mounting bolts. Torque to 40–50 lb-ft (54-68 N·m).
7. Reinstall the clamp bolts and tighten securely.
8. Close the accumulator bleed needle valve and tighten jam nut.

Valve Shaft Rotary Position Sensor Replacement

This section does not apply to units that exclude the valve shaft rotary position sensor.

1. Remove the sensor housing cover and open the junction box cover.
2. Disconnect the dual position sensor wires from their contacts in the junction box. Pull the sensor wires down the conduit.
3. Note the rotational location of the dot on the old sensor and mark its location on the housing. Loosen the cleat screws that hold the position sensor into the sensor housing. The cleat will clear the sensor with a ¼ turn counterclockwise rotation of the cleat once the screw is loose.

4. Install the new sensor, aligning the dot on the sensor as close as possible to the mark made in step 3.
5. Feed the new wires up to the junction box through the conduit.
6. Leave service wire loops on both ends. Connect the wires as shown in Figure 1-6 (wiring diagram).
7. Start the hydraulic pump. In Cal Mode, command the actuator to 0% (Valve Slew min). The current output should measure 5.1 ±0.5 mA.
8. Loosen the cleat screws and rotate the sensor as necessary to achieve the correct calibration. Tighten cleat screws.
9. Replace the sensor housing cover (torque to 70 lb-in (95 N·m) and close the junction box cover.

Temperature Sensor Replacement

The temperature-sensing units are in dry wells, so no oil will be lost when changing them out. Disconnect the leads in the junction box, remove the conduit, remove, and replace the temperature sensing unit. Reinstall the conduit and connect the new wires, leaving a service loop, as shown in Figures 1-6 and 1-7 (wiring diagram).

Rosemount Pressure Transmitter Replacement

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Loosen jam nut and open accumulator bleed valve on top of actuator.
3. Loosen and remove the Rosemount saddle clamp bolts.
4. Disconnect the sensor wires from their contacts in the junction box.
5. Remove the jam nut on the conduit connector inside the junction box.
6. Disconnect the hydraulic tubing line at the connection below the test port valve.

IMPORTANT

Hydraulic fluid may spill during Pressure transmitter removal.

7. Remove the transmitter. Transfer the conduit and plumbing hardware to the new valve.
8. Install the new transmitter assembly, reversing the steps to remove it.
9. Torque saddle clamp screws to 15-18 lb-ft (20–24 N·m).
10. Close the accumulator bleed needle valve and tighten jam nut.

Actuator (alone) Removal

The following instructions are for the removal of the actuator alone, leaving the valve, transfer case, and yoke in place.

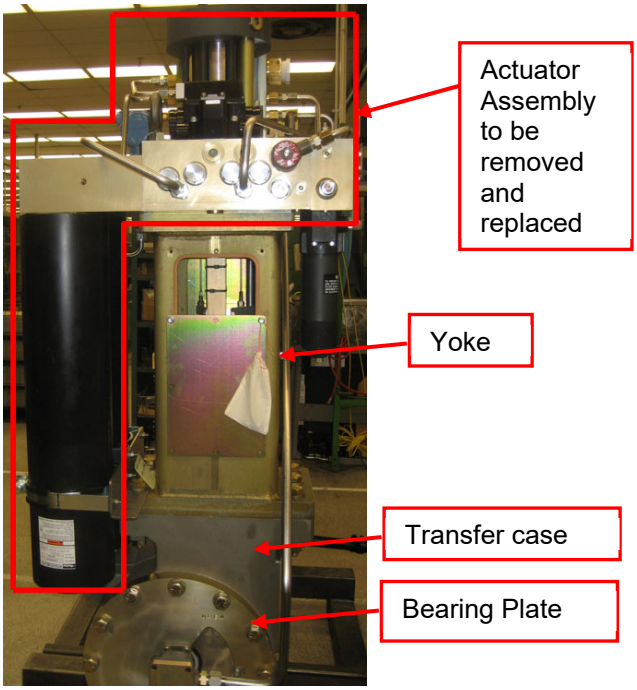


Figure 5-7. Assembly Diagram

1. In Calibration Mode, command the actuator to the 0% (Valve Slew min) position. Record the exact position reading from the valve shaft rotary position sensor. This does not apply to units that exclude the valve shaft rotary position sensor. This reading will be used later during reinstallation to check for correct rigging linkage adjustment between the actuator and butterfly valve.
2. Command the actuator to the 100% valve open position (Valve Slew max).
3. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
4. Loosen lock nut and open accumulator bleed valve at least 3 full turns.

⚠WARNING

The failsafe emergency trip system will suddenly and rapidly move the valve to the full open position upon loss of hydraulic supply or loss of trip solenoid voltage. DO NOT do any work on the actuator unless the hydraulic supply is turned off, locked out and accumulator bleed valve opened, and all accumulator pressure bled off. Failure to do so could result in severe personal injury.

5. Disconnect the hydraulic supply and drain lines. Note: Oil loss will occur and oil collection containers should be used.
6. Open the junction box and disconnect all customer wiring connections and conduit.
7. Disconnect the rotary position sensor wires and conduit from the junction box. The conduit clamp on the side of the yoke will need to be loosened to do this. This step does not apply to units that exclude the valve shaft rotary position sensor.
8. Loosen and remove the accumulator clamp bracket bolts.

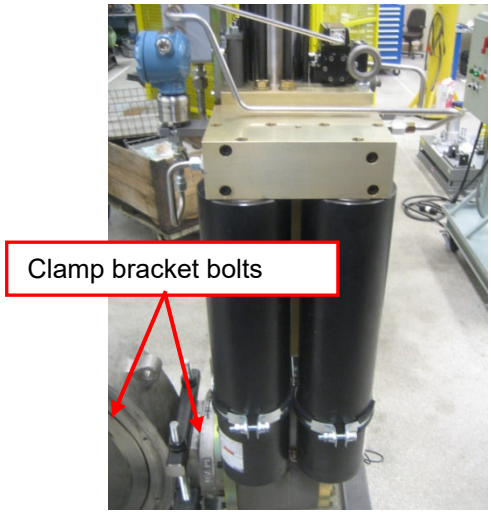


Figure 5-8. Accumulator Brackets

9. Remove inspection covers on both sides of the yoke.
10. Remove the linkage upper rod end from the clevis. First loosen the nut on the clevis clamp bolt 1–2 turns. Next, loosen and remove upper rod end nut and shoulder bolt.
11. Push the rod end sideways out of the clevis.

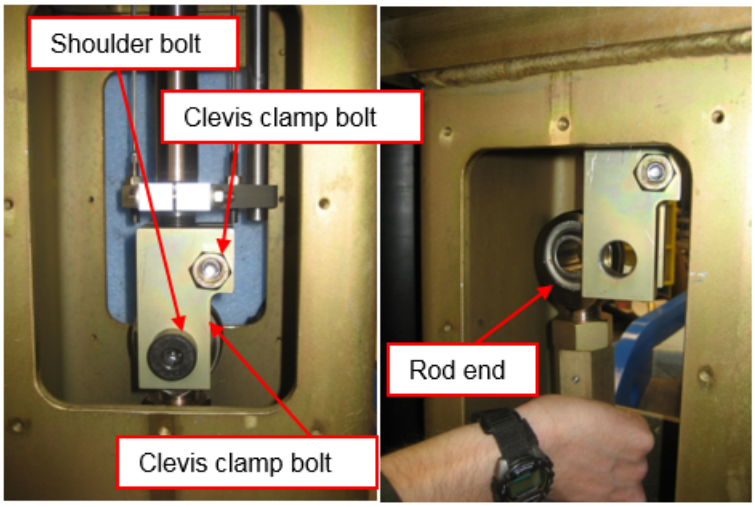


Figure 5-9. Upper Clevis Assembly Figure and Upper Rod End Removal

12. The clevis is threaded onto the actuator piston rod. Before removing the clevis from the actuator piston rod, measure its exact location from the bottom of the actuator manifold, with the actuator fully extended against its internal stop, is needed for reinstallation of the clevis on the replacement actuator. Make sure that the actuator is **fully extended** using Tool 1013-2567 when making this measurement. This measurement is used to position the clevis on the new actuator to ensure correct rigging of the actuator to the valve. After recording the measurement, remove the clevis from the piston rod. When a new actuator is installed, the clevis must be installed on the new actuator within ±0.020 inch (±0.51 mm) of the same axial distance from the bottom of the actuator as the one that was removed.

NOTICE

The clevis must be correctly installed to this tolerance. Failure to do so could cause damage to the valve and/or actuator.

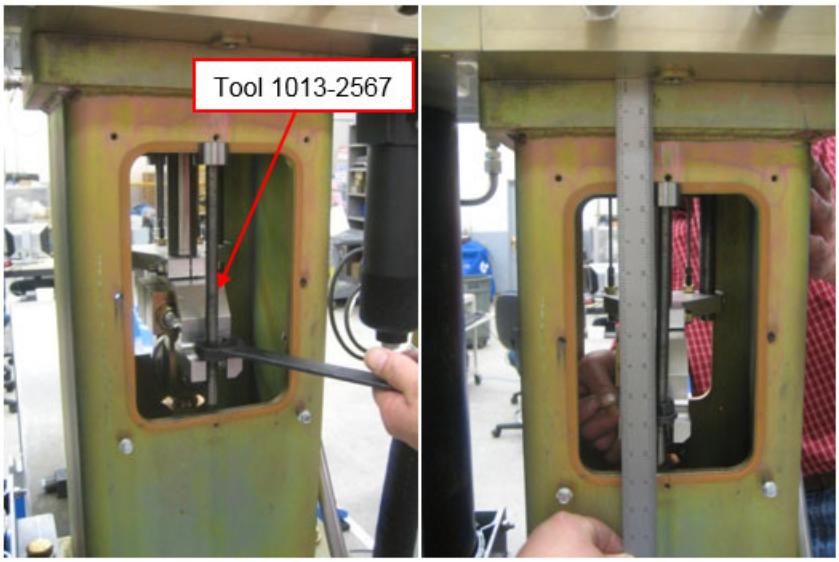


Figure 5-10a. Actuator Extension and Clevis Position

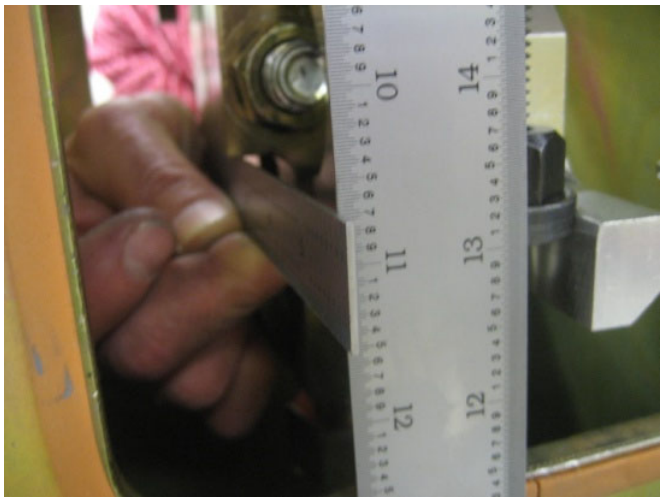


Figure 5-10b. Clevis Position Measurement

13. Remove Tool 1013-2567.
14. Attach appropriate lifting means to the two lifting eyes on top of the actuator.
15. Remove the four ¾” manifold bolts attaching the manifold to the yoke.

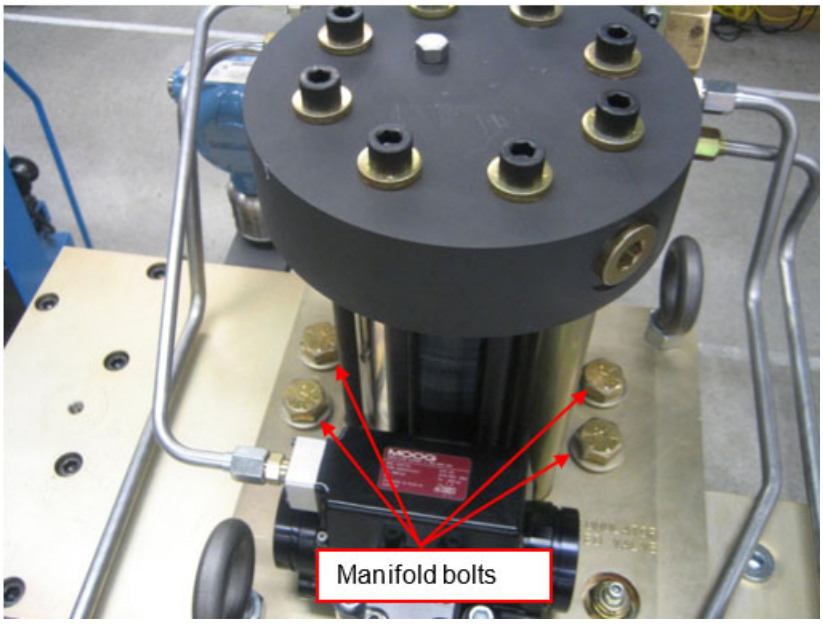


Figure 5-11. Manifold Bolt Removal

16. Remove the actuator. Extreme care must be taken to lift the actuator straight up in order to prevent damage to the LVDTs as they pass through the top plate of the yoke.

Actuator Installation

1. With the actuator output rod fully retracted, use the lifting eyes and appropriate lifting equipment to carefully place the actuator on top of the yoke. Extreme care must be taken to lower the actuator straight down in order to prevent hitting and damaging the LVDTs.
2. Install the four ¾” bolts and washers attaching the yoke to the transfer case. Torque to 220–270 lb-ft (300–366 N·m).
3. Open accumulator bleed valve.
4. Thread the clevis onto the piston rod and adjust the clevis until the distance from the bottom of the actuator matches that of the previously removed actuator within ±0.020 inch (±0.51 mm). Make sure that the actuator is fully extended using Tool 1013-2567 when making this measurement.
5. Remove Tool 1013-2567 after the clevis measurement is verified.
6. The clevis rotational orientation must be such that the shoulder bolt axis is positioned parallel with the valve shaft axis. Do not tighten the clevis clamp bolt at this time. It will be tightened after the rod end shoulder bolt is installed and torqued. Push the rod end sideways into the clevis.
7. Install upper rod end shoulder bolt and nut. Torque to 270 lb-ft (366 N·m).
8. Tighten the nut on the clevis clamp bolt to 140–180 lb-ft (190–244 N·m).
9. Install the accumulator clamp bracket bolts and tighten.

For units that include the shaft rotary position sensor, complete steps 10-15 listed immediately below (skip for units that exclude the shaft rotary position sensor).

10. Reconnect the rotary position sensor wires and conduit to the junction box.
11. Tighten the conduit clamp on the side of the yoke.
12. Reconnect all customer wiring connections and conduit. Close junction box.
13. Reconnect the hydraulic supply and drain lines.
14. Close the accumulator bleed valve and tighten jam nut.

15. Turn on the hydraulics and in Cal Mode, command the actuator slowly to the 0% (Valve Slew min) position. Compare the position reading from the valve shaft position sensor to that recorded before disassembly. The position needs to be –0.25 to +0.5 degrees (–0.04 to +0.06 mA) of the original reading. If not, turn off the hydraulics and open bleed valve. Remove the rod end from the clevis (loosen clamp bolt first) and adjust the clevis up (~0.040 inch/half turn [~1.02 mm/half turn]) to increase the reading or down to decrease the reading. The final clevis rotational orientation must be such that the shoulder bolt axis is positioned parallel with the valve shaft axis. Reconnect the rod end using steps 4 through 6. Repeat until position reading is within specification.

⚠WARNING

The failsafe emergency trip system will suddenly and rapidly move the valve to the full open position upon loss of hydraulic supply or loss of trip solenoid voltage. DO NOT do any work on the actuator unless the hydraulic supply is turned off, locked out and accumulator bleed valve opened, and all accumulator pressure bled off. Failure to do so could result in severe personal injury.

16. Reinstall covers on both front and back of the yoke.

Complete steps 17-25 for units that exclude the valve shaft rotary position sensor (skip units that include the shaft rotary position sensor).

17. Remove the position indicator shaft cover. There are four ¼” screws that attach the housing/cover to the bearing plate (see Figure 5-12).
18. Remove the indicator window retaining screw and window (see Figure 5-12).
19. Remove the twelve ¾” bolts attaching the bearing plate to the transfer case. Remove the bearing plate (see Figure 5-12).
20. With the actuator fully extended, using Tool 1013-2567 verify that the clearance between the valve lever and the bottom over-travel stops is approximately .100 inch (2.54 mm) (see Figure 5-13). This serves as verification that the clevis has been positioned properly. If needed, re-complete steps 4 through 6 until the clearance between the valve lever and bottom over travel stops is approximately .100 inch (2.54 mm).
21. Install the bearing plate. Torque the twelve bolts to 220–270 lb-ft (300–366 N·m).
22. Mount the position indicator shaft cover to the bearing plate with four ¼-20 screws. Torque to 70 lb-in (95 N·m).
23. Remove Tool 1013-2567. VBV 2 (closest to the turbine) butterfly valve disc weight will act to open the valve when the tool is removed from the top of the clevis. USE CAUTION when removing the tool and be aware that the valve and linkage may move to the valve open position.

⚠CAUTION

The weight of the butterfly valve on VBV 2 acts in the direction to open the butterfly valve. In some cases when the valve is new, the friction of the valve seal will hold the disc closed, but this cannot be depended upon. Working on the linkage in this position could apply enough force for the valve to start moving suddenly and cause a pinch point. Always move the VBV 2 butterfly valve to the open position using Tool 1013-2567 before working on the linkage.

24. Reinstall covers on both front and back of the yoke.
25. Close the accumulator bleed valve and tighten jam nut.

Complete Actuator and Transfer Case Removal

The following instructions are for the removal of the complete actuator assembly from the valve.

1. Turn off the hydraulic supply. Lock out-tag out pump or shutoff valve.
2. Loosen lock nut and open accumulator bleed valve at least three full turns.

⚠WARNING

The failsafe emergency trip system will suddenly and rapidly move the valve to the full open position upon loss of hydraulic supply or loss of trip solenoid voltage. DO NOT do any work on the actuator or valve unless the hydraulic supply is turned off, locked out and accumulator bleed valve opened and all accumulator pressure bled off. Failure to do so could result in severe personal injury.

3. Disconnect the hydraulic supply and drain lines.
   Note: Oil loss will occur, and oil collection containers should be used.
4. Open the junction box and disconnect all customer wiring connections and conduit.
5. Remove inspection covers on both sides of the yoke.
6. Remove the complete valve shaft Rotary Position Sensor assembly and conduit or remove the position indicator shaft cover on units that do not include the valve shaft rotary position sensor. There are four ¼" screws that attach the housing/cover to the bearing plate.

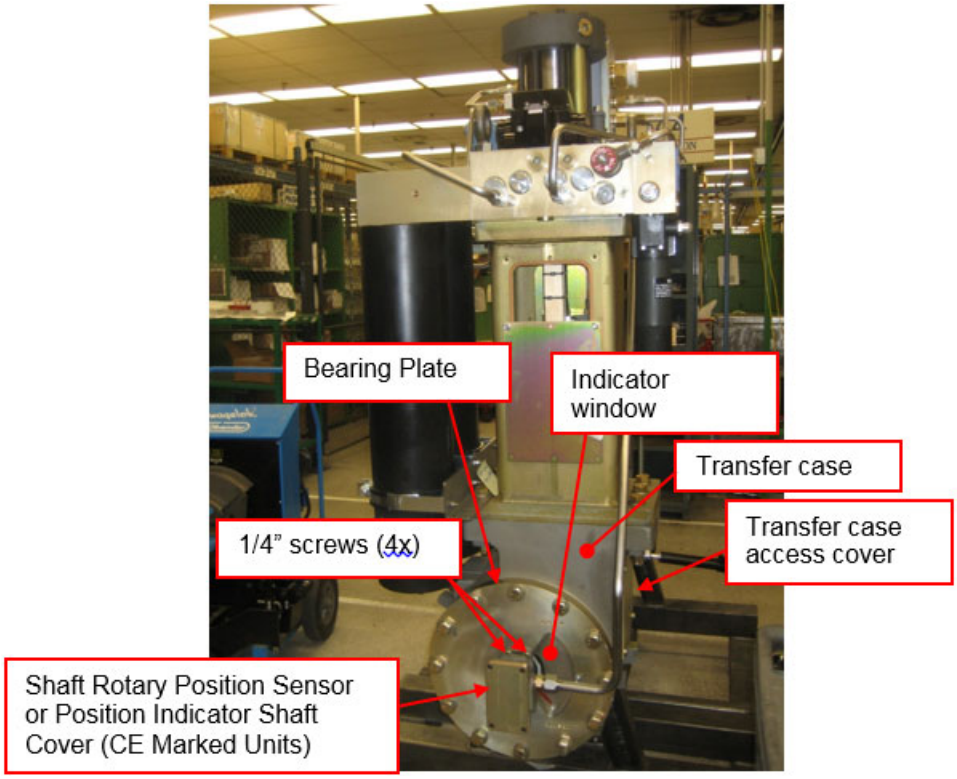


Figure 5-12. Transfer Case Diagram

7. Remove the indicator window retaining screw and window.
8. If this actuator is going to be reinstalled on this same valve, use a precision measurement device like calipers or depth micrometer to measure and record the height of the sensor magnet above the surface of the bearing plate before removing it. Also, the orientation of the dot on the magnet must be marked on the bearing plate with a permanent marker. This step does not apply to units that do not include the valve shaft position sensor.

9. "Loosen the two jam nuts on the magnet holder shaft, or the visual indicator arrow screw for valves without the position sensor. Remove the visual indicator arrow and magnet holder assembly (or visual indicator arrow screw) from the end of the butterfly valve shaft."
10. Remove the twelve ¾" bolts attaching the bearing plate to the transfer case. Remove the bearing plate.
11. Remove the transfer case access cover.
12. Remove the shoulder bolt that attaches the lower linkage rod end to the lever. The nut can be reached with a 1-1/8" wrench (29– mm) through the transfer case access port.
13. To remove the linkage upper rod end from the clevis, first loosen the nut on the clevis clamp bolt 1–2 turns. Next, loosen and remove upper rod end nut and shoulder bolt. Hold/support the linkage rod when removing the shoulder bolt (see Figure 5-9a).
14. Move the rod end sideways out of the clevis and remove the linkage rod through the rear yoke access window (under the junction box) (see Figure 5-9b).
15. Loosen both lever clamp screws and remove the lever from the valve shaft.

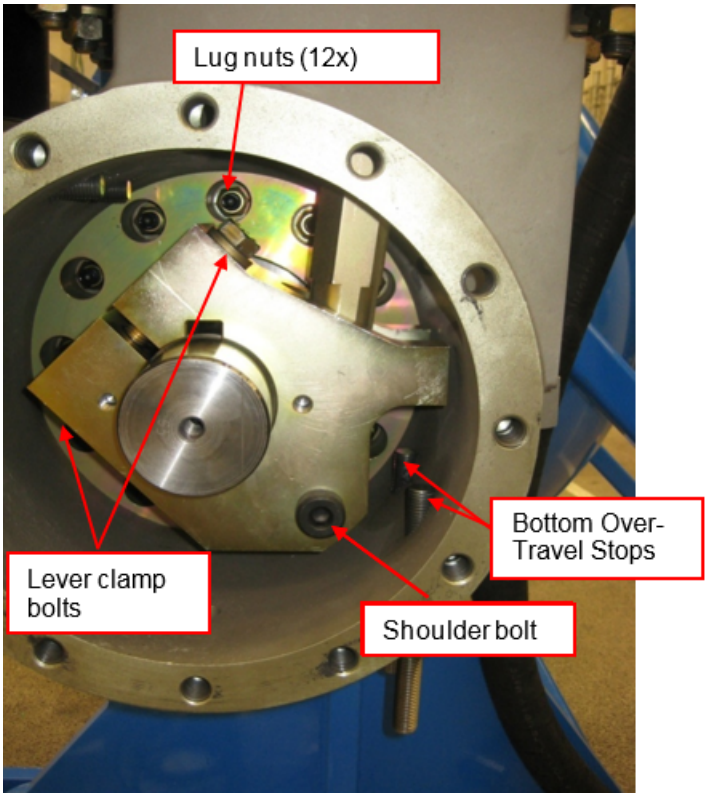


Figure 5-13. Lower Rod End and Valve Lever Removal

16. Attach appropriate lifting means to the two lifting eyes on top of the actuator and apply tension to support the weight of the actuator assembly.
17. Remove the twelve (lug) nuts inside the transfer case that attach the actuator assembly to the valve flange.
18. With the weight of the actuator fully supported by the crane, slide the actuator assembly off of the mounting studs and clear of the valve.

Complete Actuator and Transfer Case Installation

The following instructions are for the installation of the complete actuator assembly onto the butterfly valve.

NOTICE

Proper adjustment of linkage connecting the actuator to the valve is critical. Failure to properly adjust the linkage or over-travel stops will result in damage to the valve and/or actuator assembly.

IMPORTANT

Skip steps marked with an asterisk (*) if the exact same valve and actuator assembly are being reinstalled, WITH NO CHANGES to the actuator, actuator clevis position, linkage (rod end change or adjustment), valve shaft to disc pinning, or anything else that would affect the position of the butterfly valve disc relative to the actuator output rod. The linkage shaft may be reused as set from the factory in this situation only. Otherwise, all steps must be followed to ensure proper adjustment.

1. With the weight of the actuator fully supported by the crane, slide the actuator assembly carefully onto the mounting studs on the butterfly valve.
2. Install the twelve (lug) nuts inside the transfer case that attach the actuator assembly to the valve flange. Torque to 90–110 lb-ft (122–150 N·m).
3. Remove lifting equipment.
4. * Preset transfer case lever over-travel stops, back out until ~2 inches (~50 mm) is exposed on each stop screw (4x) outside of the transfer case.

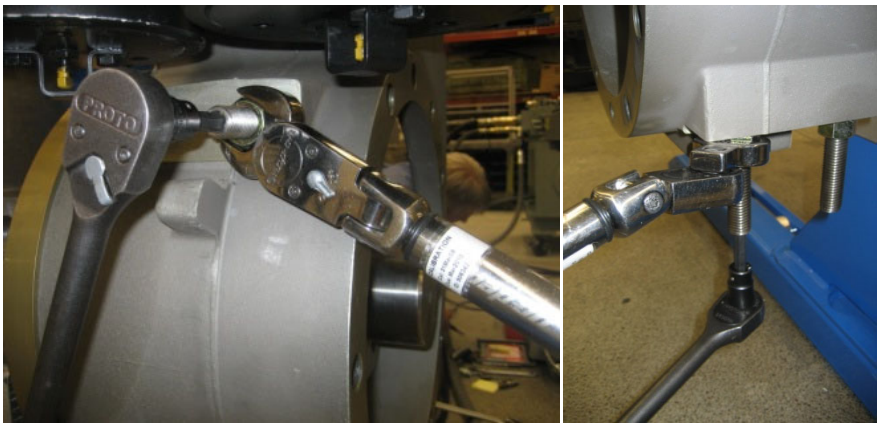


Figure 5-14. Side Over-Travel Stops and Bottom Over-Travel Stops

5. Install the key in the butterfly valve shaft.
6. Install the lever onto the butterfly valve shaft. Setback 2.75 inches (69.8 mm) from the end of the valve shaft and tighten the lever clamp screws to 330–400 lb-ft (447–542 N·m).

* Skip to step 21 if reinstalling a matched set VBV actuator and valve that have had no changes.

7. * Preset actuator linkage to its shortest length before installation. Loosen secondary locking set screw on the upper end of the linkage shaft. Loosen both lock nuts and turn both rod ends all the way into the shaft (shortest).
8. * Install the linkage shaft through the rear yoke window under the junction box. The machined end of the shaft is the lower end (has the left-hand thread rod end). Fit rod ends into the lever and clevis and install both upper and lower shoulder bolts.

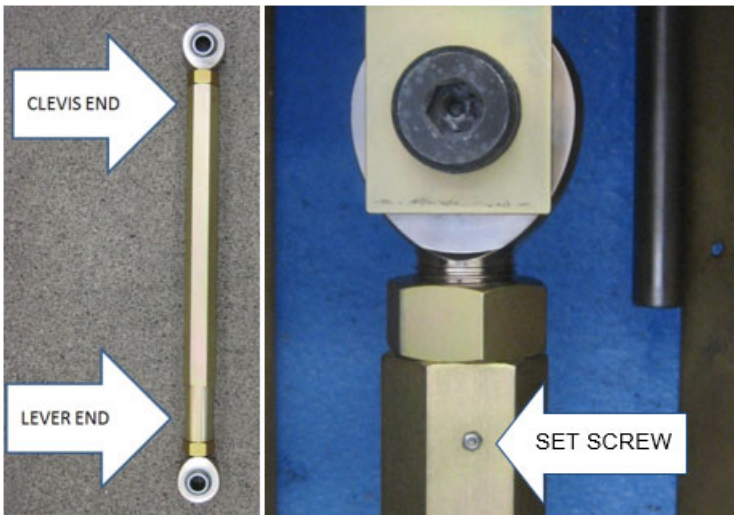


Figure 5-15. Actuator Linkage Assembly

9. * Install the nut on the upper shoulder bolt and torque to 270 lb-ft (366 N·m).
10. * Install the nut on the lower shoulder bolt and torque to 365 lb-ft (495 N·m).
11. * Torque the clevis clamp bolt to 140–180 lb-ft (190–244 N·m).
12. * Install the bearing plate. Torque the twelve bolts to 220–270 lb-ft (300–366 N·m).
13. * Open the accumulator bleed valve. Then, using Tool 1013-2567 (see Figure 5-5a), force the clevis downwards until the cylinder output rod is fully extended hard against its internal stop. Significant resistance (~50+ lb-ft, ~68+ N·m) will be felt on the jack screw nuts when the cylinder output rod is fully extended.
14. * Reach in through the transfer case access window and turn the linkage rod in the direction to extend it. Continue turning, which closes the valve, until significant resistance is felt. This will be felt when the butterfly valve disc contacts its “closed” stop on the valve housing. At this point the groove cut in the end of the valve shaft will be vertical. Next, turn the linkage shaft back ½ turn (shorten) which will give 0.18–0.38 inch (4.6–9.7 mm) of clearance for the valve disc from its stop. With this adjustment, the actuator will provide the rotation stops for the valve, preventing any damage to the valve disc stop from over travel.

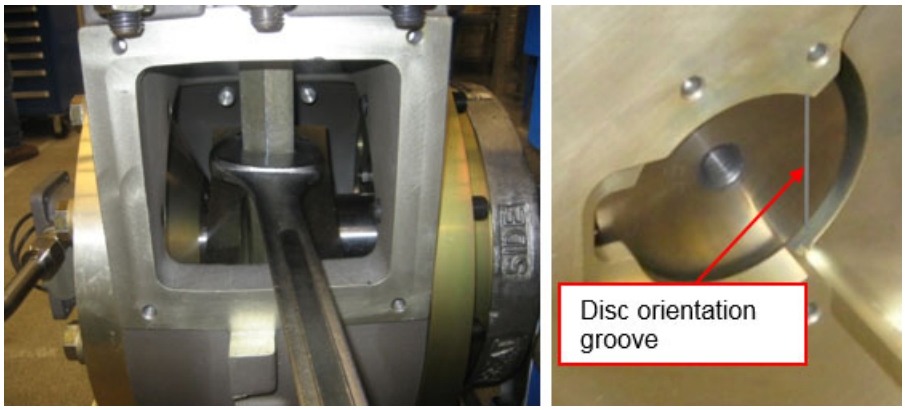


Figure 5-16 Actuator Linkage Adjustment and Disc Orientation

15. * Snug the linkage jam nuts against the hex shaft to prevent further rotation and loss of rigging adjustment of the linkage. Next, the linkage shaft needs to be removed in order to fully torque the jam nuts.
16. * Remove Tool 1013-2567. VBV 2 (closest to the turbine) butterfly valve disc weight will act to open the valve when the tool is removed from the top of the clevis. USE CAUTION when removing the tool and be aware that the valve and linkage may move to the valve open position.

On VBV 2 only, reinstall Tool 1013-2567 on the bottom side of the clevis and move the clevis upwards toward the open position until the linkage is unloaded (upper shoulder bolt is loose).

On VBV 1, the butterfly valve disc weight acts to close the valve, so there is no need to move the disc at this time.

⚠CAUTION

The weight of the butterfly valve on VBV 2 acts in the direction to open the butterfly valve. In some cases when the valve is new, the friction of the valve seal will hold the disc closed, but this cannot be depended upon. Working on the linkage in this position could apply enough force for the valve to start moving suddenly and cause a pinch point. Always move the VBV 2 butterfly valve to the open position using Tool 1013-2567 before working on the linkage.

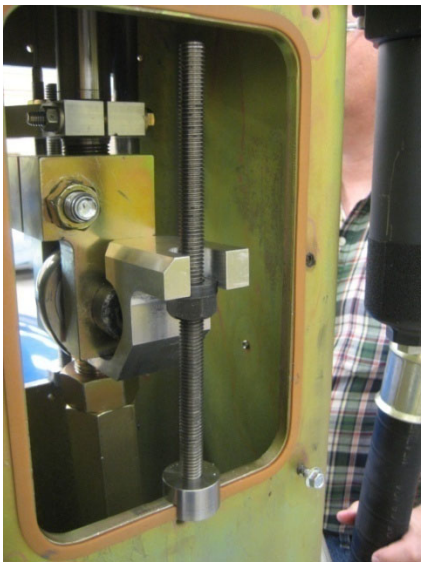


Figure 5-17. Tool 1013-2567 to Move Clevis Up

17. Remove the bearing plate, shoulder bolts, and then the linkage. Hold/support the linkage rod when removing the shoulder bolts. Remove the linkage through the rear access window (under the junction box).
18. While being careful to not lose the length adjustment, back off both jam nuts so that “removable” Loctite (242, 246, or equivalent medium strength thread locker) can be applied to the exposed rod ends threads.

Figure 5-18. Application of Thread Locker to Rod Ends

19. * Torque the jam nuts against the hex shaft to 900-1100 lb-ft (1220-1490 N·m). Make sure that the rod ends stay aligned with each other during this operation. **Failure to properly torque the jam nuts could allow them to loosen and the linkage length to change causing damage to the valve and possibly the turbine.**
20. * Tighten set screw into upper rod end to 13 lb-in (1.5 N·m).

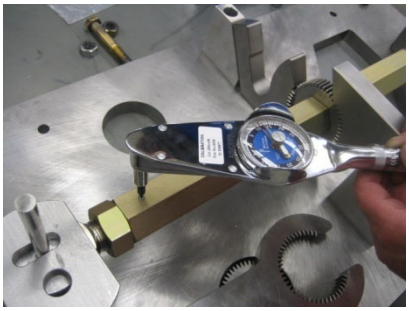


Figure 5-19. Tightening of Rod End Set Screw

21. Install the linkage shaft through the rear yoke window (under the junction box). The machined end of the shaft is the end that goes into the lever (also has the left-hand thread rod end). Fit rod ends into the lever and clevis and install both upper and lower shoulder bolts.
22. Install the nut on the upper shoulder bolt and torque to 270 lb-ft (366 N·m).
23. Install the nut on the lower shoulder bolt and torque to 365 lb-ft (495 N·m).
24. Torque the clevis clamp bolt to 140–180 lb-ft (190–244 N·m).
25. Install the bearing plate. Torque the twelve bolts to 220–270 lb-ft (300–366 N·m).
26. Using Tool 1013-2567 (see Fig. 5-5a), force the clevis downwards until the cylinder output rod is fully extended hard against its internal stop. Significant resistance (~50+ lb-ft, ~68+ N·m) will be felt on the jack screw nuts when the cylinder output rod is fully extended. The tool will hold the butterfly valve in the closed position while the Rotary Position sensor and valve position indicator are calibrated

For valves that exclude the rotary valve shaft position sensor, proceed to the below section titled "**Actuator and Transfer Case Installation (Continued) for Valves without the Rotary Position Sensor**" for further instructions and skip steps 27 through 41 listed immediately below.

27. Assemble the magnet holder with the two nuts and the indicator as shown. Thread into the end of the butterfly valve shaft.

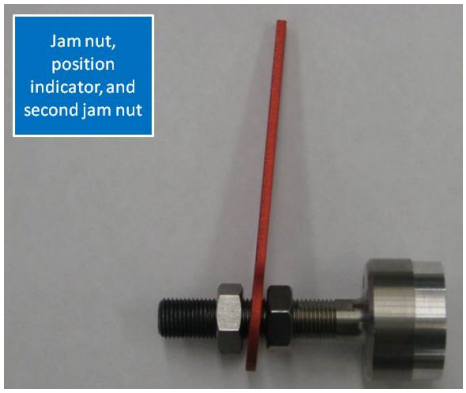


Figure 5-20. Magnet Holder Assembly

28. The magnet must be threaded into a position such that the gap between the magnet and the sensor is 0.040–0.060 inch (1.0–1.5 mm). Use a depth micrometer to measure the depth of the sensor below the sensor housing face that mates with the bearing plate and also the height of the magnet above the bearing plate. The sensor depth minus the magnet height must be 0.040–0.060 inch (1.0–1.5 mm). After achieving the correct setting, lock the first jam nut against the valve shaft. Torque to 19–24 lb-ft (26–32 N·m).

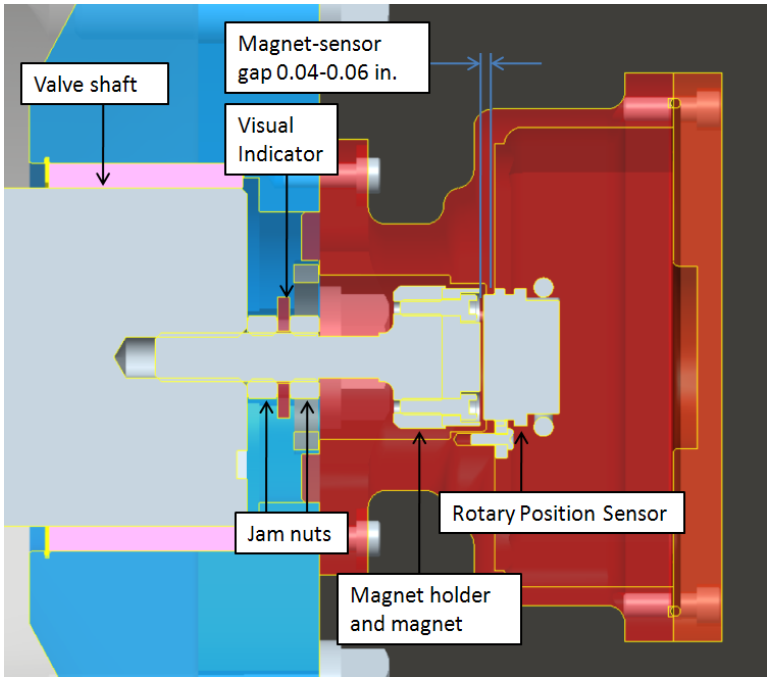


Figure 5-21. Installation of Magnet Holder Assembly

Hold the Visual Indicator in the closed position as shown and lock the second jam nut. Torque to 19–24 lb-ft (26–32 N·m).

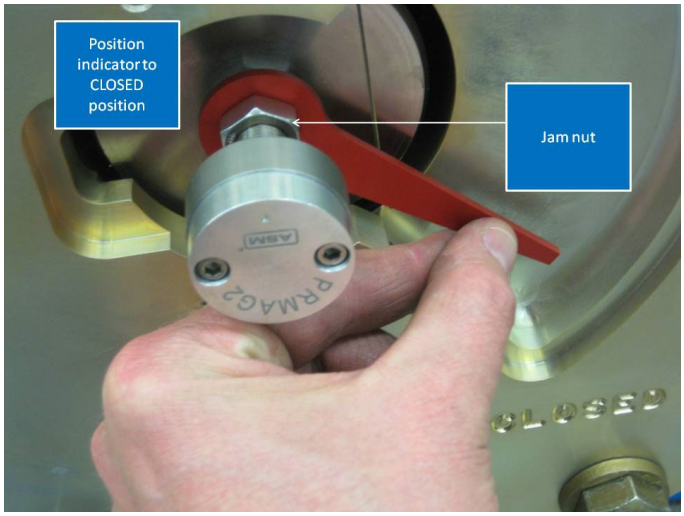


Figure 5-22. Visual Indicator Positioning

29. Open the cover on the rotary position sensor housing. The dots on the magnet and on the sensor are alignment calibration marks that coincide with mid-travel. With the valve in its current closed position, the sensor dot needs to pre-position approximately 50 degrees counterclockwise of the dot on the magnet. If the magnet dot is in the wrong quadrant, its two mounting screws may be removed, and the magnet repositioned to the closest quadrant. Next, loosen the cleat screws and rotate the sensor as necessary to achieve the correct orientation. Tighten cleat screws.
30. Install the clear window and retain with the ¼-20 screw with the rubber washer against the window.
31. Mount the Sensor housing to the bearing plate with four ¼-20 screws. Torque to 70 lb-in (95 N·m). Connect conduit and connect wiring in the junction box as shown in Figure 1-6 (wiring diagram).

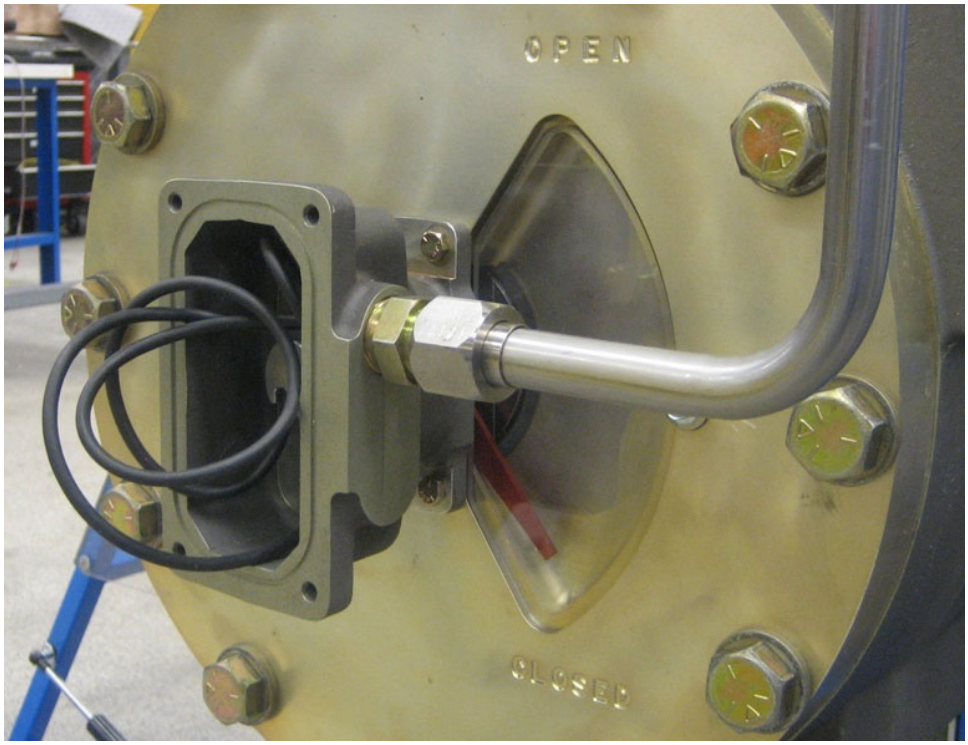


Figure 5-23. Rotary Position Sensor Installation

32. Final calibration of the Rotary position sensor. With 24 Vdc supply, the current output should measure 5.1 ±0.5 mA at the valve closed position. Loosen the cleat screws and rotate the sensor as necessary to achieve the correct calibration. Tighten the cleat screws.

33. Replace the sensor housing cover and torque screws to 70 lb-in (95 N·m).
34. *Loosen the jam nuts on the bottom over-travel stop screws. Turn each screw in until it just contacts the valve lever, then back out ½ turn. Torque jam nuts to 220–270 lb-ft (300–366 N·m).

Figure 5-24. Bottom Over-Travel Stop Screws

Remove Tool 1013-2567. Replace both yoke access covers and the transfer case cover. VBV 2 (closest to the turbine) butterfly valve disc weight will act to open the valve when the tool is removed from the top of the clevis. USE CAUTION when removing the tool and be aware that the valve and linkage may move to the valve open position.

⚠CAUTION

The weight of the butterfly valve on VBV 2 acts in the direction to open the butterfly valve. In some cases when the valve is new, the friction of the valve seal will hold the disc closed, but this cannot be depended upon. Working on the linkage in this position could apply enough force for the valve to start moving suddenly and cause a pinch point. Always move the VBV 2 butterfly valve to the open position using Tool 1013-2567 before working on the linkage.

35. Make all electrical connections as shown in Figure 1-6 or 1-7 (wiring diagram).
36. Connect the Hydraulic Supply and Drain lines.
37. Close the accumulator bleed needle valve and tighten the jam nut.
38. Turn on the hydraulic pump and check for leaks.
39. *In Calibration Mode, command the actuator to the 100% (Valve Slew max) position.
40. *Loosen the jam nuts on the side over-travel stop screws. Turn each screw in until it just contacts the valve lever, then back out ½ turn. Torque jam nuts to 220–270 lb-ft (300–366 N·m).

Figure 5-25. Side Over-Travel Stop Screws

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a "trip" command. During the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to "trip".

- **Command the actuator to stroke (but do not command it to "trip") between its fully retracted and fully extended positions at least 5 cycles to purge entrapped air from the actuator.**

Actuator and Transfer Case Installation (Continued) for Valves without the Rotary Position Sensor

Continued from step 26 in the above section titled "**Complete Actuator and Transfer Case Installation**".

27. Assemble the visual position indicator screw with the two nuts and the indicator as shown. Thread into the end of the butterfly valve shaft.

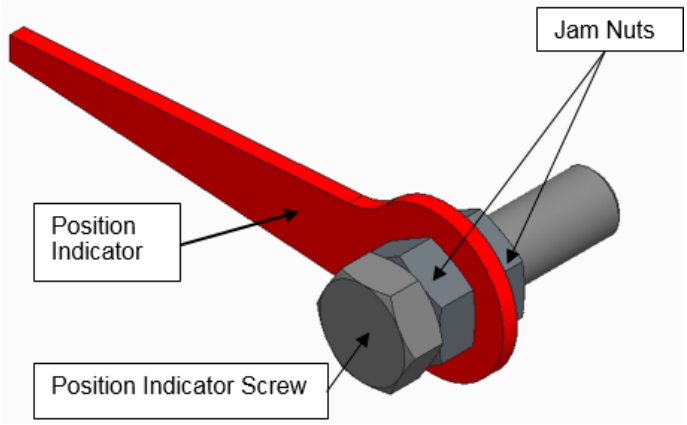


Figure 5-26. Position Indicator Assembly

28. The visual position indicator screw must be threaded into a position such that head of the screw will not interfere with the position indicator shaft cover. Use calipers or preferred method to measure the height of the screw head above the bearing plate. The screw head height must be 0.290-.340 inch (7.37-8.64 mm) above the bearing plate. After achieving the correct setting, lock the first jam nut against the valve shaft. Torque to 19–24 lb-ft (26–32 N·m).

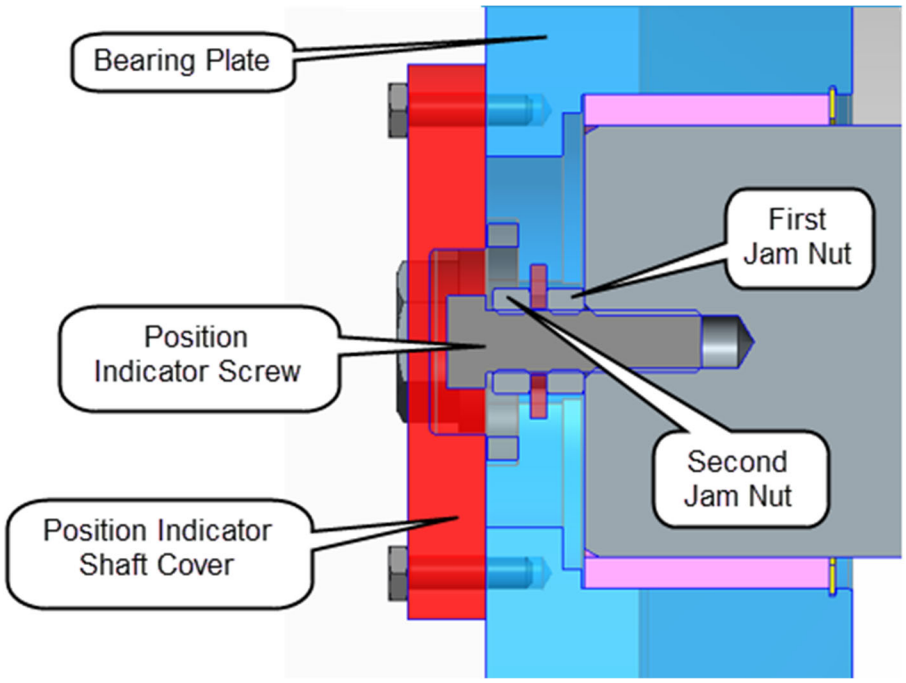


Figure 5-27. Installation of Position Indicator Assembly

29. Hold the Visual Indicator in the closed position as shown in Figure 5-22 and lock the second jam nut. Torque to 19–24 lb-ft (26–32 N·m).
30. Install the clear window and retain via the ¼-20 screw with the rubber washer and placed against the window.
31. Mount the position indicator shaft cover to the bearing plate with the four ¼-20 screws. Torque to 70 lb-in (95 N·m).
32. *Loosen the jam nuts on the bottom over-travel stop screws. Turn each screw in until it just contacts the valve lever, then back out ½ turn. Torque the jam nuts to 220–270 lb-ft (300–366 N·m) (see Figure 5-24).
33. Remove Tool 1013-2567. Replace both yoke access covers and the transfer case cover. VBV 2 (closest to the turbine) butterfly valve disc weight will act to open the valve when the tool is removed from the top of the clevis. USE CAUTION when removing the tool and be aware that the valve and linkage may move to the valve open position.

⚠CAUTION

The weight of the butterfly valve on VBV 2 acts in the direction to open the butterfly valve. In some cases when the valve is new, the friction of the valve seal will hold the disc closed, but this cannot be depended upon. Working on the linkage in this position could apply enough force for the valve to start moving suddenly and cause a pinch point. Always move the VBV 2 butterfly valve to the open position using Tool 1013-2567 before working on the linkage.

34. Make all electrical connections as shown in Figure 1-7 (wiring diagram).
35. Connect the Hydraulic Supply and Drain lines.
36. Close the accumulator bleed needle valve and tighten the jam nut.
37. Turn on the hydraulic pump and check for leaks.
38. *In Calibration Mode, command the actuator to the 100% (Valve Slew max) position.
39. *Loosen the jam nuts on the side over-travel stop screws. Turn each screw in until it just contacts the valve lever, then back out ½ turn. Torque the jam nuts to 220–270 lb-ft (300–366 N·m) (see Figure 5-25).

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a "trip" command. During the initial start-up and prior to operation following service of the actuator, oil filter, or hydraulic supply line, the following procedure must be completed before the unit is commanded to "trip".

Command the actuator to stroke (but do not command it to "trip") between its fully retracted and fully extended positions at least 5 cycles to purge entrapped air from the actuator.

Troubleshooting Charts

The following steps describe troubleshooting for the triple offset butterfly valves.

⚠WARNING

Disassembly of the actuator/valves in the field, other than what is presented in this manual, is not recommended due to the potentially dangerous forces contained in the springs. Under unusual circumstances where disassembly becomes necessary, all work and adjustments should be made by personnel thoroughly trained in the proper procedures.

When requesting information or service help from Woodward, it is important to include the part number and serial number of the valve assembly in your communication.

Table 5-2. Troubleshooting

Symptom	Possible Causes	Remedies
External hydraulic leakage	Static O-ring seal(s) missing or deteriorated	Replace O-rings fitted to user-serviceable components (filter, servovalve, trip relay valve) as needed. Otherwise, contact Woodward for service.
	Dynamic O-ring seal missing or deteriorated	Contact Woodward for service.
Internal hydraulic leakage	Servovalve internal O-ring seal(s) missing or deteriorated	Replace servovalve.
	Servovalve metering edges worn	Replace servovalve.
	Piston seal missing or deteriorated	Contact Woodward for service.
	Needle valve is not seated properly for normal operation	Hand tighten the needle valve for normal operation.
External process fluid leakage	Piping flange gaskets missing or deteriorated	Replace gaskets.
	Piping flanges improperly aligned	Rework piping as needed to achieve alignment requirements.
	Piping flange bolts improperly torqued	Rework bolts as needed to achieve appropriate torque requirements.
	Packing missing or deteriorated	Contact Woodward for service.

Symptom	Possible Causes	Remedies
Valve will not open	Servovalve command current incorrect. (The sum of the current through the three coils of the servovalve must be less than the null bias of the servovalve for the VBV to open.)	Trace and verify that all wiring is in accordance with the electrical schematic and the site wiring schematic(s). Pay special attention to the polarity of the wiring to the servovalve and LVDTs.
	Servovalve failure	Replace servovalve.
	Hydraulic supply pressure inadequate	Supply pressure must be greater than 2500 psig/172 Bar
	Trip relay not energized	Trip voltage must be between 20-28 Vdc.
	Filter element plugged	Check filter DP indicator. Replace element if the DP indicator shows red.
	Needle valve is not seated properly for normal operation	Hand tighten the needle valve for normal operation.
Valve will not close	Servovalve command current incorrect. (The sum of the current through the three coils of the servovalve must be more than the null bias of the servovalve for the VBV to close.)	Trace and verify that all wiring is in accordance with the electrical schematic and the site wiring schematic(s). Pay special attention to the polarity of the wiring to the servovalve and LVDT.
	Servovalve failure	Replace servovalve.
	LVDT failure	Replace LVDT.
	Linkage broken	Contact Woodward for service.
Valve will not respond smoothly	Hydraulic filter clogged	Check the differential pressure indicator on the filter housing.
	Servovalve spool sticking	Verify hydraulic contamination levels are within recommendations of Chapter 1.
	Servovalve internal pilot filter clogged	Replace servovalve.
	Piston seal worn out	Contact Woodward for service.
	Control system instability	Contact control system supplier.
Actuator seals wear out prematurely	Hydraulic contamination level is excessive	Verify hydraulic contamination levels are within recommendations of Chapter 1. The use of excessive dither may reduce life in contaminated systems.
	System is oscillating (seal life is proportional to distance traveled). Even small oscillations (on the order of ±1%) at slow frequencies (on the order of 0.1 Hz) cause wear to accumulate rapidly.	Determine and eliminate the root cause of oscillation. Possible causes include inlet pressure regulation, control system setup or algorithm, and improper wiring practices.

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 **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

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 (5-01-1205) 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 Product and Service Warranty 5-01-1205).

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 Product and Service Warranty 5-01-1205) 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 Product and Service Warranty 5-01-1205). 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 assure 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. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: **www.woodward.com**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **www.woodward.com/directory**, 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 obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
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) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
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 F—

- Corrected arrow location on Figure 5-4

Changes in Revision E—

- Removed ATEX Directives and EMC Directive from the Regulatory Compliance Section
- Edited the North American Compliance verbiage
- Added Pressure sensor part number 1699-1322 to Table 5-1
- Removed “Emergency” from the Shutdown Solenoid from Table 5-1
- Removed referenced to CE Markings
- Removed EU Declaration of Conformity

Changes in Revision D—

- Added new certifications and updated existing certifications to the Regulatory and Compliance Section
- New content added to Special Conditions for Safe Use
- New Warning box on pg. vii
- New Ambient Temperature Range Specification
- New DOC/DOI
- Replaced drawing in Figure 1-7

Declarations

NOTE—Sample DoCs are provided, a serialized DoC ships with each valve and accumulator.

DeZURIK, Inc.

DeZURIK

EC Declaration of Conformity (PED)

To the Pressure Equipment Directive #97/23/EC

Sold to:

GEXPRO
PO BOX 3221
NAPERVILLE, IL 60566

Authorized Representative
Within the European Community:

Customer Purchase Order No 440906861AA C001 Manufacturer Sales Order No 860379 - 1

Manufacturer's Tag Number	Qty	Description	PED Product Category	Technical File & Revision No.
A860379001001	1	BHP,36,W1,S2,TC,S2-S5-FT-RT,PEDL**YYZ017	III	
A860379001002	1	BHP,36,W1,S2,TC,S2-S5-FT-RT,PEDL**YYZ017	III	
A860379001003	1	BHP,36,W1,S2,TC,S2-S5-FT-RT,PEDL**YYZ017	III	
A860379001004	1	BHP,36,W1,S2,TC,S2-S5-FT-RT,PEDL**YYZ017	III	

Notified Body address & No:
BUREAU VERITAS UK. LTD
MANCHESTER UK, M202RE
I.D. No: 0041

EC Certificate Module "H"
Other EC Directives Machinery Directive maybe applicable.
Reference Design Standards ASME B16.34, ASME B31.3

We hereby declare that the product(s) described above are in conformance with the European Community Pressure Equipment Directive #97/23/EC.

Signature [signature] Title Principal Research Engineer Date 3/1/10
Print Name JOHN E. FALE Title Principal Research Engineer
Prepared by [signature] Title Quality Technician Date 03/01/10
Print Name JEFF TEER Title Quality Technician

DeZURIK * 250 Riverside Ave. N. * Sartell, Minnesota 56377 USA
Telephone: (320) 259-2000 * Fax: (320) 259-2227
Web Site: www.dezurik.com * E-mail: info@dezurik.com

Form No. 1691-1009

Konformitätserklärung
Declaration de conformité
EC DECLARATION OF CONFORMITY

Parker Hydraulics

Herausgegeben in Übereinstimmung mit der Druckgeräterichtlinie 97/23/EC
Selon Directive européenne 97/23/CE
Issued in accordance with the PRESSURE EQUIPMENT DIRECTIVE (PED) 97/23/EC

Parker Hannifin / Hydraulic Accumulator Division
10711 N. Second Street
Rockford, IL 61115 USA
United States of America

Wir erklären hiermit, dass das unten genannte Produkt in Übereinstimmung mit der oben genannten Richtlinie für die Aufnahme von Flüssigkeiten und Gase nach Gruppe 2 hergestellt wurde.

Le signataire ci-dessous déclare que la fabrication du produit décrit ci-dessous est conforme à la directive concernant les fluides dangereux liquides et gazeux du groupe 2.

We hereby declare that the Products listed below have been manufactured in accordance with the above mentioned Directive for use with non-hazardous fluids of Group 2.

Modell-Nr. / Modèle N° / **Model No.**	Serien-Nr. / Identification N° / **Serial No:**	Teilenummer Kunde / numéro de pièce client / Customer Part Number	Bestellnummer Kunde / numéro de commande / achat client / Customer Purchase Order Number
A6E0578L1K	554931-01-01 to 554931-01-02	Unknown	6149428

Volumen des Flüssigkeitsraums / Volume interne de la capacite hydraulique / **Internal volume of Hydraulic Chamber**	Volumen des Gasraumes / Volume interne de capacite gazeuse / **Internal volume of Gas Chamber**	Maximaler Betriebsdruck / Pression d'utilisation maximale / **Maximum Working Pressure:**	Verkäufe Auftragsnummer / Numéro De Commande De Ventes / **Sales Order Number:**
9.47 Liters	9.98 Liters	350 Bars	554931-01

Auslegungstemperaturbereich (min / max) / Plage de temperature calculee (min / max) / **Design Temperature Range (min/max)**	Monat und Jahr der Herstellung / Mois et annee de la fabrication / **Month and Year of Manufacture:**	Zeichnungsnr / Plan N° / **Drawing No:**	Kategorie / Categorie / **Category**
-20° C to +100° C	May 2009	871080	IV

Dauerfest bei max. zulässige Druckschwankungsbreite / Pression differentielle maximale pour duree de vie optimale / **Maximum Pressure Differential for Fatigue Free Life**	Zulassungsnummer: / Numéro de controle apres examen: / **EC Design Examination Number:**	Beschreibung des Produkts: / Type de produit: / **Product Description:**
197.9 Bars	CE-0041-PED-H1-PAR 01-07-USA	Piston Accumulator

Dieser Druckspeicher wird in unterchiedlichen Betriebszuständen eingesetzt und die Festigkeit wurde ermittelt. (Zyklen im Druckbereich)
Ces accumulateurs fonctionnent sous des conditions de charge changeantes et ont ete evalue pour leur resistance a la fatigue (Cycles pressione)
These accumulators operate under changing load conditions and were evaluated for their resistance to fatigue. The following cycle limits are imposed. (Cycles at pressure range)

695,734 @ 140 to 350 Bars

Angewandte Konformitätsbewertungsverfahren / Procédure d'évaluation de la conformité utilisée / Conformity assessment Modules used	Organisme notifié Code identification: / Bennante Stelle Identnummer: / Notified Body Identification No:	Angewendte Normen: / Standards applicables: / **Applicable Standards:**
H1	0041	PED Annex I, ASME Section II, AD Merklatter B, EN 14359

Cert. No.: CE-0041-PED-H1-PAR 01-07-USA

ISO Cert No. 205527

Mitgeteilte Körper-Adresse:
Adresse Annoncée De Corps:
Notified Body Address:
Bureau Veritas Inspection Limited
Parklands 825A Wilmslow Road
Didsbury, Manchester M20 2RE

Signature autorisee par le fabricant:
Verbindliche Unterschrift des Hertsellers:
Authorized Signature for the manufacturer:

Paul Thompson, Plant Quality Manager

Wednesday, May 06, 2009

Form-0113 Rev 1

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

File name:	00393-04-EU-02-01
Manufacturer's Name:	WOODWARD INC.
Manufacturer's Address:	1041 Woodward Way Fort Collins, CO 80524 USA
Model Names:	Variable Bleed Valve for GE LMS100
This product complies, where applicable, with the following Essential Requirements of Annex I:	1.1, 1.2, 1.3, 1.4, 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.

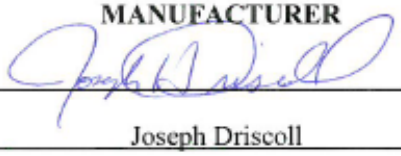
The person authorized to compile the technical documentation:

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 Governor Company 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

Joseph Driscoll
Full Name

Engineering Manager
Position

Woodward Inc., Fort Collins, CO, USA
Place

12/4/16
Date

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

Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26504.

B 2 6 5 0 4 : F

PO Box 1519, Fort Collins CO 80522-1519, USA
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.