WOODWARD

Product Manual 26572
(Revision NEW)
Original Instructions

Woodward M-Spring Actuator with 12-inch Triple Offset Butterfly Valve

Installation and Operation 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* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, 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* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, 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 Out-of-date translations are marked with ⚠.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.

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Important Definitions

⚠ This is the safety alert symbol. It is 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.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

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 of Electrical Components

Servo Valve:

- Certified to European Standard EN60079-15:2005 per KEMA 02ATEX1016X.
- Certified for Class I, Division 2, Groups A, B, C, D for use in the United States per FM4B9A6AX.
- Certified for Class I, Division 2, Groups A, B, C, D for use in Canada per CSA 1072373.

LVDT:

- Certified to European Standard EN60079-15:2005 per ITS06ATEX45394X.
- Certified for Class I, Division 2, Groups A, B, C, D for use in the United States and Canada per ETL J98036083-003.

Junction Box:

- Compliant to European Standard EN60079-15:2005 by DoC issued by Rose Enclosures.
- Certified for Class I, Zone 1, AEx e II, Ex e II hazardous locations in the United States and Canada per UL E203312.

Electric Trip Solenoid:

- Compliant to European Standard EN60079-15:2005 by DoC issued by G.W. Lisk Company, Inc.
- Certified for Class I, Divisiion 2, Groups A, B, C, D for use in the United States and Canada per CSA 1260548.

Wiring must be in accordance with North American Class I, Division 2 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field Wiring must be suitable for at least 100 °C.

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

⚠WARNING	**Explosion Hazard—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division 2 or Zone 2 applications.**

⚠AVERTISSEMENT	**Risque d'explosion—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.** **La substitution de composants peut rendre ce matériel inacceptable pour les emplacements de Classe I, Division 2 ou Zone 2.**

Chapter 1.
General Information

Introduction

The Woodward Triple Offset Valve is a metal-seated butterfly type. The sealing system geometry is two matching conical zones that must be carefully mated to each other and coupled to the remainder of the working elements in order to achieve the characteristics desired.

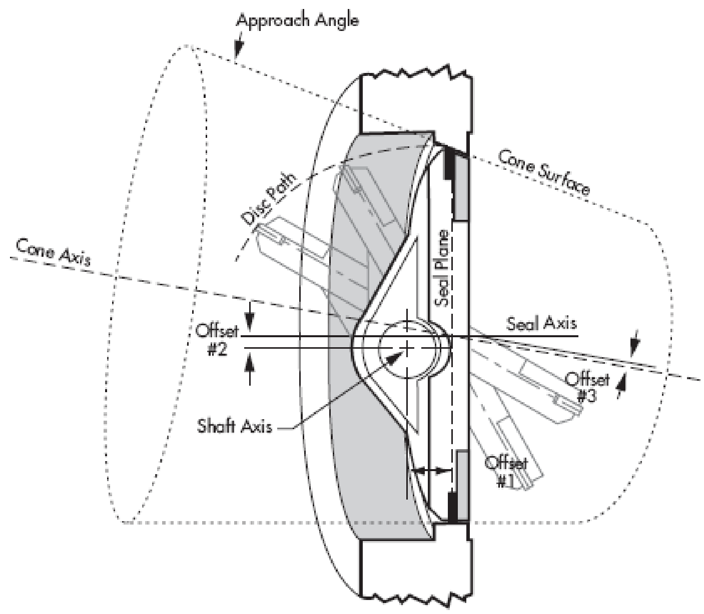


Figure 1-1. Triple Offset Valve Geometry

Optimum control of the gas turbine requires that the actuator and valve accurately and quickly track the demand signals transmitted by the control. The M-Spring (Mechanical Spring) actuator 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 electric trip relay valve has been selected to provide high operating force margins, high flow capacity, and to ensure the desired closure rate of the valve under trip conditions.

By using a long actuation rod between the hydraulic cylinder and the valve lever arm, the side-loading forces on the actuator shaft and seals are greatly reduced, decreasing the wear between sliding parts, and increasing the useful service life of the system. The ample distance between the wetted heavy-duty linear slide rings within the M-Spring actuator, accommodates any remaining side load. These provisions provide extended service life even in severe service conditions.

Gas Stop/Ratio Valve Functional Characteristics

Feature	12 Inch TOV
GE order ordering drawing	389A3956
GE function specification	389A3955
Mating Valve	12 Inch Class 300 TOV 1309-6157
Valve Body Material	A351 CF8M (316 SS)
Valve Max Cv	2730
Cv accuracy	±10%
Modulating service	Continuous modulation 25 deg to 85 deg
Actuator Type	Single Acting Spring Return
Valve stem travel stops	Actuator serves as stop in opening direction, valve serves as stop in closing direction
Shutoff Leakage Classification	VI
Allowable Vent Packing Leakage	1 sccm
Total Trip time	0.35 s
Trip Valve Type	Electric (90–140 Vdc; 10 W max.)
LVDT Stroke	8.5 inches (21.6 cm)
LVDT Voltage Span	0.7–3.0 Vrms
Number of LVDTs	2
LVDT Accuracy	±1% of Full Stroke
Hydraulic Supply Pressure	1600 ±20 psig (10 342 ±138 kPa)
Slew Time (open/closed)	0.7 ±0.3 s
Ambient Temp	–20 to +180 °F (–29 to +82 °C)
Maximum Fluid Temperature	500 °F (250 °C)
Max Differential Pressure Forward	500 psid (2241 kPa)
Max Differential Pressure Reverse	570 psid (2792 kPa)

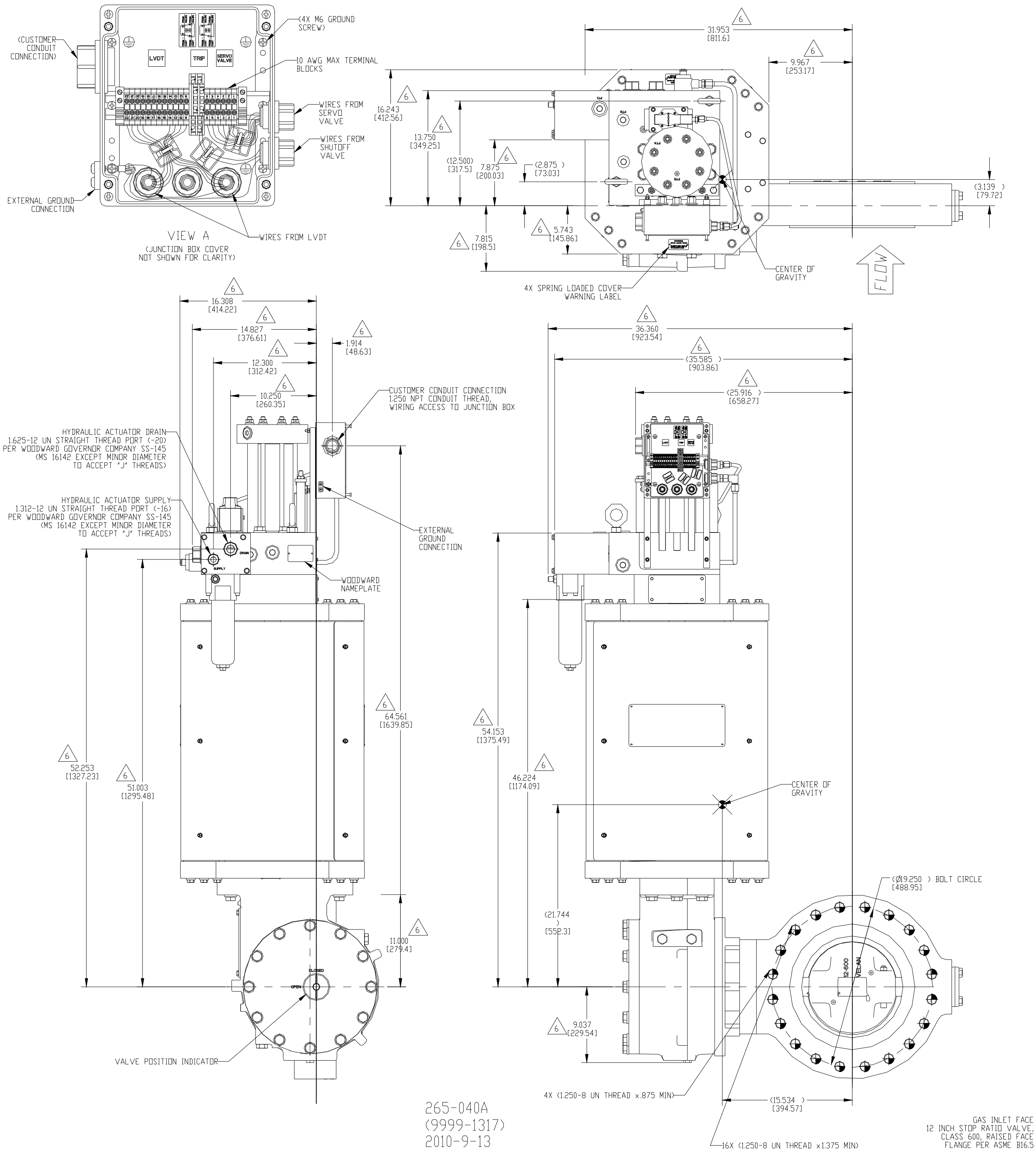
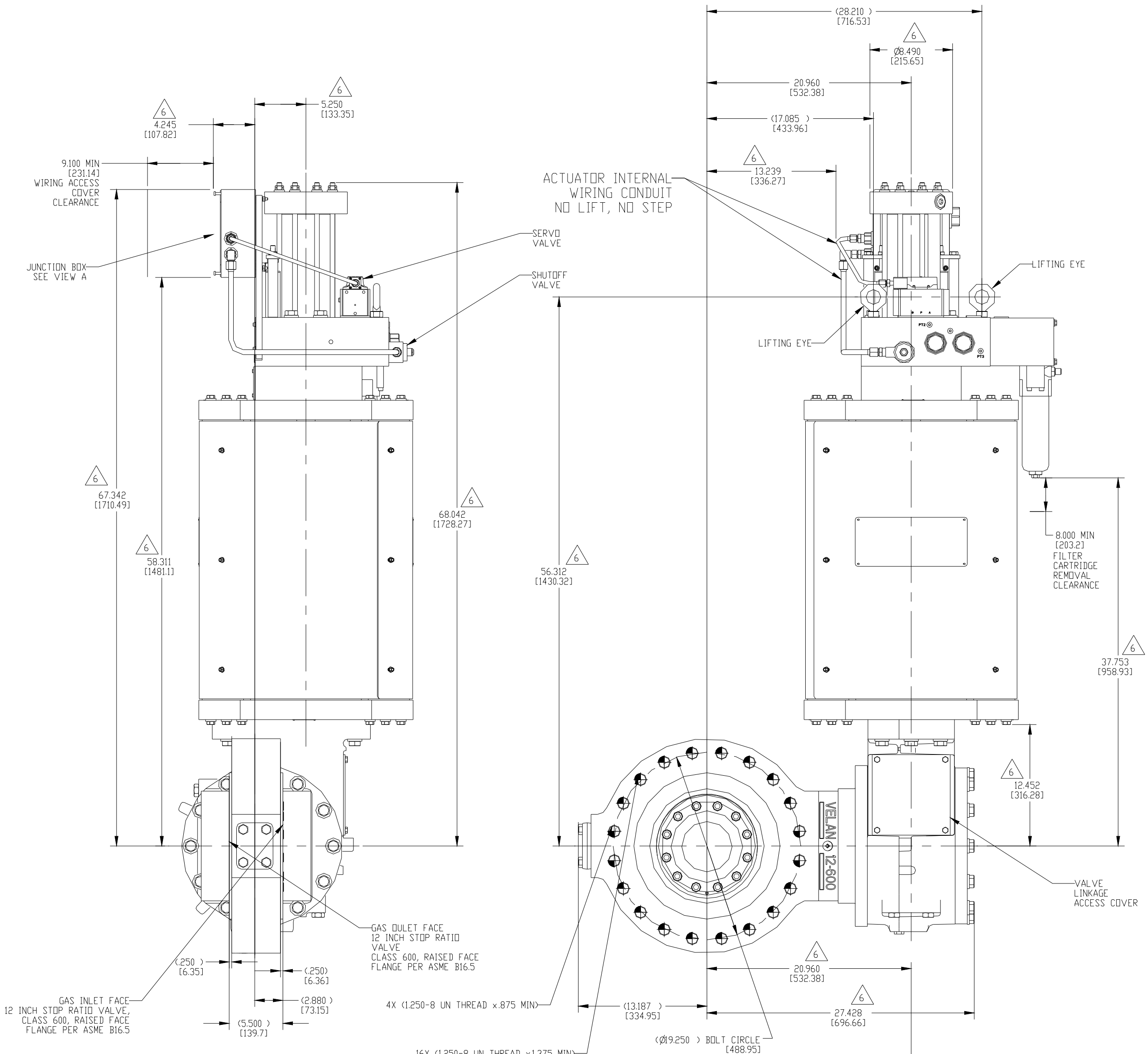


Figure 1-2a. 12" Triple Offset Butterfly Valve Outline Drawing



NOTE:

1. THIS IS AN INSTALLATION DRAWING FOR 9904-1442.
2. INSTALLATION ORENTATION
   - PIPE SUPPORTED ONLY
   - ORENTATION VERTICAL APPROXIMATELY AS SHOWN
   - SEE MANUAL FOR OTHER INSTALLATION RECOMMENDATIONS.
3. APPROXIMATE WEIGHT 1880 LBS.
4. PROCESS FLUID: SYNGAS
   MAXIMUM WORKING FLUID TEMP: SYNGAS 482°F

5. .250-18 NPTF PORT FOR PACKING "LEAK OFF" VENT (INNER SEAL)

6. FOR FIRST ARTICLE INSPECTION (FAI) REQUIREMENTS. SEE WOODWARD 4-09-2704.

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Figure 1-2b. 12" Triple Offset Butterfly Valve Outline Drawing

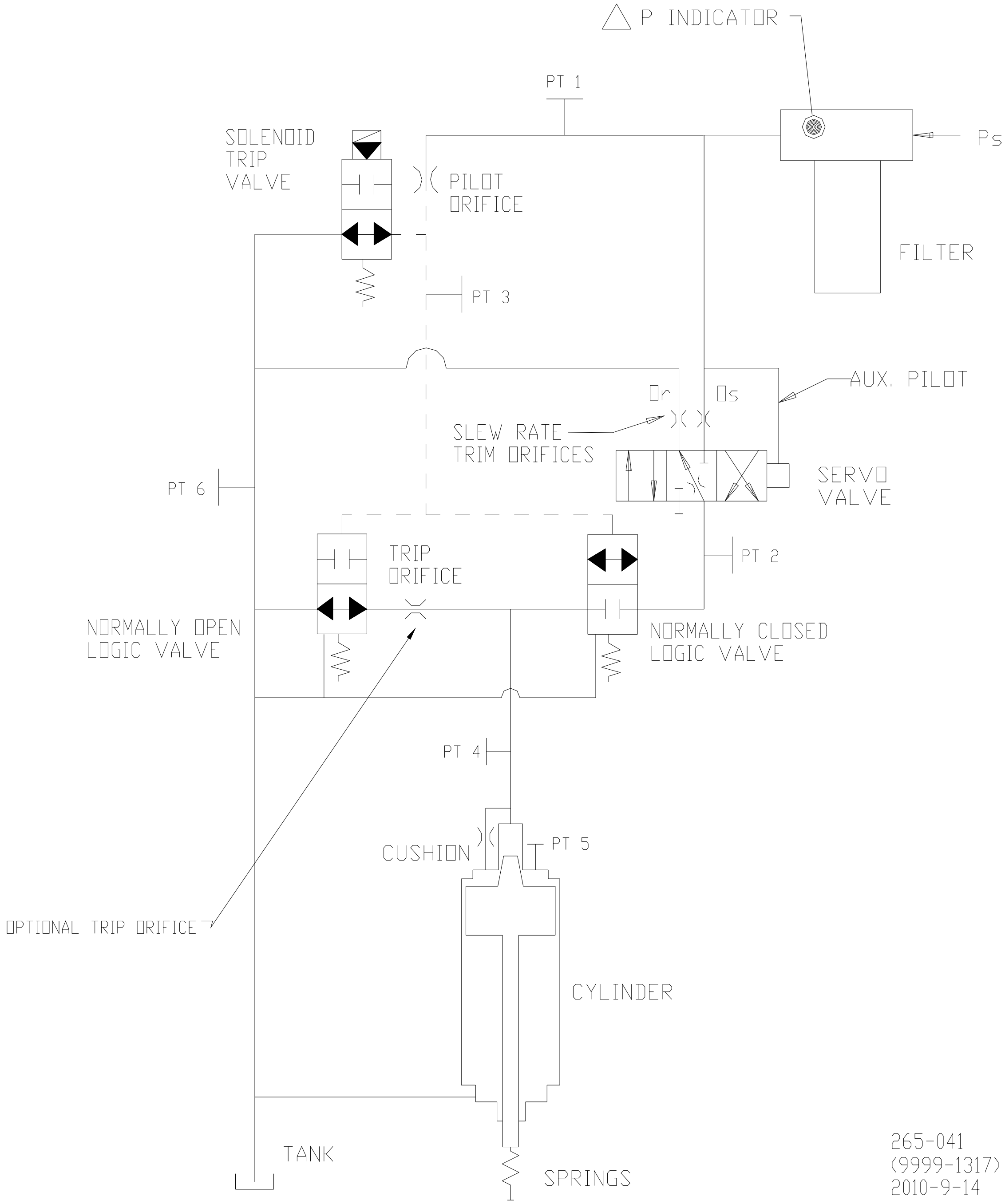

Figure 1-3. M-Spring Actuator Hydraulic Schematic

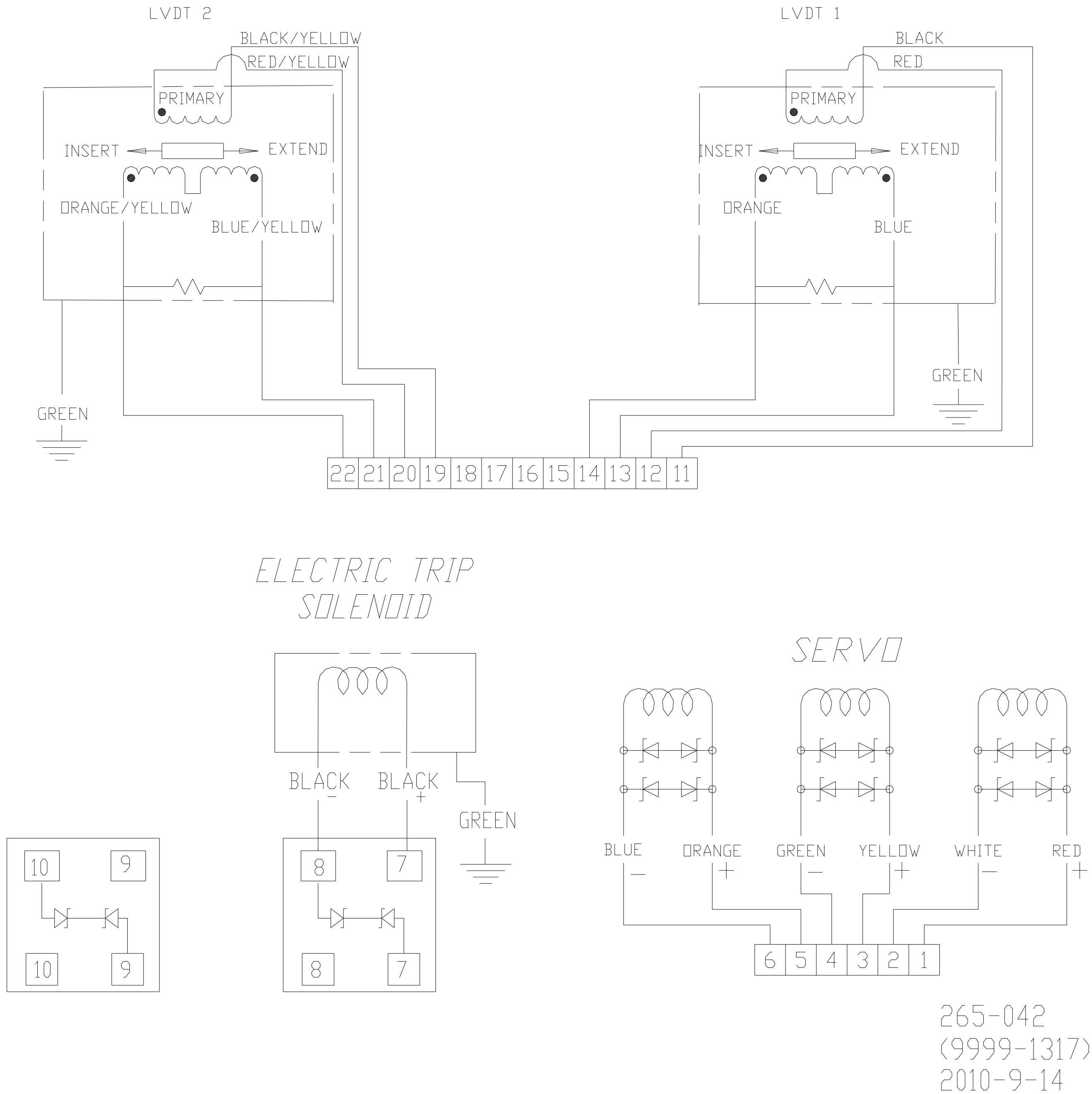

Figure 1-4. M-Spring Actuator Electrical Schematic and Wiring Diagram (Dual LVDT)

Chapter 2.
M-Spring Actuator Operation

The M-Spring 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 1-3 for a functional schematic of the single acting actuator.

Hydraulic oil enters the actuator via a removable element filter with integral high ∆P indicator and is directed to a four way, electrohydraulic servo valve used in a three-way configuration. The PC1 control pressure output from the servo valve is directed to the top of the hydraulic piston. When the force exerted by the hydraulic pressure exceeds the force of the opposing loading springs, the output piston extends, rotating the valve in the opening direction.

The trip relay circuit utilizes a solenoid operated valve and two logic valves to override the servo pressure that is normally directed to the top of the hydraulic piston. When the trip solenoid is de-energized, these valves act in concert to block the servo valve output and to dump the pressure above the hydraulic piston to drain. The actuator spring force then rapidly retracts the actuator, rotating the gas valve to the closed position.

Redundant LVDT position feedback transducers are also 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.

Chapter 3. Standard Component Details

Triple Coil Electrohydraulic Servo Valve Assembly

The M-Spring actuator utilizes a two stage hydraulic servo valve to modulate the position of the output shaft and thereby control the Triple Offset 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.

If the control system requires a rapid movement of the valve to increase fuel pressure to the control valves, the total current is increased well above the null current. In such a condition, supply oil is admitted to the cavity above the actuator piston. The flow rate delivered to the upper piston cavity 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 a rapid movement to reduce fuel pressure downstream of the butterfly valve, the total current is reduced well below the null current. In such a condition, the actuator piston cavity is connected to the hydraulic drain circuit. The flow rate returning from the upper piston cavity of the valve is proportional to the magnitude of the total current below the null value. The flow rate and closing velocity of the valve are in this case proportional to the total current below the null point.

Near the null current, the servo valve essentially isolates the upper piston cavity from the hydraulic supply and drain, and the upper piston pressure and spring load 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 coil to obtain proper closed loop operation of the system.

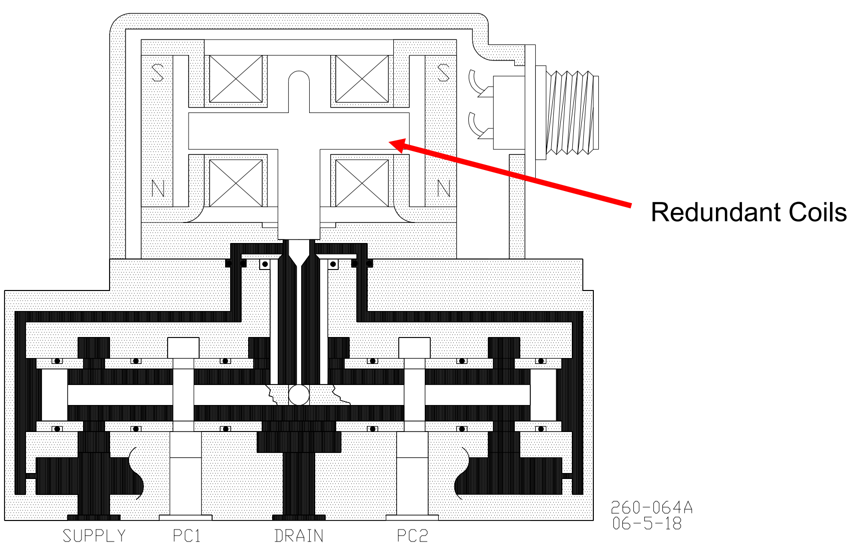

Figure 3-1. Servovalve Cutaway

Trip Solenoid Valve Assembly

The M-Spring actuator trip circuit utilizes a three-way, two position, solenoid operated valve to override the commanded actuator position in response to a loss of solenoid coil voltage. The output of this trip solenoid valve controls two logic valves. A pilot-to-open (PTO) logic valve is interposed between the servo valve and the top of the hydraulic cylinder. A pilot-to-close (PTC) logic valve is interposed between the top of the hydraulic piston and drain. These logic valves, operated by the trip relay valve, provide the large flow area required for rapid actuator motion.

When the trip valve solenoid is energized, the PTO logic valves allow servo valve pressure to reach the top of the hydraulic piston and the PTC valve prevents loss of this pressure to drain. When the trip valve solenoid is de-energized, the trip valve shifts, causing the PTC and PTO valves to also shift. The PTO valve closes, blocking the servo valve outlet, and the PTC valve opens, dumping the hydraulic piston pressure to drain. The force supplied by the actuator return springs then pushes the actuator pushrod up, rotating the gas valve to the closed position, stopping fuel flow to the fuel metering system.

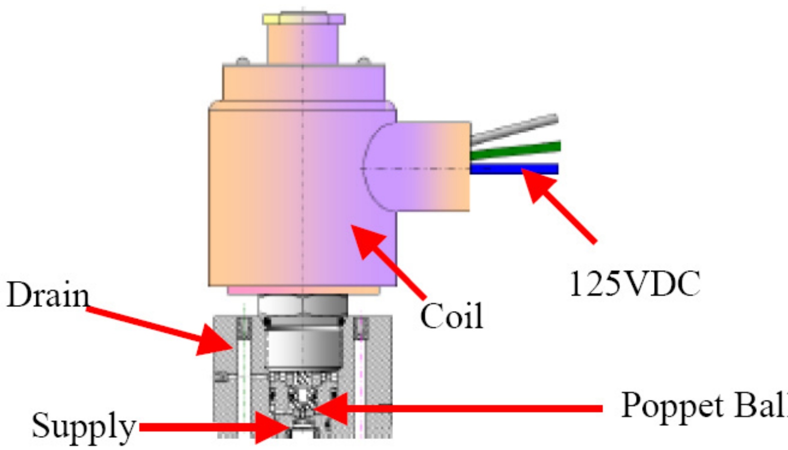

Figure 3-2. Electric Trip Solenoid

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a "trip" command. So, 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".

- **Bleed entrapped air from the hydraulic line supplying the actuator.**
- **Command the actuator to rapidly stroke (but do not command it to "trip") between its fully retracted and fully extended positions at lease 20 cycles to purge entrapped air from the actuator.**

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to "trip" before entrapped air has been removed from the actuator and from the hydraulic supply line.

Hydraulic Filter Assembly

The M-Spring 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.

LVDT Position Feedback Sensors

The M-Spring actuator uses redundant LVDTs for position feedback. The M-Spring actuator has the option for either dual or triple LVDTs. The LVDTs are factory set to give 0.7 ±0.1 Vrms feedback at the valve-closed position and 3.0 ±0.5 Vrms feedback at the valve-open position. The actual voltage values for each LVDT are recorded on a label placed inside the actuator electrical box, for reference during field calibration.

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 with numerous attachment locations to aid in the structural support of the assembly during operation. See the installation drawings for details.

See the outline drawings for:
- Overall dimensions
- Process piping flange locations
- Hydraulic fitting sizes
- Electrical connections
- Lift points and center of gravity
- Weight of the valve
- Structural Support Locations

Installation attitude does not affect actuator or valve performance, but a vertical actuator position is generally preferred to conserve floor space, provide more space for making electrical and hydraulic connections, and changing the hydraulic filter element. Proper structural support is required (see Outline Drawings in Chapter 1 for mounting points).

The Woodward valve rotates clockwise to close.

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

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

⚠WARNING	**Due to typical noise levels in 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.**

⚠WARNING	**Do not lift or handle the valve by any conduit. Lift or handle the valve only by using the eyebolts.**

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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.

Piping Installation

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 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 to align with the valve flanges.

ASTM/ASME grade bolts or studs should be used to install the valve into the process piping. Refer to ASME B16.5 for details of flange, gasket, and bolt types and dimensions.

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.

When installing the valve into the process piping, it is important to properly torque the stud/bolts in the appropriate sequence in order 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 listed in the following table. 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 three hydraulic connections that must be made to each valve: supply, return, and trip oil. The connections to the valve are straight-thread O-ring style ports per SAE J514. The tubing up to the valve must be constructed to eliminate any transfer of vibration or other forces into the valve.

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.

The hydraulic supply to the actuator is to be 1.312 inch (33.32 mm) tubing.

The hydraulic drain should be 1.625 inch (41.28 mm) 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.

Electrical Connections

WARNING — **Due to the hazardous location listings associated with this valve, proper wire type and wiring practices are critical to operation.**

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 (Figure 1-3).**

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 Figure 1-4 (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.

The electric trip solenoid valve must use wire suitable for at least 300 V.

Fuel Vent Port

The fuel vent port, located on the neck of the Triple Offset Butterfly valve, must be vented to a safe location. In normal operation, this vent should have less than 1 cc/min of leakage. However, if excessive leakage is detected from this vent port, contact a Woodward representative for assistance.

Tool Requirements

There are no special tools required for installation and maintenance 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. The use of nylon slings (as manufactured by Lift All, type EE2-803), secured around the valve bearing areas, is recommended to reduce the possibility of mechanical damage occurring to the valve body and actuator.

Valve Installation

General Considerations Prior to Installations

Since the seating torque of a triple offset butterfly valve is normally greater than all other torque considerations, the triple offset butterfly valve is less sensitive than other butterfly valves in regards to the effects of installation upon fluid dynamic torque requirements. The triple offset butterfly valve, however, must still be installed with the eccentric velocity of the fluid in mind, if the flow rates are high. The typical installation for a butterfly valve connected to an elbow would be to align the shaft axis to allow equal flow on each side of the shaft, minimizing dynamic torque requirements for the valve. The triple offset butterfly valve, due to the available torque, may not be subject to the same orientation requirement, depending upon the resulting flow characteristics effect on the system.

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 should be removed, using a commercial solvent.

The valve should be installed with the shaft in a horizontal plane. This reduces the axial load on the annular key and prevents debris build-up in the bearing area. However, the valve can be installed in a vertical or angular orientation, if so desired.

The valve should be mounted so that the shaft is on the downstream side of the disk (see Figure 4-1).

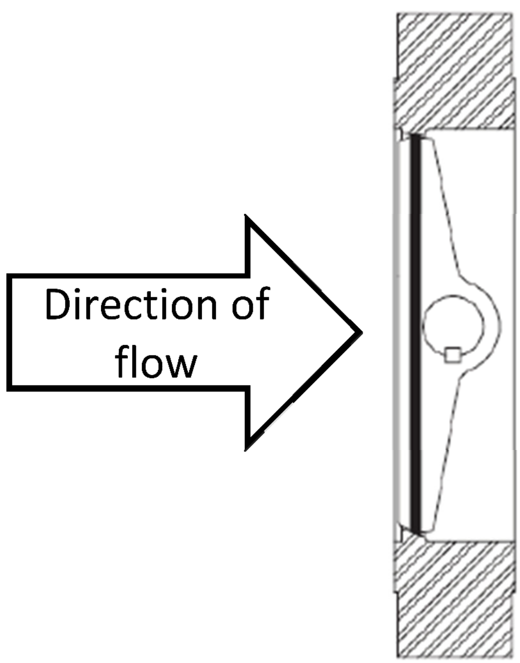

Figure 4-1. Valve Flow Direction

The valve must be installed so that pipeline stresses are not transmitted to the valve body. Despite its solid manufacture, such stress may affect valve operation. Severe pipeline stresses should be cushioned by expansion joints or compensators. If supports are necessary for the valve, they should only support the dead weight of the valve and should not serve as base points for the pipeline.

The connecting flanges of the piping system must be properly oriented, the flange bolts having the correct clearance, and the faces parallel to prevent the introduction of unwanted piping stresses.

DO NOT USE A PARTIALLY INSTALLED VALVE AS A BASE POINT TO ALIGN THE CONNECTING PIPELINE. When one side of the valve is secured to the pipeline, the opposite valve flange may not be used to draw the connecting pipe into alignment, with the exceptions as described later in this section. Any pipe supports that maintain the connecting pipe in place must be evaluated as to the restrictive nature of the support, with regard to correct flange alignment.

Two basic valve body configurations are considered for installation techniques (see Figure 4-2). The lugged style valve is supplied with all flange holes tapped. The wafer style valve is supplied in two variations, one being the flange holes drilled through the body to allow the use of full length studs, the other being a combination of drilled through holes and blind tapped holes which use short bolting. Table 4-1 contains the torque limitation for all tapped holes on the valve body flange holes. When a valve has drilled-through holes, the only limitation of torque is based on the chosen stud material.

ABSOLUTELY NO LIFTING DEVICES MUST EVER PASS THROUGH THE VALVE PORT WHEN RIGGING A VALVE FOR INSTALLATION OR REMOVAL, SINCE SEAT AND/OR SEAL DAMAGE MAY RESULT.

Table 4-1. Torque Tables

Reference Bolt Torque Tables

Maximum Flange Bolt Torque Table

Valve Size	Bolt Dia.	lb-ft
3-4”	5/8”	110
6-8”	3/4"	200
10-12”	7/8”	320
14-16”	1”	480
18-20”	1-1/8”	300
24”	1-1/4”	840

Maximum Disc Bolt Torque Table

1/4-20	80 lb-in
5/16-18	140 lb-in
3/8-16	250 lb-in
7/16-14	400 lb-in
1/2-13	550 lb-in
5/8-11	100 lb-ft
¾-10	130 lb-ft

Note—These values are for fasteners of 316 SST and must be used for higher strength materials of bolting.

General Fastener Torque Table

Size	316 SST	A193 GR B7	SAE GR 5	A193 GR B8M
1/4-20	70 lb-in	90 lb-in	70 lb-in	—
5/16-18	138 lb-in	17 lb-ft	13 lb-ft	—
3/8-16	18 lb-ft	30 lb-ft	20 lb-in	86 lb-in
1/2-13	40 lb-ft	76 lb-ft	55 lb-ft	19 lb-ft
5/8-11	87 lb-ft	150 lb-ft	95 lb-ft	37 lb-ft
3/4-10	115 lb-ft	265 lb-ft	130 lb-ft	64 lb-ft
7/8-9	180 lb-ft	420 lb-ft	285 lb-ft	103 lb-ft
1-8	270 lb-ft	630 lb-ft	432 lb-ft	154 lb-ft
1-1/8 to 8	389 lb-ft	820 lb-ft	560 lb-ft	199 lb-ft
1-1/4 to 8	429 lb-ft	1300 lb-ft	756 lb-ft	316 lb-ft
1-1/2 to 8	837 lb-ft	2317 lb-ft	1745 lb-ft	565 lb-ft

1.0 lb-in = 0.113 N·m; 1.0 lb-ft = 1.356 N·m

Basic Installation Techniques

IMPORTANT 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.

NOTICE 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.

NOTICE The use of impact wrenches to install a Woodward Triple Offset Butterfly Valve is not permitted. Use of impact wrenches can cause the valve body seat to change shape, increasing the possibility of valve leakage or internal binding.

All valves must be in the full closed position during installation or removal. It is not necessary to torque seat the valve, but the disc travel must be restricted to prevent seal damage.

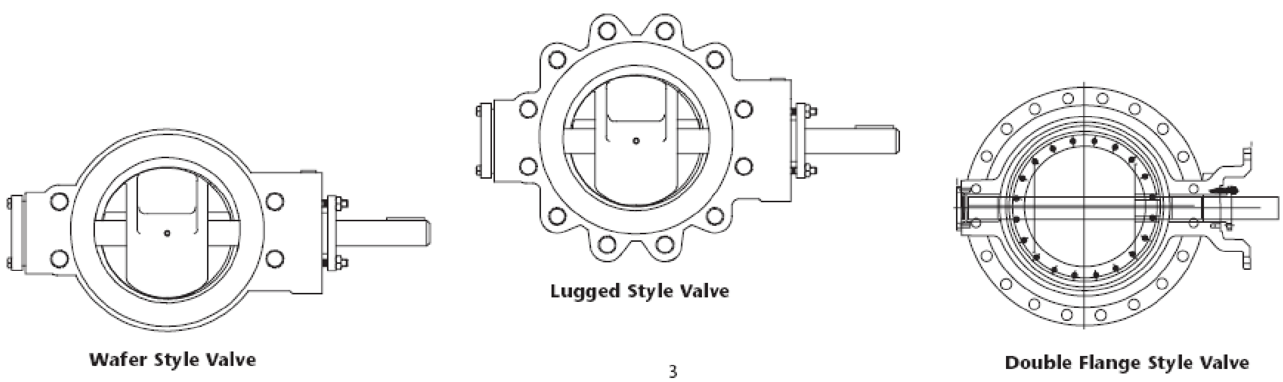

Figure 4-2. Valve Styles

Lugged or Flange Style Valves

Connect one side of the valve to a mating pipe flange. It is not important which side of the valve is connected first, providing all of the subsequent directions are followed.

Assure that each bolt is centered within the bolt holes of the flange. This can be critical, as any bolt touching a flange hole may increase the chance of stress introduction to the valve internals, either causing the valve to bind in rotation or the seat of the body to become distorted.

Torque four equally spaced bolts in the first flange, to approximately 25% of the final torque value.

IMPORTANT The final flange bolt pre-load is entirely dependent on the type of gasket used, the pipeline media, operating temperature, and the working (or design) pressure of the system. Refer to Table 4-1 for the maximum allowable torque level for the flange holes in the valve body.

The pipe support(s) may need to be partially disengaged. A determination as to pipe flange alignment and space between the pipe flange and the valve face must be made at this time. The optimum spacing would be such as to only allow the flange gasket to be installed, at the maximum, and the flange bolt holes would be concentric.

The connecting pipe flange face may not be more than ¼ inch away from the valve flange face. Alternate methods of alignment, other than using the flange bolts, must be utilized to conform to this requirement.

Install the remaining bolts in both flanges and assure that the correct clearance is maintained around the bolt diameters.

Seat the second flange by alternate tightening of four equally spaced flange bolts no more than 1/4 turn per bolt, until the flange faces seat. During this operation, continually check the relative distance between the flange faces and adjust the tightening method to maintain the parallelism of the flange faces. Torque the bolts to approximately 25% of the final torque value.

Inspect the remaining bolts and assure correct alignment. Tighten to the same level as the first four bolts.

Complete the tightening of all flange bolting in a minimum of four increments to the final determined torque value.

Electronic Settings

Dynamic Tuning Parameters

It is imperative that the correct dynamic characteristics of this valve be input into the control system to ensure that the operation of the valve/control system is within acceptable limits.

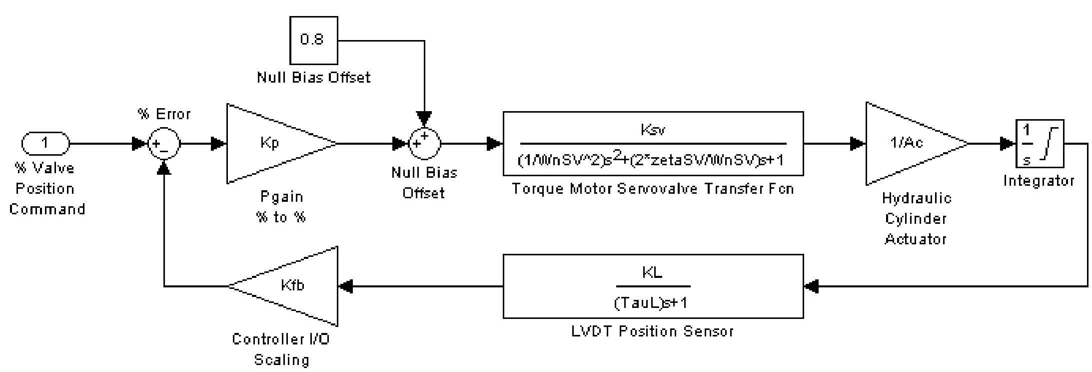

Figure 4-3. TOV Valve Block Diagram

Ksv nominal =	23.58 in³/sec/mA at 1600 psi supply; Ksv is proportional to square root of supply, and constant with position.
ZetaSV =	0.8
WnSV =	60 rad/s; WnSV is proportional to square root of supply
Ac =	12.57 in²
KL =	0.2875 Vrms/inch
Servo Travel =	8.0 inches
TauL =	0.005 seconds (typical, depends on excitation/demodulation)

Null Current Adjustment

Every valve shipped contains documentation that gives the actual Null Current as measured by Woodward. It is imperative that the control system null current match the as-measured current for each valve in the system. Incorrect null current setting, with proportional control only, will result in position error.

Rigging Procedure

Inside the electrical enclosure of the valve, there is an adhesive label that contains the appropriate valve position (as a percent of full stroke), the physical stroke (inches), and the corresponding LVDT feedback signals for each LVDT (assuming 7.0 Vrms excitation at 3000 Hz).

Once the control system is connected to the valve and control of the valve is established, set the valve command position to 0% of full stroke. Measure the feedback voltage from each LVDT. Adjust the Offset in the feedback loop until the feedback voltage matches the documented values (see the label inside the electrical enclosure) for that position. Adjust the command position to 100% of full stroke. Adjust the Gain of the feedback loop until the LVDT feedback voltage matches the documented values. Set the command position to close the valve. Verify that the valve is closed visually and that the feedback voltage from the LVDT is 0.7 ± 0.1 Vrms. This process may have to be repeated to ensure the feedback voltages at both the 0% and 100% command positions match the documented values.

Chapter 5.
Maintenance and Hardware Replacement

Maintenance

The Triple Offset Butterfly Valve requires no maintenance or adjustment in preparation for or during normal operation.

Woodward recommends routine checks of the DP gauge 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.

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.

Hardware Replacement

⚠WARNING	**To prevent possible serious personal injury, or damage to equipment, be sure all electric power, hydraulic pressure, and gas pressure have been removed from the valve and actuator before beginning any maintenance or repairs.**

⚠WARNING	**Explosion Hazard—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.** **Substitution of components may impair suitability for Class I, Division 2 or Zone 2 applications.**

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

⚠WARNING	**Due to typical noise levels in turbine environments, hearing protection should be worn when working on or around the CV500 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.**

⚠WARNING	**Do not lift or handle the valve by any conduit. Lift or handle the valve only by using the eyebolts.**

IMPORTANT	**Disassembly of this valve without a Woodward Technician present will void the Woodward warranty.**

See the outline drawing (Figure 1-2) for the location of items.

Hydraulic Filter Assembly/Cartridge

The hydraulic filter is located on the hydraulic manifold, hanging directly under the servo valve.

Replacement of Filter Assembly

1. Remove four 0.312-18 UNC socket head cap screws.
2. Remove the filter assembly from manifold block.

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

3. Remove the two O-rings present in the interface between the filter and the manifold.
4. Obtain a new filter assembly.
5. Place two new O-rings in the new filter assembly.
6. Install filter onto manifold assembly. Be sure to place the filter in the correct orientation. See the outline drawings (Figure 1-2).
7. Install four 0.312-18 cap screws through filter and torque into manifold to 160–200 lb-in (18.1–22.6 N·m).

NOTICE

Entrapped air may defeat the hydraulic cushion action of the actuator, resulting in excessive impact forces during a “trip” command. So, 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”.

- **Bleed entrapped air from the hydraulic line supplying the actuator.**
- **Command the actuator to rapidly stroke (but do not command it to “trip”) between its fully retracted and fully extended positions at least 20 cycles to purge entrapped air from the actuator.**

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to “trip” before entrapped air has been removed from the actuator and from the hydraulic supply line.

Replacement of Filter Cartridge

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

1. Using a 1-5/16 inch (~33+ mm) wrench, loosen the bowl from the filter assembly.
2. Remove the filter element by pulling it downward.
3. Obtain a new filter element.
4. Lubricate the O-ring on the ID of the cartridge with hydraulic fluid.
5. Install the cartridge into the assembly by sliding the open end of the cartridge upward onto the nipple.

6. 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. So, 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".

- **Bleed entrapped air from the hydraulic line supplying the actuator.**
- **Command the actuator to rapidly stroke (but do not command it to "trip") between its fully retracted and fully extended positions at least 20 cycles to purge entrapped air from the actuator.**

This precautionary procedure is especially important when the actuator is oriented horizontally or upside-down (actuator below the process valve). There is risk of actuator damage if it is commanded to "trip" before entrapped air has been removed from the actuator and from the hydraulic supply line.

Trip Solenoid Valve

The trip solenoid valve is located on the manifold block on the opposite side of the LVDTs.

IMPORTANT

Hydraulic fluid may spill during cartridge removal.

1. Remove the cover to the electrical junction box.
2. Disconnect the solenoid wires from the connector blocks per wiring diagram.
3. Loosen the conduit fittings from the electrical box and the solenoid.
4. Carefully remove the conduit from the solenoid and pull the wiring out of the conduit.
5. Loosen the ¾ inch jam nut on top of the solenoid coil (see Figure 5-1).
6. Loosen the coil retention nut (see Figure 5-1).
7. Using 1-inch wrench, loosen and remove the solenoid from the actuator.
8. Obtain a replacement solenoid from Woodward and verify part number and revision with the existing unit.
9. Verify that the O-rings on the replacement solenoid are undamaged and present as compared to the old solenoid.
10. Lubricate the O-rings with a light oil or petroleum jelly.
11. Install replacement solenoid into actuator and tighten to 75 lb-in (8.5 N·m).
12. Install wiring through the conduit and into the electrical box.
13. Connect the conduit to the solenoid and torque to 100 lb-in (11.3 N·m).
14. Torque the conduit to the electrical box to 100 lb-in (11.3 N·m).
15. Install wires into the solenoid connector blocks as shown in the wiring diagram at the end of Chapter 1. If it is necessary to cut wires for installation, be sure to retain at least one service loop of wiring.
16. Replace the cover onto the junction box and tighten the screws.

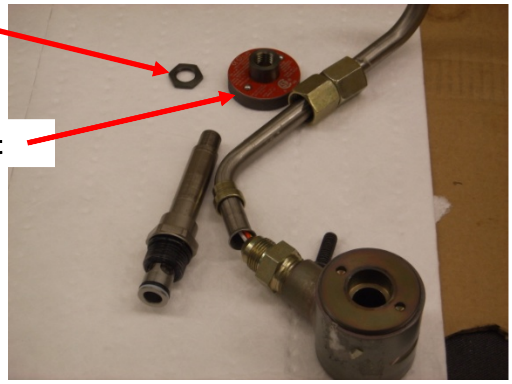

Figure 5-1. Trip Solenoid Assembly

Servo Valve

The servo valve is located on the top of the hydraulic manifold directly above the filter assembly. Refer to the outline drawings (Figure 1-2).

1. Remove the cover to the electrical junction box.
2. Disconnect the servo valve wires from the connector blocks labeled 1–6.
3. Loosen the conduit fittings from the electrical box and the servo valve.
4. Carefully remove the conduit from the servo valve and pull the wiring out of the conduit.
5. Remove the four 0.312-18 UNC socket head cap screws holding the servo valve to the manifold.
6. Discard the nine O-rings between the servo valve, the adapter plate, and the manifold.
7. Obtain replacement servo valve and verify part number and revision with existing unit.
8. Place four new O-rings on the adapter plate.
9. Reposition adapter plate onto hydraulic manifold ensuring hydraulic passages and bolt holes are aligned correctly. Be sure that all four O-rings remain in their proper location during assembly on the lower side of the adaptor plate facing the manifold.
10. Remove protective plate from replacement servo valve and verify that O-rings are on all five counter bores of the servo valve.
11. Place the servo valve onto the adapter plate that has been positioned on the hydraulic manifold. Be sure to orient the servo valve to match the original orientation. Be sure that all five O-rings remain in their proper location during assembly.
12. Install four 0.312-18 UNC socket head cap screws and torque to 108–132 lb-in (12.2–14.9 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 labeled 1–6 as shown in the wiring diagram (Figure 1-4). 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.

LVDT Replacement

⚠WARNING	**To prevent possible personal injury, do NOT remove the spring cover.**

The LVDTs are located on the manifold next to the actuator cylinder. Refer to the outline drawings (Figure 1-2).

1. Remove the cover to the electrical junction box.
2. Remove applicable LVDT wires from terminal block.
3. Remove the 4x socket head cap screws from that attach the junction box mounting brackets to the manifold.
4. Remove the 3x ¾” hex nuts on LVDT from inside of the junction box with a 1-1/8” wrench.
5. Loosen all conduit entries to junction box.
6. Carefully remove junction box from LVDTs and suspend to the side.
7. Remove locking nut from top of applicable LVDT.
8. Remove the two hex head screws that hold the mounting bracket to the actuator (also remove standoffs).
9. Remove LVDT from bracket and set aside.
10. Remove access cover from actuator.
11. Locate appropriate core rod for LVDT.
12. Loosen jam nut and using a wrench remove the core rod from the retaining plate.

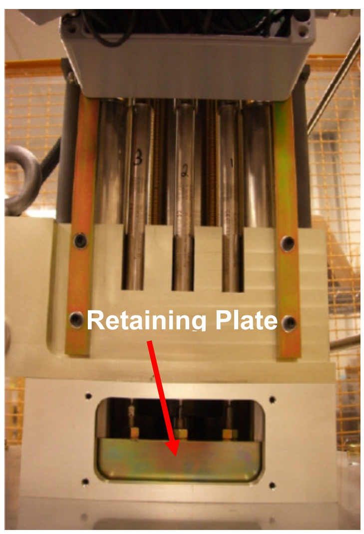

Figure 5-2a. Retaining Plate

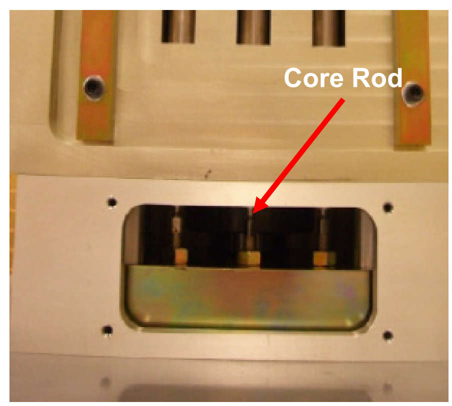

Figure 5-2b. LVDT Core Rod

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

13. Remove jam nut and install on new core rod.
14. Install new core rod in place of old unit.
15. Pre-adjust core rod visually to approximately the same height as the other core rods.
16. Install LVDT Housing into retaining plate.

17. Install retaining plate with LVDTs into actuator using standoffs and hex head screws and torque to 58-73 lb-ft (77.6-98.9 N·m).

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

18. Reinstall junction box over LVDTs.
19. Torque locking nut on top of the LVDT to 26-29 lb-ft (35.3-39.3 N·m).
20. Replace conduit and tighten to 100 lb-in (11.3 N·m).
21. Reinstall electrically wiring per wiring diagram at the end of Chapter 1. Note that wiring may need to be cut for proper fit.
22. Install junction box bracket with 4x socket head cap screws and tighten to 115-125 lb-in (13-14.1 N·m).
23. CALIBRATE LVDT
    a. Apply 7 volts RMS at 3000 Hz to the excitation side of the LVDT (see wiring diagram)
    b. Measure feedback voltage and adjust the core rod so the feedback is such that V = 0.7 ±0.1 volts RMS when the valve is fully closed.
24. Tighten jam nut on the core rod.
25. Install the access covers for the junction box, and access cover for actuator.
26. Recalibrate the control system.

Separating the Actuator & Transfer Case Assembly from the TOV Gas Valve

⚠WARNING — **To prevent possible personal injury, do NOT remove the spring cover (which is spring-loaded to over 8200 lb / 36 475 N).**

1. Shut off the actuator hydraulic pressure.
2. Remove the linkage access cover and end plate assembly from the actuator transfer case. Remove the shaft position indicator before removing the end plate from the transfer case.
3. Remove the actuator pushrod linkage cross bolt from the lever.
4. Loosen the clamp bolts on the actuator lever. Remove the lever.
5. Provide a means to support the gas valve and to support and lift the actuator and transfer case assembly.
6. Remove the eight 0.625-11 UNC nuts that attach the gas valve to the actuator transfer case.
7. Separate the transfer case and gas valve.
8. Remove the eight 0.625-11 UNC studs from the actuator mounting face of the valve if required for mounting actuator to new valve

Joining the Actuator/Transfer Case Assembly to the Gas Valve

1. Remove the linkage access cover and end plate from the actuator transfer case.
2. Remove the lower rod end and its jam nut from the actuator pushrod.
3. Remove the turnbuckle from the actuator pushrod. Leave its jam nut on the pushrod.
4. Thread eight 0.625-11 UNC studs into the actuator mounting face of the valve. Thread the studs into the valve until they bottom out and then back out ¼ turn.
5. Supporting both the actuator and the gas valve, join the actuator and valve.

6. Install the eight 0.625-11 UNC nuts that secure the gas valve to the actuator. Tighten the nuts to 180–220 lb-ft (244–298 N·m).
7. Place key into keyway of valve shaft.
8. Push the lever onto the shaft so that the front face of the lever is 3.0 ±0.050 inches (76.20 ±1.27 mm) below the front face of the transfer case housing.
9. Tighten the lever clamp bolts to 180–220 lb-ft (244–298 N·m).
10. Thread the turnbuckle onto the pushrod.
11. Thread the jam nut and lower rod end onto the turnbuckle.
12. Rotate the turnbuckle and lower rod end to make the linkage as short as possible. Thread the jam nuts onto their respective threads as necessary.
13. Slip the lower rod end around the end of the lever and into the lever slot.
14. Adjust the length of the linkage by rotating the turnbuckle until the hole in the lower rod end lines up with the hole in the lever.
15. Install the lever cross bolt, washer, and lock nut. Tighten the locknut to 95–105 lb-ft (128–142 N·m).
16. Rotate turnbuckle clockwise (viewed from top) 1-1/2 turns beyond where resistance starts.
17. Without turning the turnbuckle, move the upper and lower turnbuckle jam nuts about 2–4 threads away from the turnbuckle.
18. Apply Loctite 246 compound to the exposed threads between the turnbuckle and the jam nuts.
19. Holding the turnbuckle to prevent its rotation, tighten the jam nuts to 200–250 lb-ft (271–339 N·m). Wipe away excess Loctite.
20. Immediately (before the Loctite sets up) rotate the pushrod by hand to confirm that it is free to rock and that the lower rod end is not jammed against the side of the slot in the lever. If it is jammed, hold the turnbuckle to prevent its rotation while loosening the lower jam nut. Slightly rotate the turnbuckle as required, then re-tighten the lower jam nut while holding the turnbuckle to prevent its rotation. Repeat steps 19 and 20 to achieve a free pushrod.
21. Install the linkage access cover. Tighten screws to 10–13 lb-ft (14–18 N·m).
22. Install the actuator transfer case end plate, orienting the end plate so the word “CLOSED” is at the top. Tighten the bolts to 230–270 lb-ft (312–366 N·m).
23. Install the position indication disk on the end of the valve shaft so that the line is vertical (pointing towards the word “Closed”. Tighten the indicator screw to 70–80 lb-in (95–108 N·m).

Replacing the Valve Packing

1. Shut off the actuator hydraulic pressure.
2. Remove the linkage access cover and end plate assembly from the actuator transfer case. Remove the shaft position indicator before removing the end plate from the transfer case.
3. Remove the actuator pushrod linkage cross bolt from the lever.
4. Loosen the clamp bolts on the actuator lever. Remove the lever.
5. Follow the procedure in the Velan maintenance manual to replace the packing. The valve is a 12 inch NPS class 600 valve; which is not included in torque table 4 of the Velan manual. The packing nuts should be torqued to 48 lb-ft (65 N·m).
6. Place the key into keyway of the valve shaft.
7. Push the lever onto the shaft so that the front face of the lever is 3.0 ±0.050 inches (76.20 ±1.27 mm) below the front face of the transfer case housing.
8. Tighten the lever clamp bolts to 180–220 lb-ft (244–298 N·m).
9. Thread the turnbuckle onto the pushrod.
10. Thread the jam nut and lower rod end onto the turnbuckle.
11. Rotate the turnbuckle and lower rod end to make the linkage as short as possible. Thread the jam nuts onto their respective threads as necessary.
12. Slip the lower rod end around the end of the lever and into the lever slot.

13. Adjust the length of the linkage by rotating the turnbuckle until the hole in the lower rod end lines up with the hole in the lever.
14. Install the lever cross bolt, washer, and lock nut. Tighten the locknut to 95–105 lb-ft (128–142 N·m).
15. Rotate the turnbuckle clockwise (viewed from top) 1-1/2 turns beyond where resistance starts.
16. Without turning the turnbuckle, move the upper and lower turnbuckle jam nuts about 2–4 threads away from the turnbuckle.
17. Apply Loctite 246 compound to the exposed threads between the turnbuckle and the jam nuts.
18. Holding the turnbuckle to prevent its rotation, tighten the jam nuts to 200–250 lb-ft (271–339 N·m). Wipe away excess Loctite.
19. Immediately (before the Loctite sets up) rotate the pushrod by hand to confirm that it is free to rock and that the lower rod end is not jammed against the side of the slot in the lever. If it is jammed, hold the turnbuckle to prevent its rotation while loosening the lower jam nut. Slightly rotate the turnbuckle as required, then re-tighten the lower jam nut while holding the turnbuckle to prevent its rotation. Repeat steps 18 and 19 to achieve a free pushrod.
20. Install the linkage access cover. Tighten screws to 10–13 lb-ft (14–18 N·m).
21. Install the actuator transfer case end plate, orienting the end plate so the word "CLOSED" is at the top. Tighten the bolts to 230–270 lb-ft (312–366 N·m).
22. Install the position indication disk on the end of the valve shaft so that the line is vertical (pointing towards the word "Closed"). Tighten the indicator screw to 70–80 lb-in (95–108 N·m).

Troubleshooting Charts

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

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.

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.
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 greater than the null bias of the servovalve for the gas valve 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 LVDT.
	Servovalve failure	Replace servovalve.
	Hydraulic supply pressure inadequate	Supply pressure must be greater than 1500 psig/10342 kPa (1600 psig/11 032 kPa preferred).
	Trip relay not energized	Trip voltage must be between 90-140 Vdc.
	Filter element plugged	Check filter DP indicator. Replace element if the DP indicator shows red.
	Orifice plate installed incorrectly	Check that the “P” and “T” on the servovalve are on the same side as the “P” and “T” on the orifice plate.
Valve will not close	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 gas valve 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. The use of dither may improve performance in contaminated systems.
	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, and improper wiring practices. See Chapter 3 Installation section for wiring recommendations.

Chapter 6.
Service Options

Product Service 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 and 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 Engine Retrofitter (RER)** is an independent company that does retrofits and upgrades on reciprocating gas engines and dual-fuel conversions, and can provide the full line of Woodward systems and components for the retrofits and overhauls, emission compliance upgrades, long term service contracts, emergency repairs, etc.
- 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.

You can locate your nearest Woodward distributor, AISF, RER, or RTR on our website at:

www.woodward.com/directory

Woodward Factory Servicing 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.

How to Contact Woodward

For assistance, call one of the following Woodward facilities to obtain the address and phone number of the facility nearest your location where you will be able to get information and service.

Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (0) 21 52 14 51
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
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

You can also locate your nearest Woodward distributor or service facility on our website at:

www.woodward.com/directory

Technical Assistance

If you need to telephone for technical assistance, you will need to provide the following information. Please write it down here before phoning:

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
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	

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.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26572.

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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.

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