WOODWARD

Product Manual 26362
(Revision B)
Original Instructions

Woodward Triple Offset Butterfly Valve

Woodward Part Numbers 9904-914, 9904-915, 9904-916, 9904-917, 9904-918, 9904-947, 9904-948, 9904-949

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:

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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 Out-of-date translations are marked with ⚠.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.

Contents

Illustrations and Tables

Warnings and Notices

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.

Chapter 1.
General Information

Introduction

The following information is provided as a guide for valve installation and maintenance. It does not replace any approved and accepted practices for piping, welding, or equipment handling. An approved safety program should be in place before any work is performed on this installation.

General Valve Description

The Woodward Triple Offset Valve is a metal-seated butterfly type, which is designed and manufactured in a manner that allows the disc to rotate into and out of the seat with absolutely no interference. This results in a sealing system that, unlike butterfly valves that depend upon interference to achieve a seal, is not affected by the frequency of operating cycles.

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 non-interfering characteristics desired.

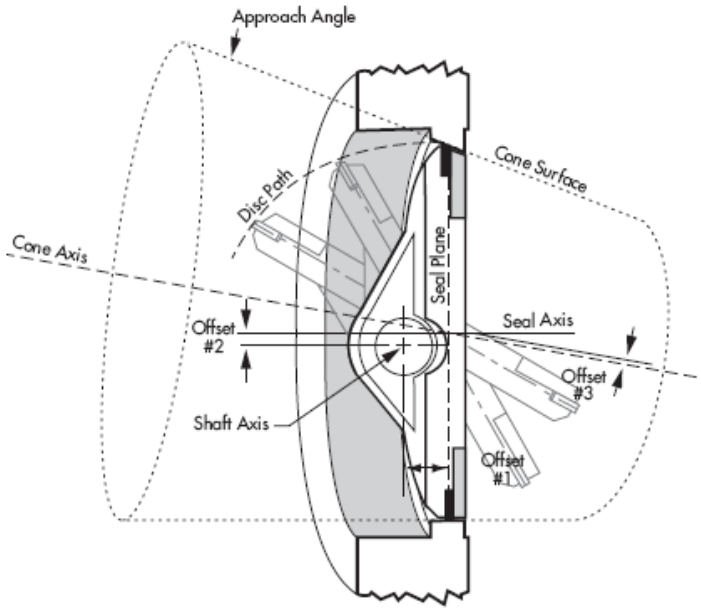


Figure 1-1. Triple Offset Valve Geometry

Triple Offset Valve Functional Characteristics

Available Valve Sizes	10”, 12”, 20”, 24” (~25, ~30, ~51, ~61 cm)
Valve Type	Triple Offset Butterfly Valve
Fluid Ports	Lugged with drilled-through holes
Flowing Media	Steam and Air
Maximum Process Pressure	Class 600# - 725 psig (5000 kPa)
Valve Proof Pressure Level	Per ANSI B16.34, ANSI B16.37/ISA S75.19
Process Fluid Filtration	25 µm absolute at 75 beta recommended
Maximum Process Fluid Temperature	1080 °F (582 °C)
Valve Ambient Temperature	120 °F (49 °C) Maximum
Shut-off Classification	Class VI
Packing Arrangement	Live Loaded High Temp Graphite

General Actuator Description

Actuator Type	H-Spring
Actuator Cylinder Size	4.625” and 5.5” (~117.48 and ~140 mm) Diameter
Fluid Ports	See Outline Drawing for details
Hydraulic Fluid	Petroleum Based and Phosphate Ester Based Fluids
Hydraulic Pressure	1500 to 2000 psig (Nominal 1600 psig) 10 342 to 13 790 kPa (Nominal 11 032 kPa)
Actuator Proof Pressure Level	3000 psig (20 685 kPa)
Hydraulic Fluid Filtration req’d.	10 µm absolute
Ambient Temperature Range	0 to 120 °F (–18 to +49 °C)

The Hydraulically Amplified Spring Return Actuator or H-Spring Actuator is a double-acting hydraulic actuator with integrated spring loaded piston accumulators that provide a hydraulically locking failsafe feature. The modularity of the H-Spring actuator allows it to match the required force output with the appropriate fail safe spring requirements to yield an actuator that is compact without compromising safety margin.

Each actuator contains multiple accumulator cartridges for redundancy and modularity. The cartridges incorporate a reliable piston and spring design to provide the motive force for fail-safe operation. This concept provides for fail-safe operation without compromising safety or reliability. Multiple springs nested within each cartridge offer the benefit of the fail-safe operation in a small space. Various combinations of counter wound return springs can be nested together to provide the necessary stored hydraulic energy for fail-safe performance. The H-Spring Actuator is designed with a redundant accumulator cartridge so that if any one cartridge ceases to function properly, the others will fully stroke the actuator/valve to its fail-safe condition.

Triple redundant LVDTs and Servo Valve Coils are standard along with a hydraulic-fluid filter and Electric Trip Solenoid. A Junction Box provides the user a NEMA 4X rated wiring cavity for all the electrical components. Additionally, there are SAE J514 hydraulic connections and a visual position indicator.

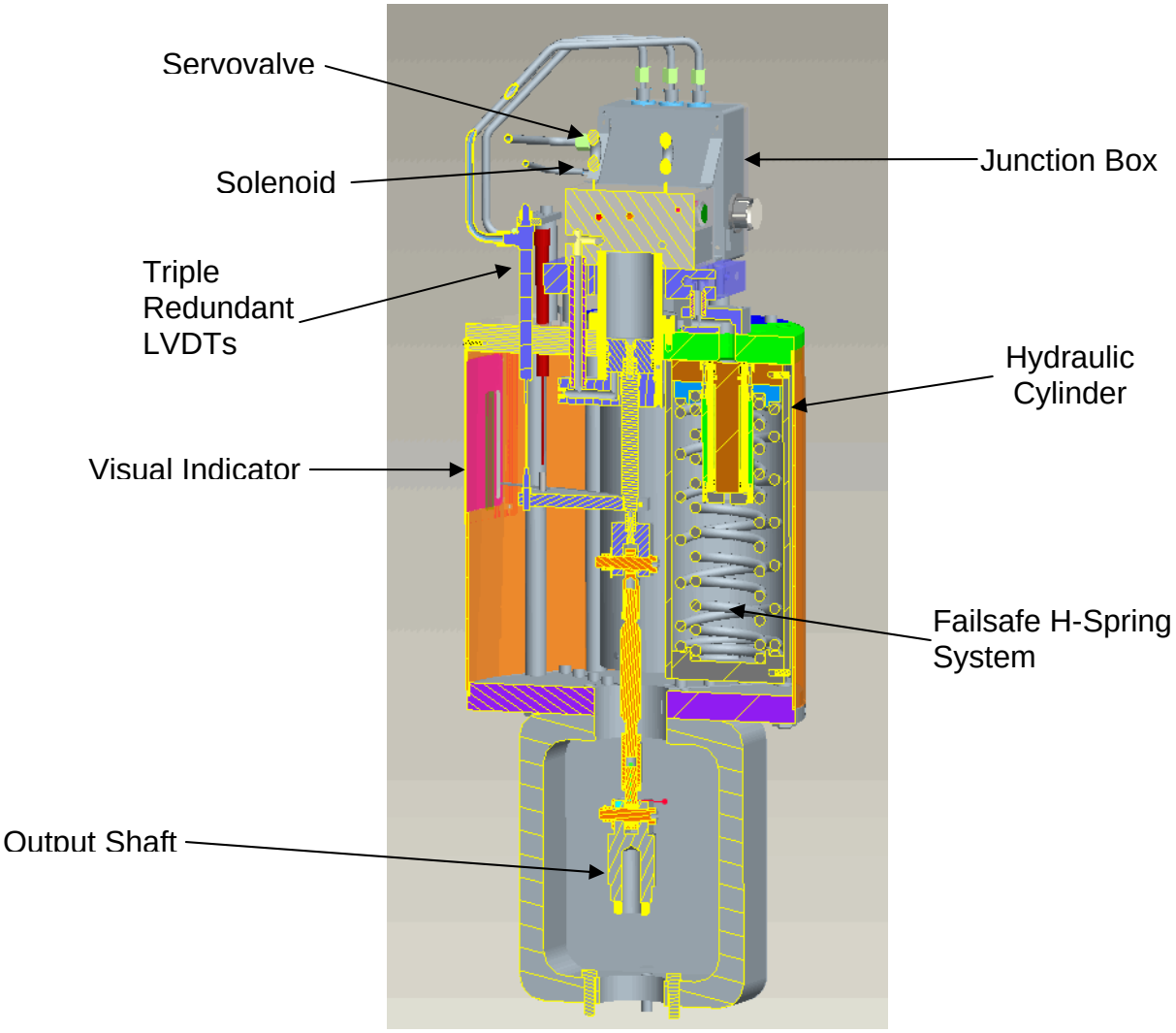


Figure 1-2. Steam Conditioning Globe Valve Geometry

For non-modulating service, the servo valve can be replaced with a primary solenoid to operate the actuator. This solenoid allows the actuator to fully stroke away from the failsafe position when energized and then back to the failsafe position when de-energized.

Hydraulic Schematic

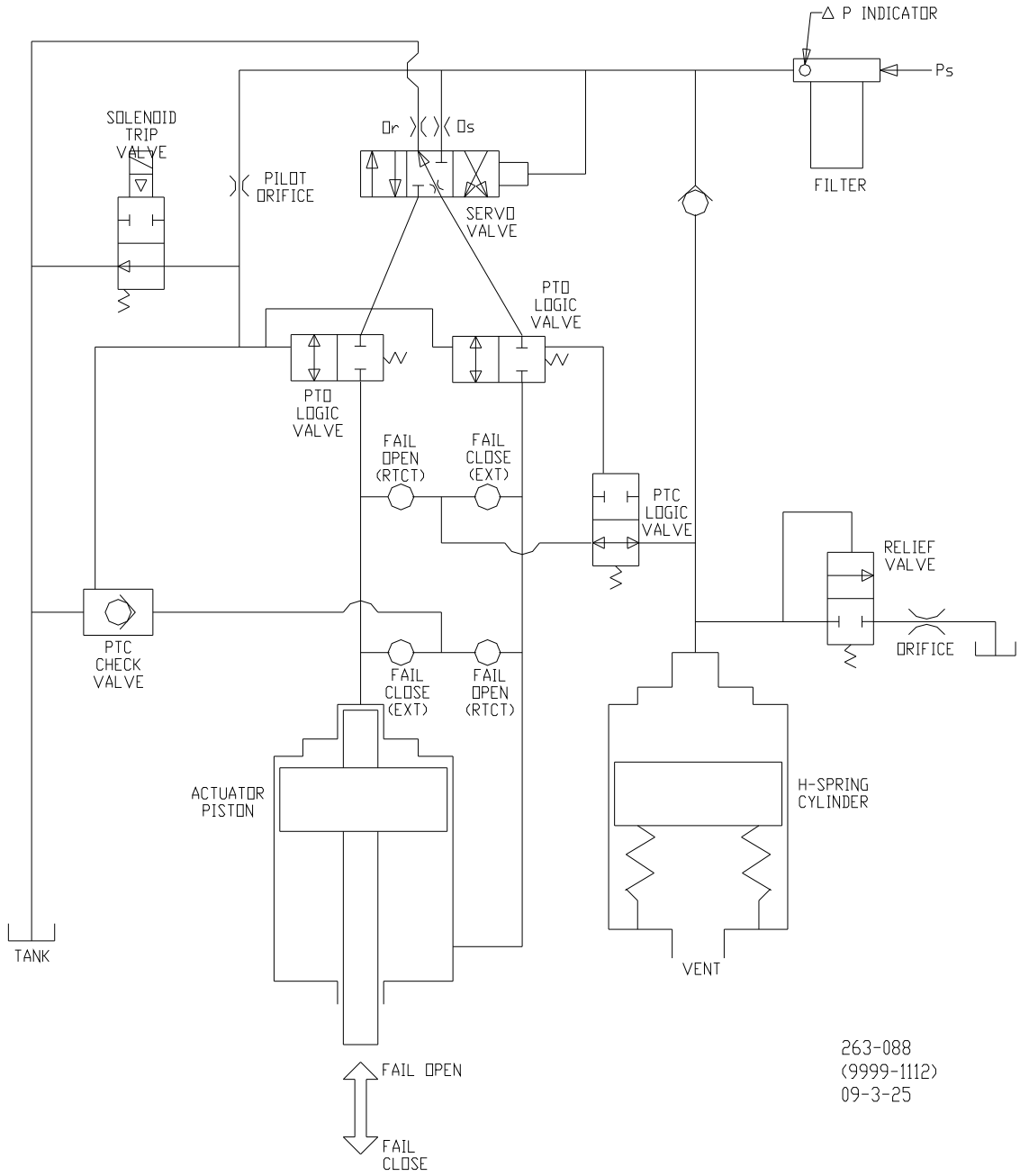


Figure 1-3. Hydraulic Schematic

Figure 1-3 gives a hydraulic schematic of the double acting hydraulic cylinder, using hydraulically amplified spring return for fail-safe operation. During normal operation, the actuator functions as a double acting hydraulic cylinder. However, when a trip command signal is sent by removing the electrical signal to the solenoid, each of the four pilot-operated valves switch to their normal states, and the hydraulic pressure contained within the H-Spring System drives the actuator/valve to its safe position.

Triple Coil Electro-Hydraulic Servovalve Assembly

The hydraulic actuator assembly uses a two-stage hydraulic servovalve to modulate the position of the actuator output shaft that controls the 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 electric current applied to the three coils.

If the control system requires a rapid movement of the valve to deliver more flow, total current is increased well above the null current. In such a condition, control port PC1 is connected to supply pressure. The flow rate delivered to the piston cavity of the actuator is proportional to the total current applied to the three coils. Thus, the opening velocity is also proportional to the current (above null) supplied to the torque motor.

If the control system requires a rapid movement to close the gas fuel valve, the total current is reduced well below the null current. In such a condition, port PC1 is connected to the hydraulic drain circuit. The flow rate from the piston cavity to drain is proportional to the magnitude of the total current below the null value. Thus, the closing velocity is also proportional to the current (below null) supplied to the torque motor.

At the null current, the four-landed valve isolates the control port from the hydraulic supply and drain, balancing the piston pressure against the spring 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 position of the valve.

Electric Trip Solenoid

The actuator uses a solenoid-operated hydraulic trip circuit to actuate the fast acting isolation functionality. This trip relay circuit consists of five functional elements: a trip relay solenoid valve, a rate control orifice, a normally open pilot operated drain check valve, a second normally-closed pilot operated supply check valve, and the spring return hydraulic actuator. Both the solenoid operated pilot valve and the pilot operated check valves are constructed with poppet style valve elements, which are resistant to hydraulic silt contamination.

The trip relay solenoid valve is energized to open the valve. This closes the solenoid valve, which prevents the trip circuit pressure from flowing to the hydraulic drain. High-pressure oil is fed into the trip relay circuit through the rate control orifice, raising the pilot pressure to both check valves. The increasing pilot pressure shifts the drain check valve to the closed position, thus closing the hydraulic path between the actuator piston and the drain. The high pilot pressure also shifts the supply check valve, which connects the hydraulic supply to the actuator. The hydraulic supply lifting the actuator piston to open the valve.

In the shutdown mode, the trip relay solenoid valve is de-energized. This opens the solenoid valve, draining the trip relay volume to the hydraulic return. As a result, the trip circuit pressure falls, since the flow rate provided through the supply orifice cannot maintain pressure with the open solenoid valve. The falling trip circuit pressure opens the drain check valve and closes the supply check valve. With the drain check valve in the open position, the actuator piston is connected to the hydraulic drain allowing the return springs to close the valve.

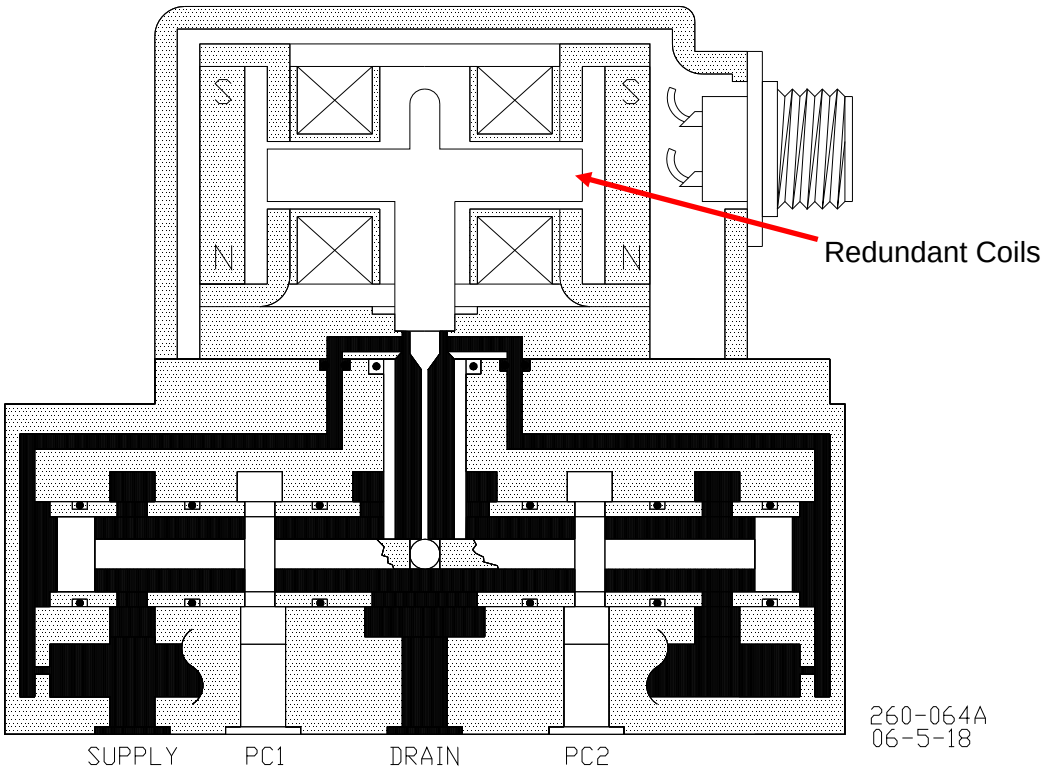


Figure 1-4. Servovalve Cutaway

The Solenoid Operated Trip Valve is a normally-open, 125 Vdc solenoid valve.

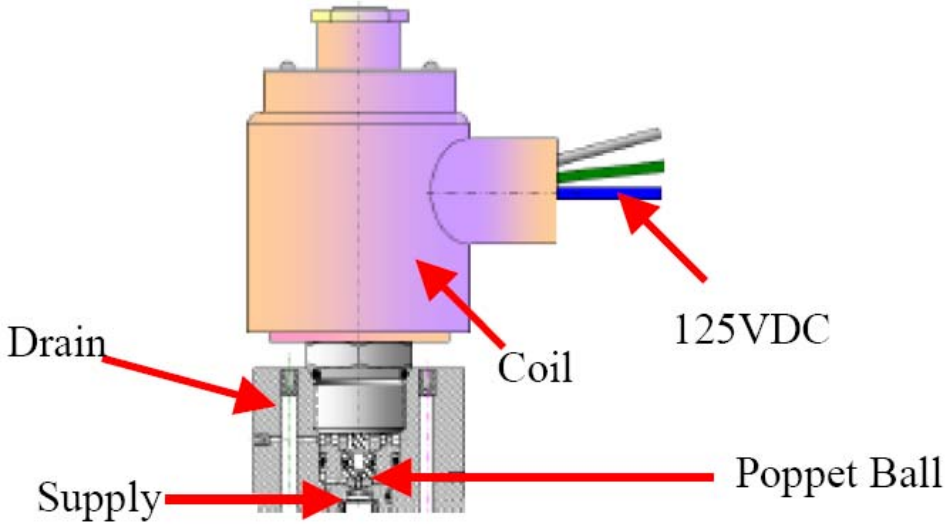


Figure 1-5. Electric Trip Solenoid

Hydraulic Filter Assembly

The valve is supplied with an integrated, high-capacity filter. The 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 recommended pressure differential has been exceeded, and thus replacement of the element is necessary.

LVDT Position Feedback Sensors

The assemblies are supplied with a triple channel LVDT feedback device. The LVDT is supplied with a 7 Vac supply voltage @ 3 kHz and generates a 0.7 to 3.5 Vac feedback. The sensor element is a four wire (for each coil), Linear Variable Displacement Transducer (LVDT), which requires an ac excitation signal and produces an ac voltage feedback signal for each coil. The rms magnitude of the A channel feedback signal is linearly proportional to the position of the core rod and inversely proportional to the B channel. The transducer is highly linear, accurate and has essentially infinite resolution.

Check Valves

There are three types of check valves used within the H-Spring actuator. The check valves used are standard, pressure operated check valves; Pilot-to-Open and Pilot-to-Close check valves. The pilot operated check valves eliminate transient flow issues during initial start up of the system and allow the trip circuit to function quickly and efficiently. The final type of check valve is a standard spring loaded check that allows free flowing supply hydraulics to charge the accumulators without allowing back flow during a trip.

Optional—Primary Operating Solenoid

If a non-modulating actuator is required, the servo valve can be replaced with a two-stage solenoid to operate the actuator. This solenoid allows the actuator to fully stroke away from the failsafe position when energized and then back to the fail-safe position when de-energized. The primary operating solenoid is included on applicable outline drawings located at the end of this chapter.

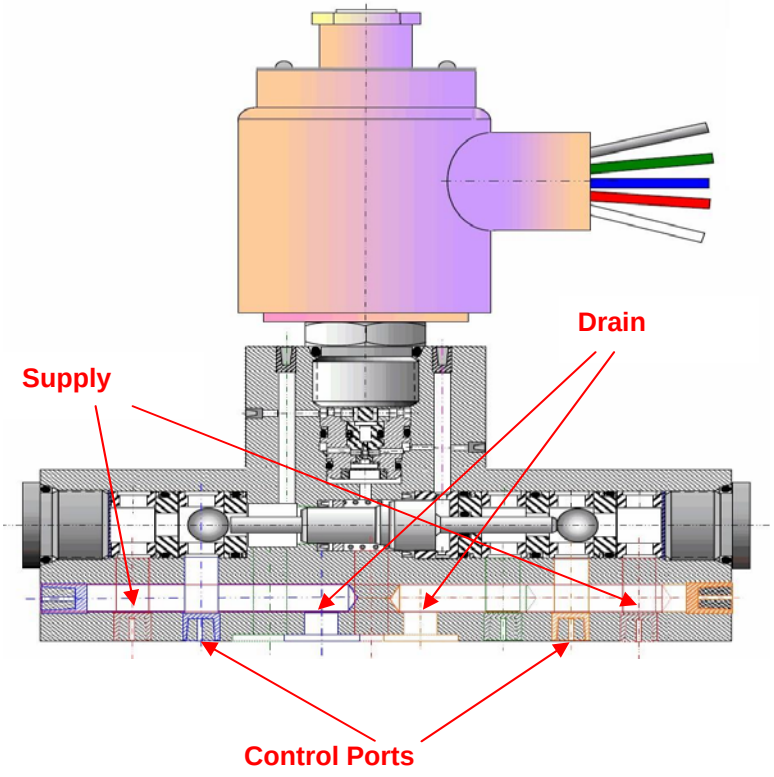
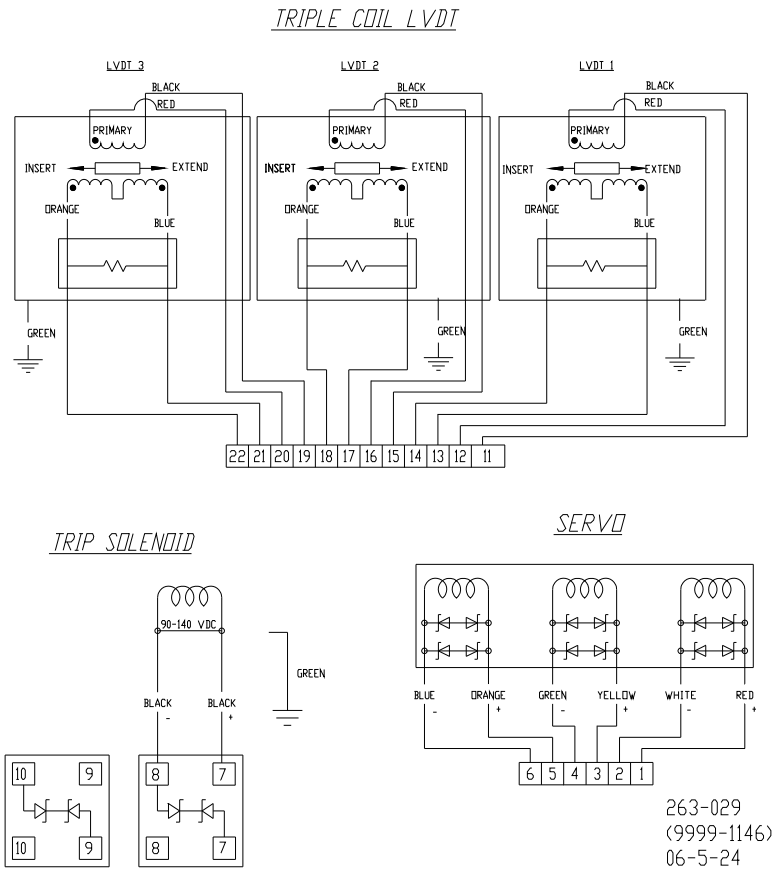


Figure 1-6. Primary Operating Solenoid Cutaway



LVDT Number	Terminal	Description
1	11	Excitation Voltage (-)
	12	Excitation Voltage (+)
	13	Feedback Voltage (-)
	14	Feedback Voltage (+)
2	15	Excitation Voltage (-)
	16	Excitation Voltage (+)
	17	Feedback Voltage (-)
	18	Feedback Voltage (+)
3	19	Excitation Voltage (-)
	20	Excitation Voltage (+)
	21	Feedback Voltage (-)
	22	Feedback Voltage (+)

LVDT Wiring Terminal Descriptions

Terminal	Description
7	Trip Voltage (+)
8	Trip Voltage (-)
9	No Connection
10	No Connection

Trip Solenoid Wiring Terminal Descriptions

Coil Number	Terminal	Description
1	1	Current (+)
	2	Current (-)
2	3	Current (+)
	4	Current (-)
3	5	Current (+)
	6	Current (-)

Servovalve Wiring Terminal Descriptions

Figure 1-7. Wiring Diagram

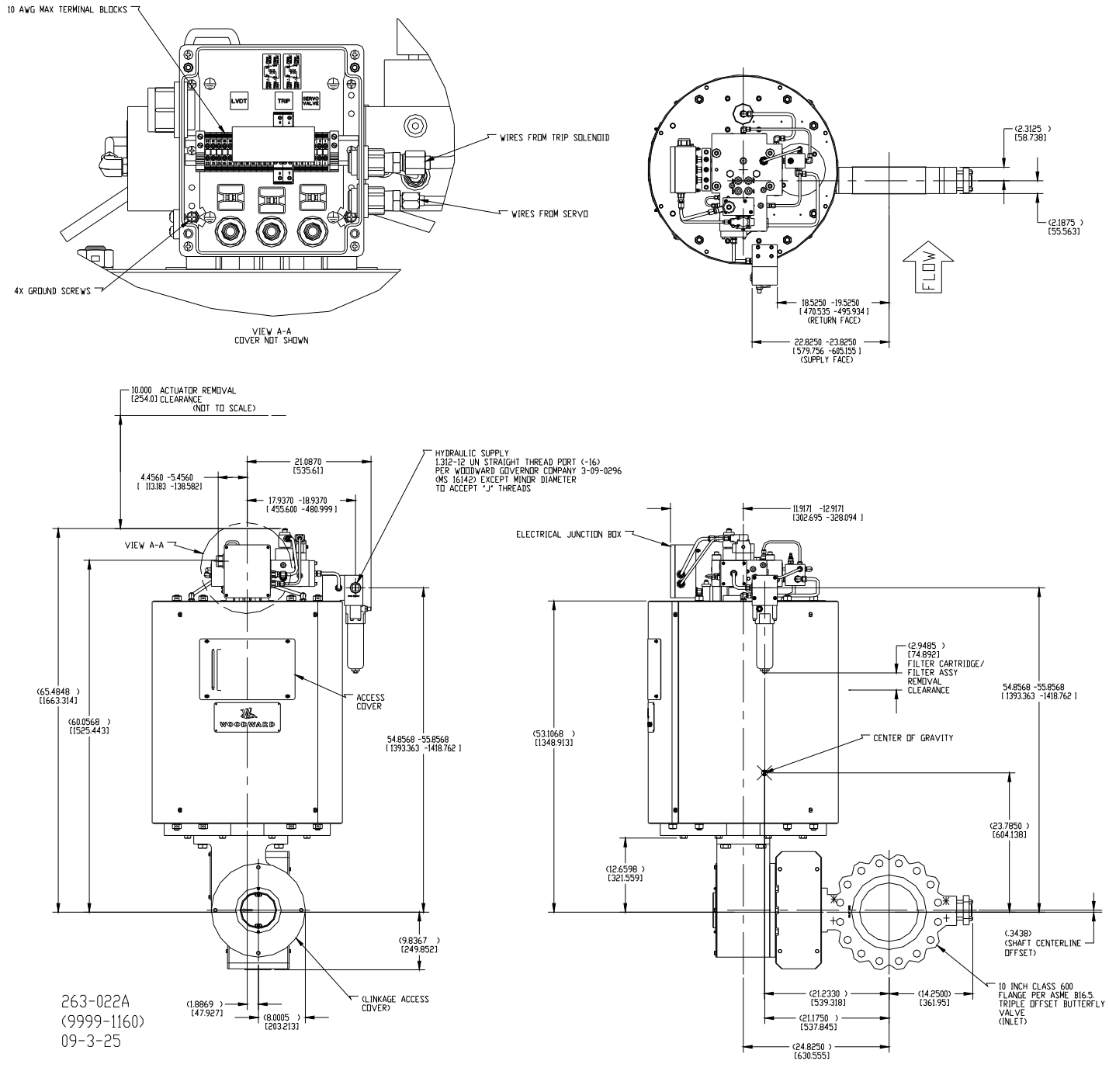


Figure 1-8a. Outline Drawing, 10” valve (9904-914, -915)

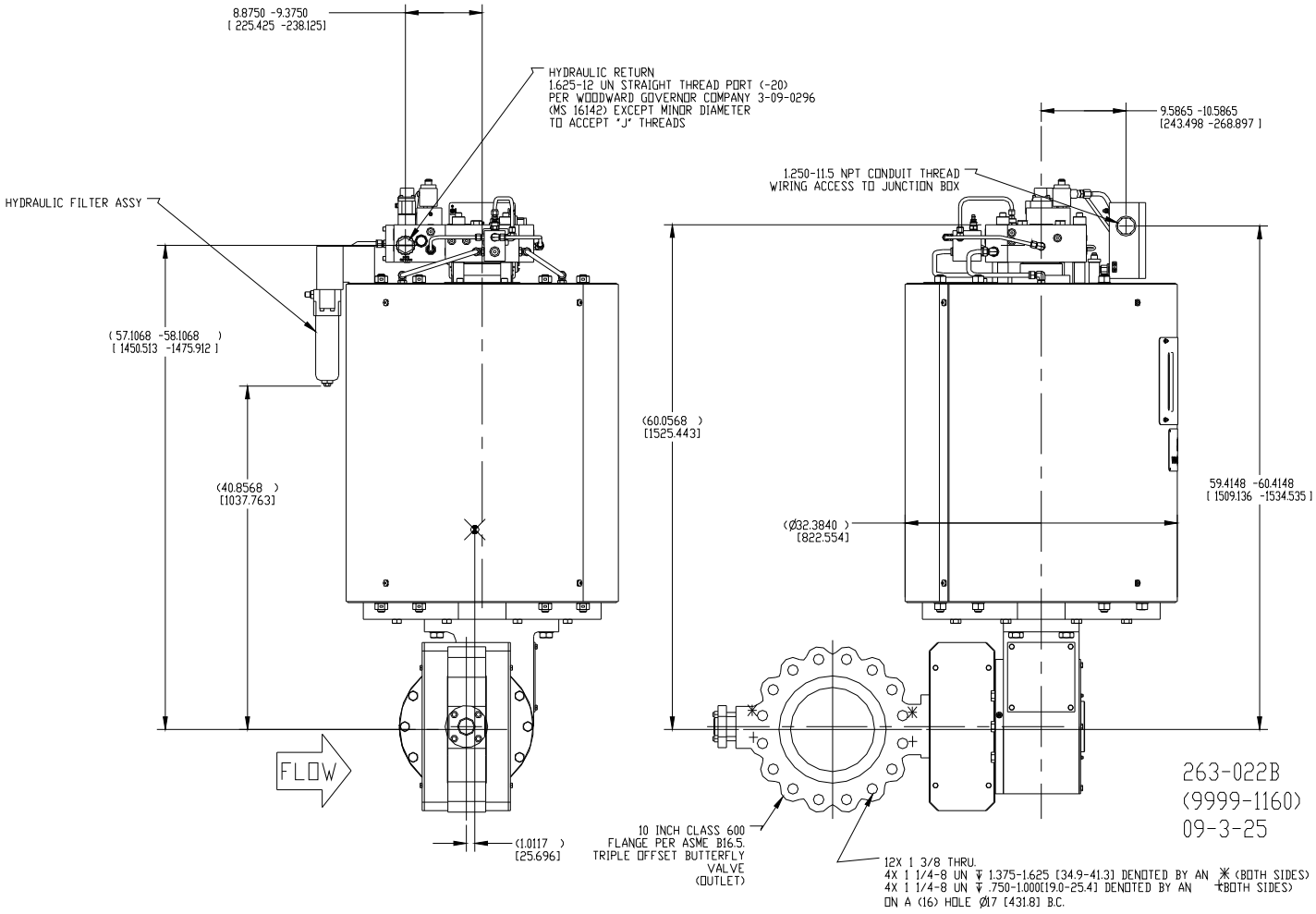


Figure 1-8b. Outline Drawing, 10” valve (9904-914, -915)

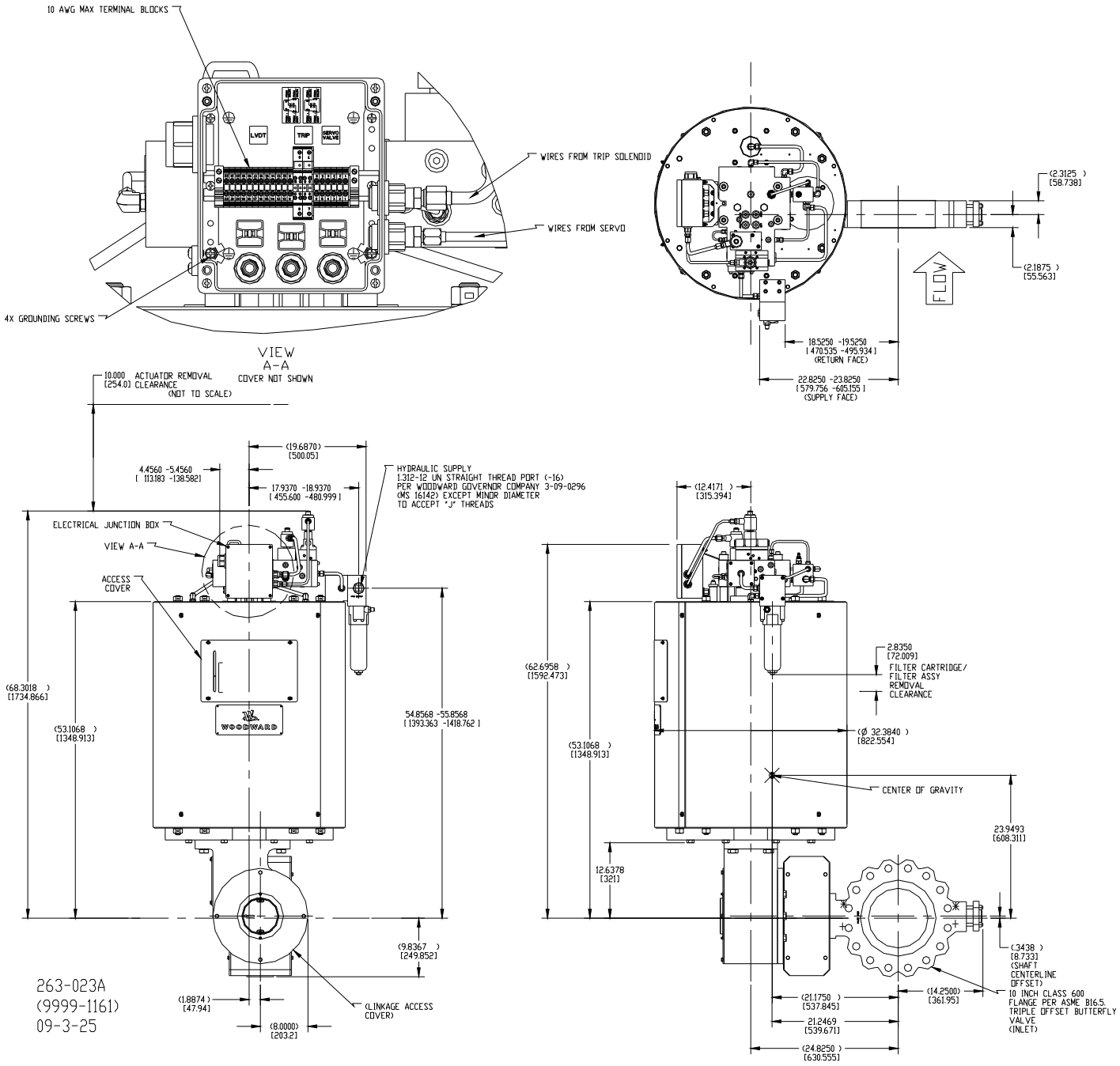


Figure 1-9a. Outline Drawing, 10” valve (9904-916)

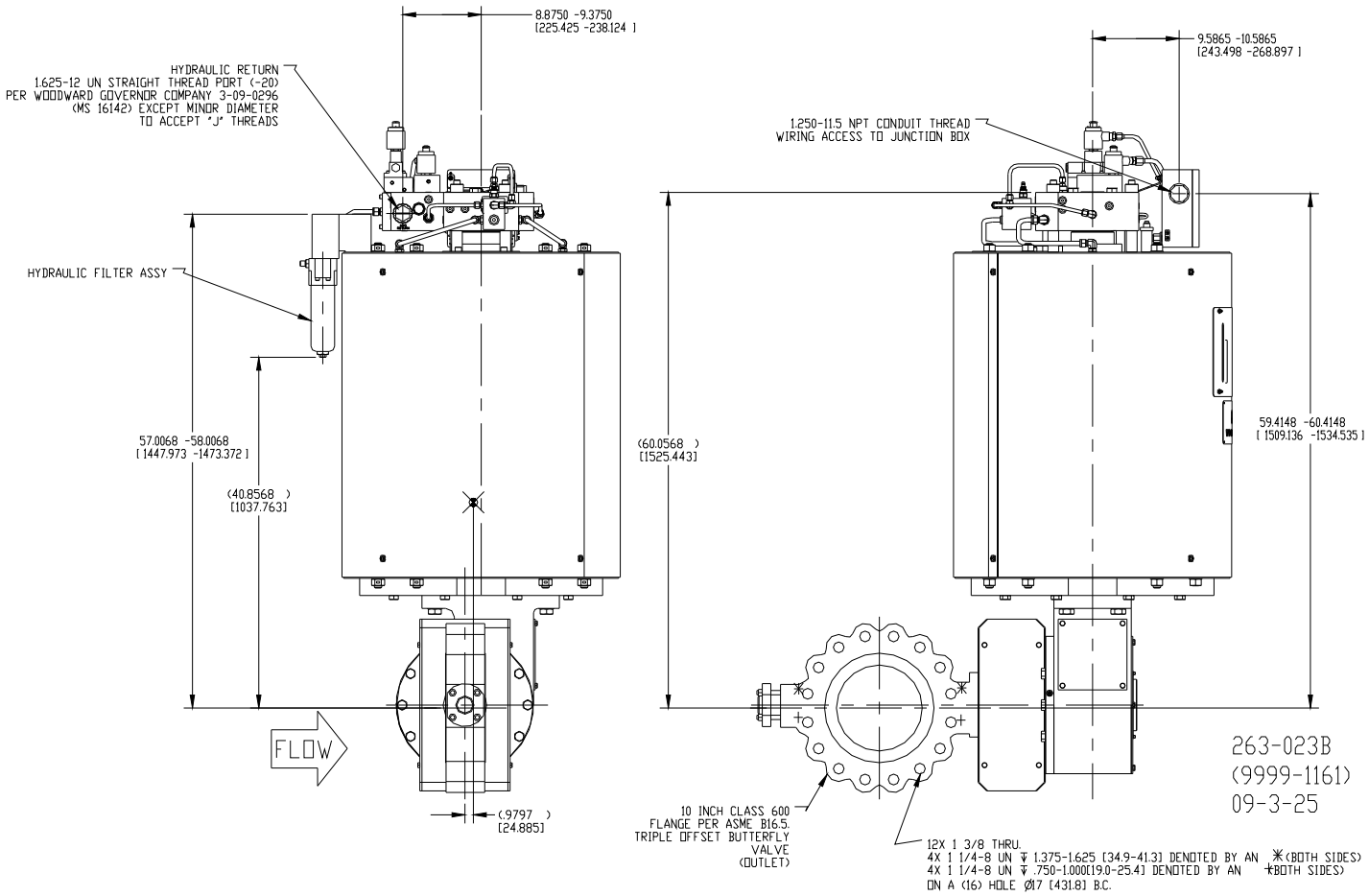


Figure 1-9b. Outline Drawing, 10” valve (9904-916)

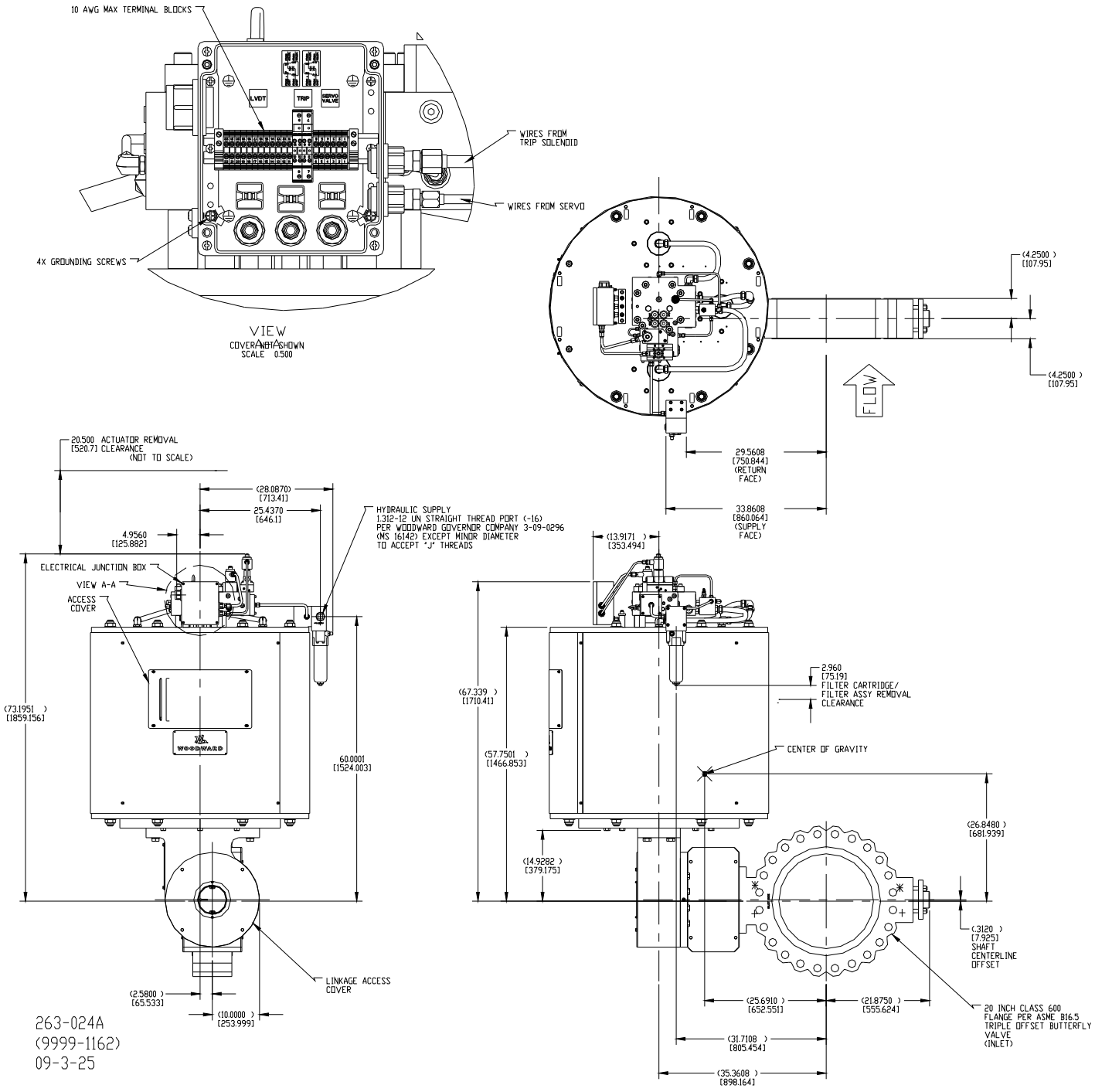


Figure 1-10a. Outline Drawing, 12” valve (9904-917, -918)

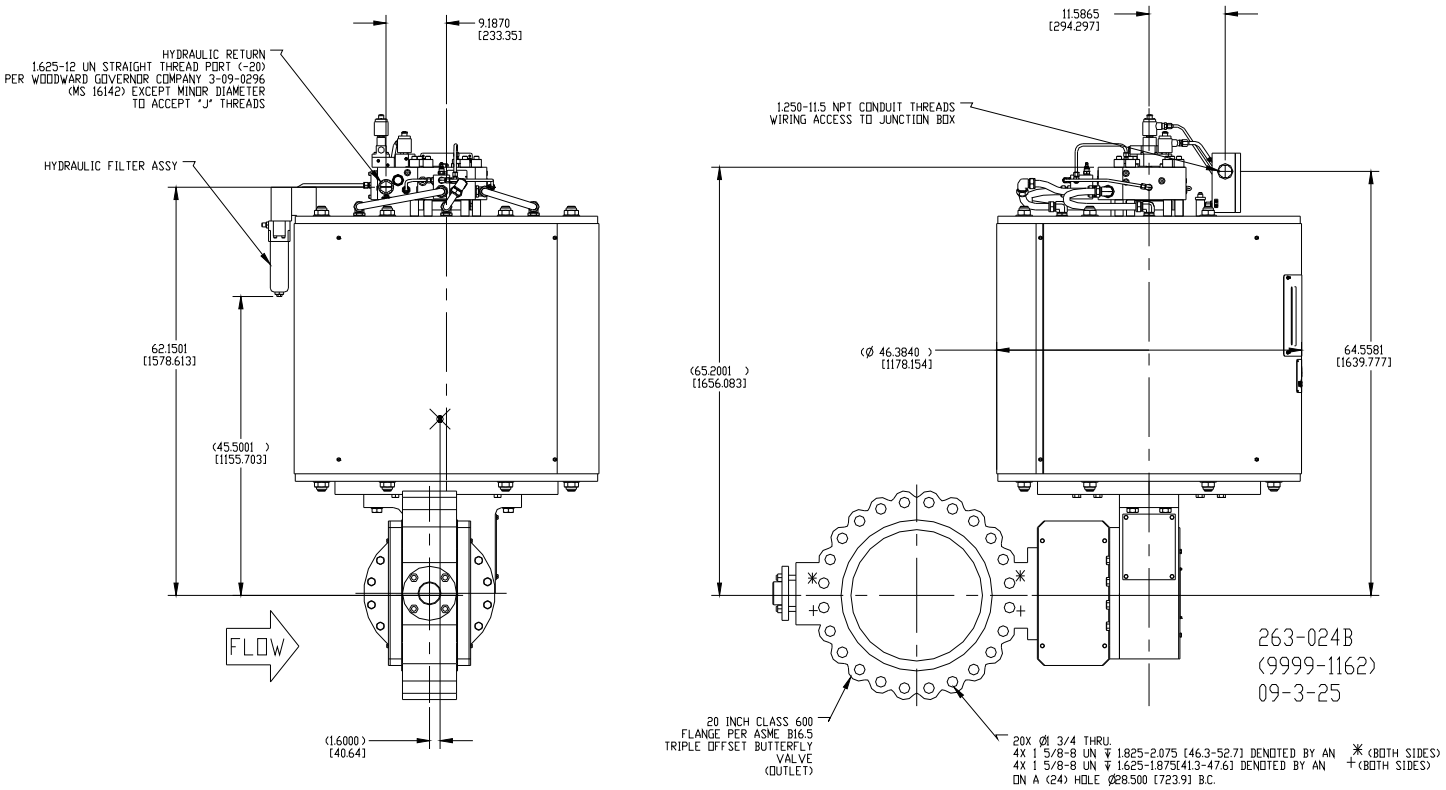


Figure 1-10b. Outline Drawing, 12” valve (9904-917, -918)

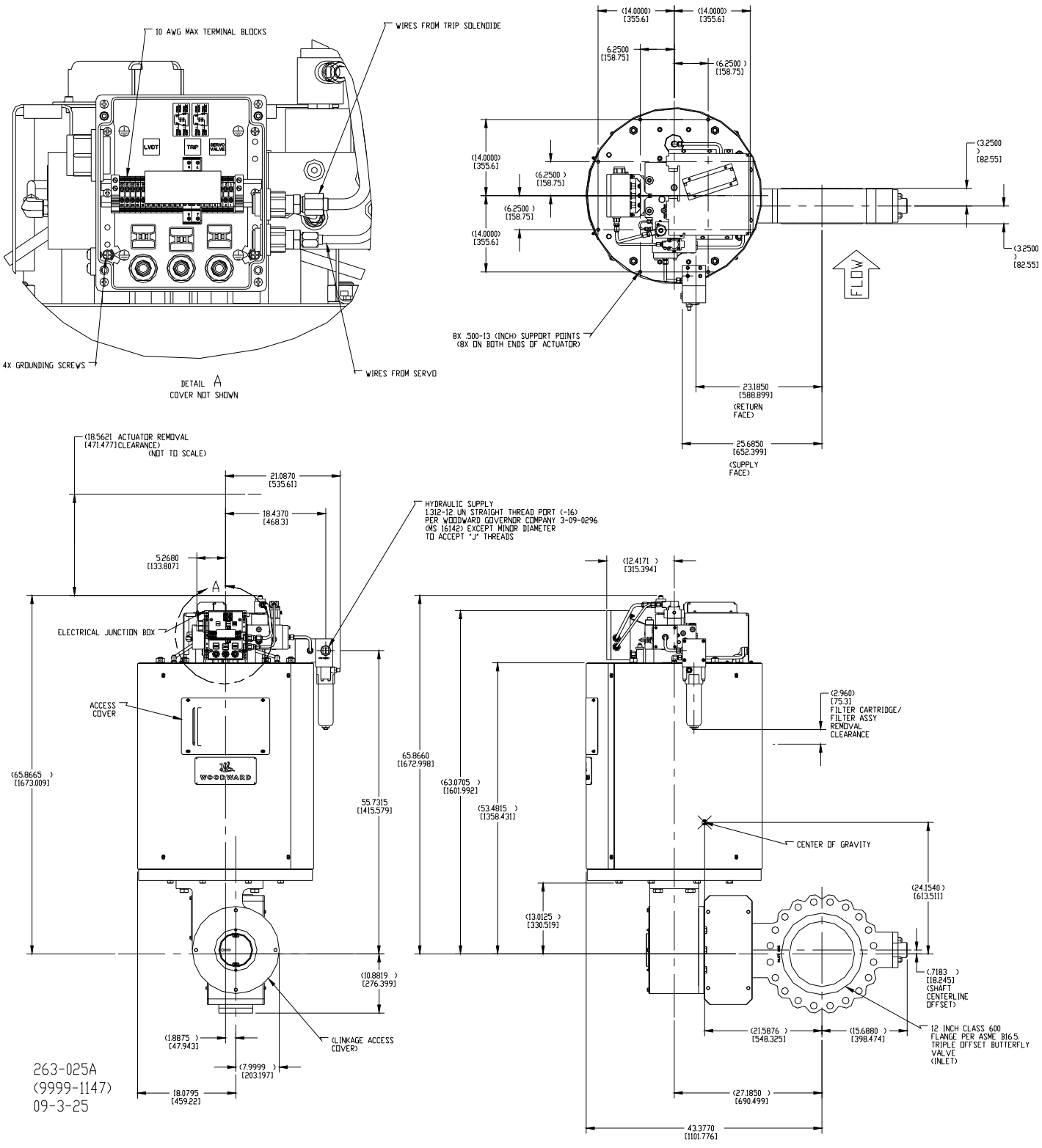


Figure 1-11a. Outline Drawing, 20” valve (9904-947)

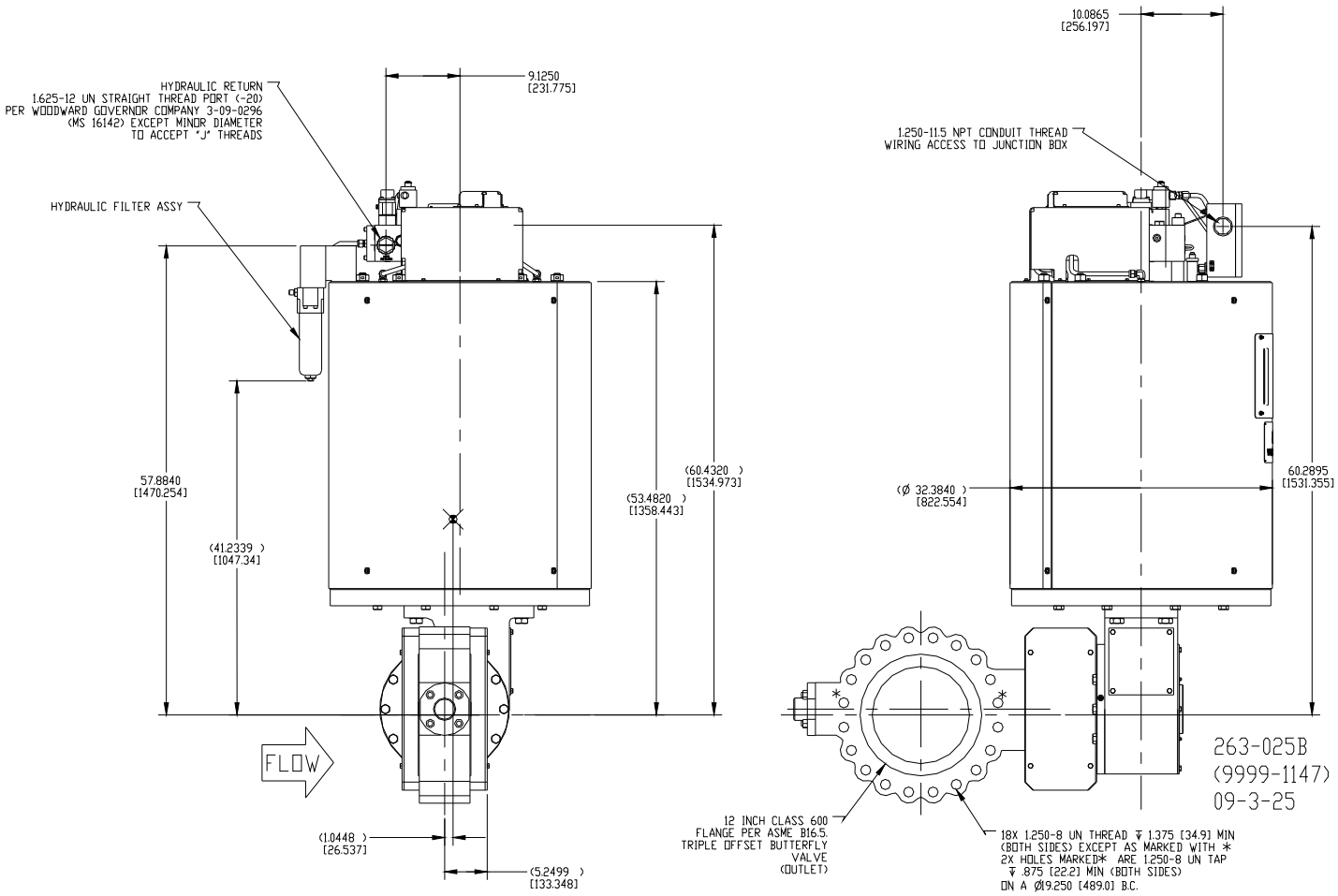


Figure 1-11b. Outline Drawing, 20” valve (9904-947)

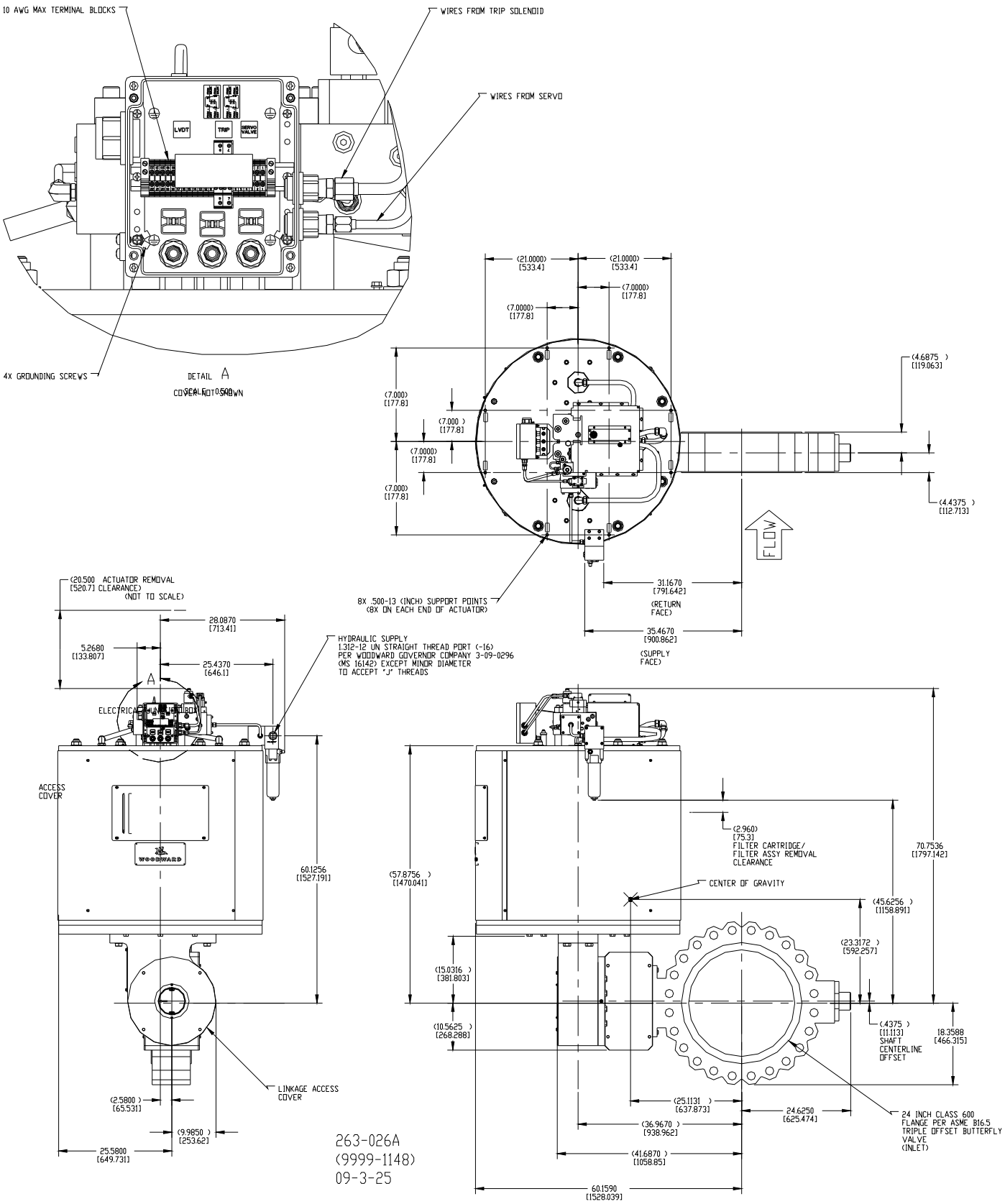


Figure 1-12a. Outline Drawing, 24” valve (9904-948, -949)

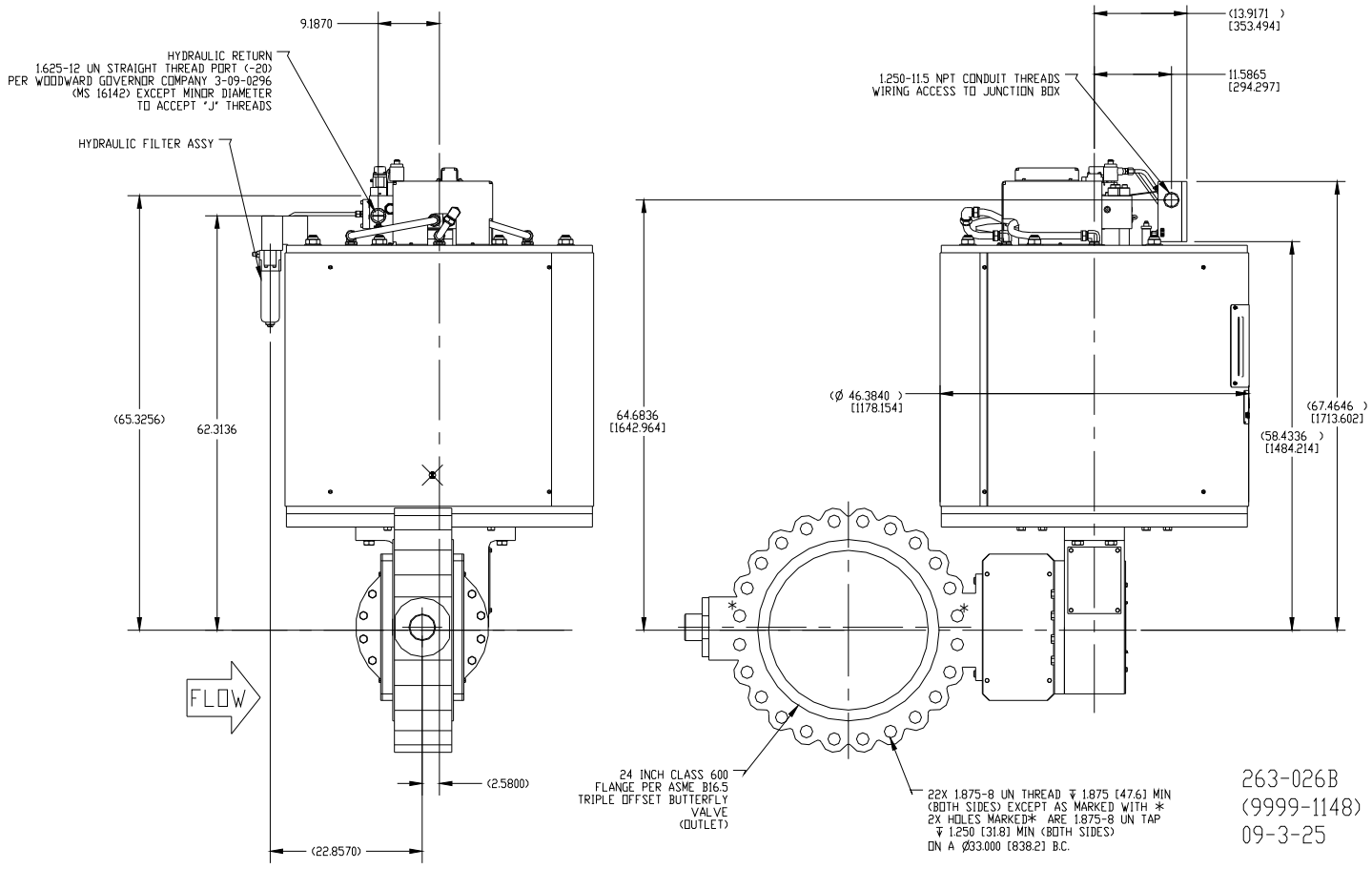


Figure 1-12b. Outline Drawing, 24” valve (9904-948, -949)

Chapter 2.
General Installation

Introduction

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.

⚠CAUTION

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

⚠CAUTION

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

The use of nylon slings secured around the valve bearing areas is recommended to reduce the possibility of mechanical damage occurring to the valve body and actuator.

Do not lift or handle the valve by any conduit. Lift or handle the valve and actuator only by using the eyebolts. Use a "Y" type lifting configuration to prevent damage to the LVDT conduit.

Unpacking

Immediate Use

The valve should be shipped in an enclosed 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.

Storage

When the valve/actuator assembly is not put into immediate service, the valve must be stored in a heated building that is fire resistant, weather-tight, and well ventilated. The storage area must be situated and constructed so that it is not be subject to flooding. Woodward recommends that all valve actuators be cycled approximately every 60 days. Any spare parts for the valve must be stored in the original packaging and under the same conditions as the valve. Acceptable storage temperature range is –20 to +125 °F (–29 to +52 °C).

Shelf Life

Item#	Description	Material	Shelf Life
4	Seal Gasket	316/C4400 or Durabla	15 years
	Gasket	C-4400 or Durabla	15 years
19*	Packing Ring	JC2871	5 years
19.1	Packing Ring	Grafoil	> 20 years

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 two hydraulic connections that must be made to each valve: supply and return. 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 supplies 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. See Chapter 3 for instructions for replacing this filter.

The hydraulic supply to the actuator is to be 1.00 inch (25.4 mm) tubing capable of supplying 10 US gallons/min (18 L/min) at 1500–2000 psig (10.3 – 13.8 MPa).

The hydraulic drain should be 1.50 inch (25.4 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.

See the installation drawings for detailed connection sizes and locations (located at the end of Chapter 1).

Electrical Connections

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 should consist of three individually shielded twisted pairs. Each pair should be connected to one coil of the servo valve as indicated in the installation drawing.

The LVDT cable should consist of two individually shielded twisted pairs for each of the three independent LVDTs. One separate pair should be used for each of the excitation voltages to the LVDT, and one separate pair used for each of the feedback voltages from the LVDT.

The electric trip solenoid cable should consist of two wires of adequate gauge (per local IEC codes) to supply 90–140 Vdc @ 2 A continuous.

A complete wiring diagram is shown at the end of Chapter 1.

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 (i.e.: 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. The assembly should never be lifted by the actuator lifting lugs or by a sling only around the actuator. These areas are for removal and installation of the actuator to the valve only.

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 shaft side of the disc is considered the high pressure side of the valve (see Figure 2-1), meaning optimal closure performance is obtained on this side of the valve, and a determination as to the best installation configuration should be made, to utilize this feature. Note that bi-directional shut-off is possible in this valve.

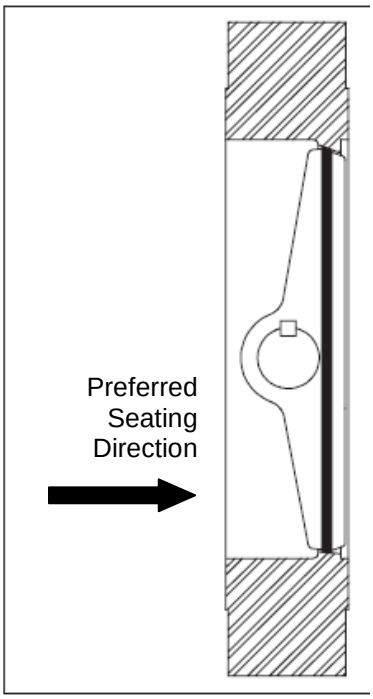


Figure 2-1. Traditional Flow Direction

The valve must be installed so that pipeline stresses are not transmitted to the valve body. Despite the valve's 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 2-2). 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 2-1 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 2-1. 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.

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.

The assembly should never be lifted by the actuator lifting lugs or by a sling only around the actuator. These areas are for removal and installation of the actuator to the valve only.

NOTICE

The use of impact wrenches to install a Woodward Triple Offset Butterfly Valve is <u>not permitted</u>. 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.

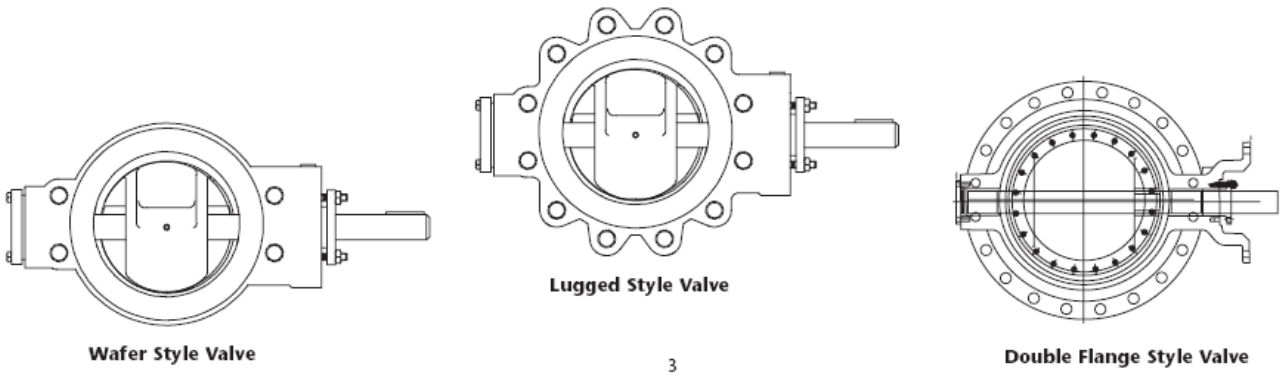


Figure 2-2. Valve Styles

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 2-1 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.

Chapter 3.
Maintenance and Hardware Replacement

Introduction

⚠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. This applies to all steps in this chapter.

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 should be replaced.

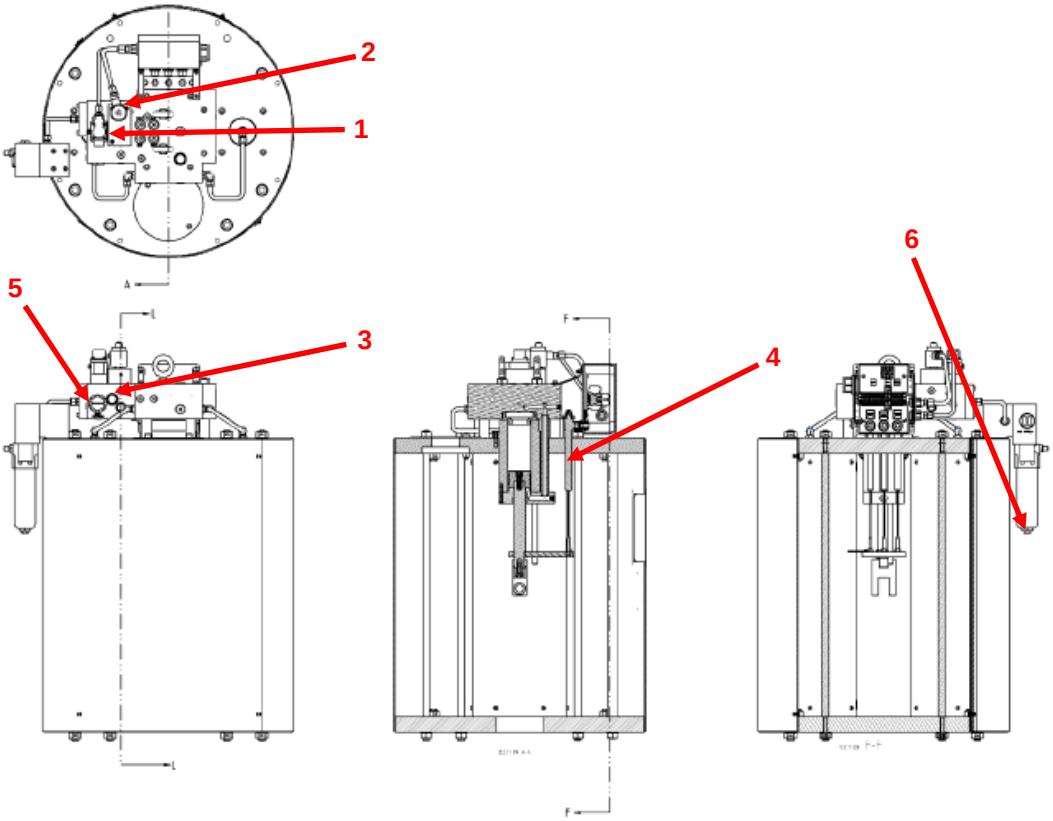


Figure 3-1. Actuator Cutaway Diagrams

Table 3-1. Field Replaceable Actuator Parts

Key	Key Description	Qty Per Valve
1	Servovalve	1
2	Trip Solenoid	1
3	Check Valve (Pilot to Open)	2
4	LVDT	3
5	Check Valve (Pilot to Close)	2
6	Filter Element	1

*Contact Woodward for Recommended Spare Parts List.

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure to depressurize the needle valve on the top of the actuator (see section below).

⚠CAUTION

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

⚠CAUTION

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

Do not lift or handle the valve by any conduit. Lift or handle the valve and actuator only by using the eyebolts. Use a "Y" type lifting configuration to prevent damage to the LVDT conduit.

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 by the actuator lifting lugs or by a sling only around the actuator. These areas are for removal and installation of the actuator to the valve only.

Depressurizing the H-Spring Cartridges

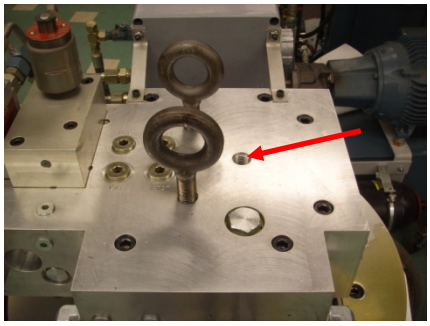


Figure 3-2. Needle Valve Orifice

Figure 3-3. Adjusting Needle Valve

1. This step MUST be performed prior to performing ANY work on the valve or actuator.
2. Using a wrench, loosen the needle valve (two turns max) located on top of the actuator. This will depressurize the unit (some oil may appear on top of the actuator).
   ➔ Do NOT completely remove needle valve to avoid uncontrolled release of Pressurized Hydraulic Fluid.
3. Prior to beginning operation of the unit, ensure the needle valve is hand tightened.
   ➔ If this step is not performed, fail-safe function of the actuator will be compromised.

Hydraulic Filter Assembly/Cartridge

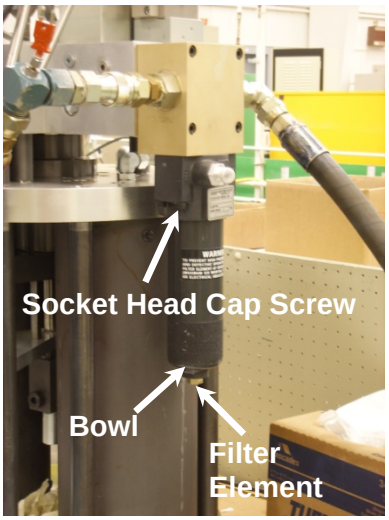


Figure 3-4. Filter Assembly

Replacement of Filter Assembly

WARNING

To prevent possible serious personal injury, or damage to equipment, be sure to depressurize the needle valve on the top of the actuator. See Needle Valve instructions "Depressurizing the H-Spring Cartridges" in this chapter.

1. Remove the four 0.312-18 socket head cap screws.
2. Remove the filter assembly from the manifold block. The filter contains a large amount of hydraulic fluid. *Be cautious when handling*.
3. Verify that two O-rings are present in the interface between the filter and the manifold.
4. Obtain a new filter assembly from Woodward.
5. Verify that two new O-rings are present in the new filter assembly.
6. Install the filter assembly onto the manifold assembly. Be sure to place the filter in the correct orientation. See the outline drawing at the end of Chapter 1.
7. Install the four cap screws through the filter and torque to 180 lb-in (20.3 N·m).
8. Retighten the needle valve. See Needle Valve instructions "Depressurizing the H-Spring Cartridges" in this chapter.

Replacement of Filter Element

1. Be sure to depressurize the H-Spring Cartridges prior to any work on the actuator. See Needle Valve instructions "Depressurizing the H-Spring Cartridges" in this chapter.
2. Using a 1-5/16 wrench, loosen the bowl from the filter assembly.
3. The filter bowl contains a large amount of hydraulic fluid. *Be cautious when handling*.
4. Remove the filter element by pulling straight down from the rest of the assembly.
5. Obtain a new filter element from Woodward.

6. Lubricate the O-ring on the inside diameter of the cartridge with hydraulic fluid.
7. Install the cartridge into the assembly by sliding the open end of the cartridge onto the nipple.
8. Install the filter bowl onto the assembly. Tighten only by hand. Do not torque the bowl.
9. Retighten the needle valve. See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.

Electric Trip Solenoid Replacement

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure to depressurize the needle valve on the top of the actuator). See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.

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 Figures 3-4 and 3-5).
6. Loosen the coil retention nut (see Figures 3-4 and 3-5).
7. Using 1-inch wrench loosen and remove the solenoid from the actuator.

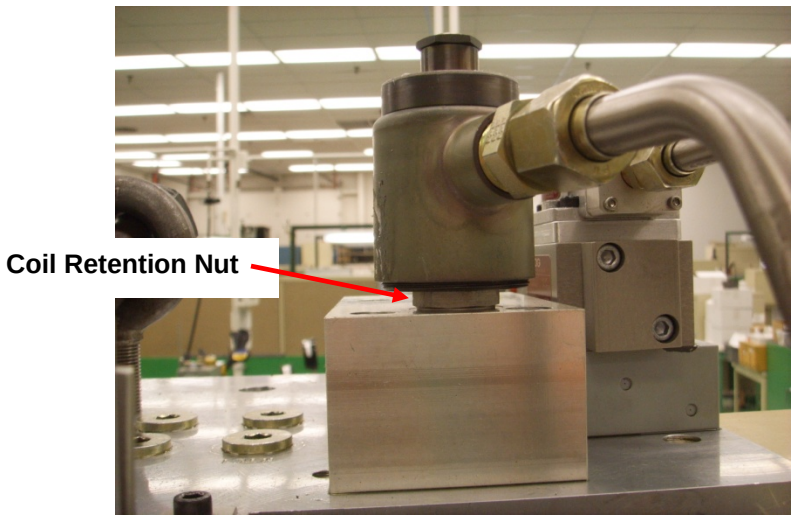


Figure 3-5. Fully Assembled Trip Solenoid

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.
17. Retighten the needle valve. See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.

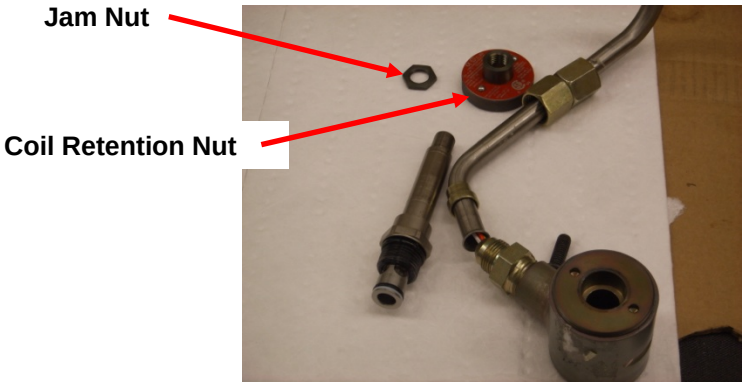


Figure 3-6. Disassembled Trip Solenoid Assembly

Servovalve Replacement

WARNING

To prevent possible serious personal injury, or damage to equipment, be sure to depressurize the needle valve on the top of the actuator. See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.

1. Remove the cover to the electrical junction box.
2. Disconnect the servovalve wires from the connector blocks (see wiring diagram).
3. Loosen the conduit fittings from the electrical box and the servovalve.

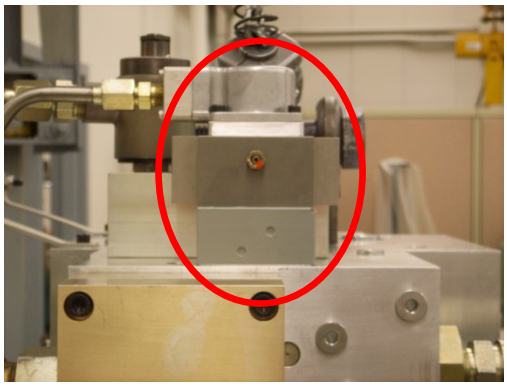


Figure 3-7. Servovalve Assembly and Manifold

4. Carefully remove the conduit from the servovalve and pull the wiring out of the conduit.
5. Remove the four socket head cap screws holding the servovalve to the manifold.

6. Verify that all four O-rings are removed from the interface between the manifold and the servovalve. On units with an intermediate orifice plate for modified slew time, verify that the four O-rings between the servovalve and plate are removed.
7. Obtain a replacement servovalve from Woodward and verify part number and revision with the existing unit.
8. Remove the protective plate from the replacement servovalve and verify that O-rings are on all four counter bores of the servovalve.
9. Place the replacement servovalve onto the hydraulic manifold. Be sure to orient the servovalve to match the original orientation. Be sure that all four O-rings remain in their proper location during assembly. On units with an intermediate orifice plate for modified slew time, verify that the four O-rings on the underside of the orifice plate are in their grooves. Verify that the plate is in the proper location by aligning the locater roll pin into its receiving hole. Be sure that all 8 O-rings remain in their proper location during assembly.
10. Install four socket head cap screws and torque to 50 lb-in (5.7 N·m).
11. Install wiring through the conduit and into the electrical box.
12. Connect the conduit to the servovalve and torque to 100 lb-in (11.3 N·m).
13. Torque the conduit to the electrical box to 100 lb-in (11.3 N·m).
14. Install wires into the servovalve connector blocks labeled 1-6 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.
15. Replace the cover onto the junction box and tighten the screws.
16. Retighten the needle valve. See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.

LVDT Replacement

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure to depressurize the needle valve on the top of the actuator. See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.

1. Remove the cover to the electrical junction box.
2. Remove applicable LVDT wires from terminal block.
3. Remove socket head cap screws from junction box to valve manifold.
4. Remove 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 socket head cap 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.

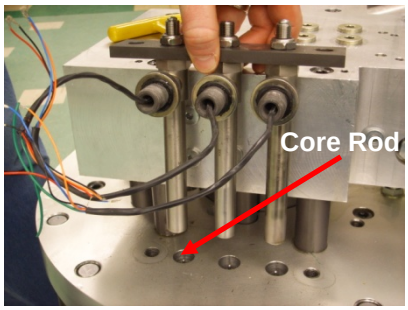


Figure 3-8a. Disassembled LVDT

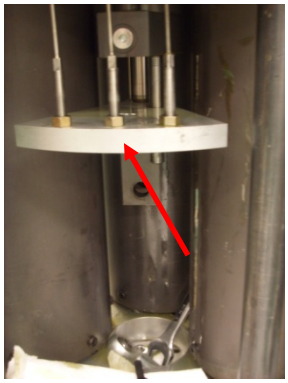


Figure 3-8b. Retaining Plate

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 socket head cap screws and torque to 90 lb-ft (10.2 N·m).

NOTICE

Bending LVDT core rods will damage them beyond repair.

18. Reinstall junction box over LVDTs.
19. Install nuts on LVDT bodies.
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 socket head cap screws and tighten to 100 lb-in (11.3 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. Replace the access covers for the junction box, and access cover for actuator.
26. Retighten the needle valve. See Needle Valve instructions “Depressurizing the H-Spring Cartridges” in this chapter.
27. Recalibrate the control system.

Removing Actuator from Valve

⚠WARNING

To prevent possible serious personal injury, or damage to equipment, be sure to depressurize the needle valve on the top of the actuator. See Needle Valve instructions "Depressurizing the H-Spring Cartridges" in this chapter.

Be sure to depressurize the H-Spring Cartridges prior to any work on the actuator. See Needle Valve instructions "Depressurizing the H-Spring Cartridges" in this chapter.

1. Remove the actuator outer covers (quantity 2).
2. Remove the transfer case front plate and valve angle indicator from the transfer case lever.
3. Remove the shoulder screw from the linkage at the valve lever.
4. Attach lifting straps to actuator tie rods, and support the actuator with the lifting device as shown in Figure 3-9.
5. Remove the mounting bolts that hold the actuator adapter plate to the transfer case housing.
6. Lift the actuator/yoke from the valve body using the actuator tie rods as shown in Figure 3-9, being careful not to damage any conduits, hydraulic lines, actuator visible position indicator pointer, or any other component mounted on the manifold.

Figure 3-9. Actuator Rigged via Tie Rods for Lifting

IMPORTANT

Some valves are set with a specific opening when closed rather than tight against the seat. For these valves, Do not remove the valve yoke or transfer case if at all possible from these valves. If the transfer case is removed, see the section of this manual for adjustment of butterfly valves with preset gaps. The valves item numbers that have pre-set gaps at the seat are 9904-948, 9904-949 (9H Systems) and 9904-916, 9904-917, & 9904-918 (7H Systems)

When reassembling be sure that the length of the linkage is not adjusted. If it is adjusted, the Linkage Adjustment Procedure must also be performed. Upon reassembly, retighten the needle valve. See Needle Valve instructions "Depressurizing the H-Spring Cartridges" in this chapter.

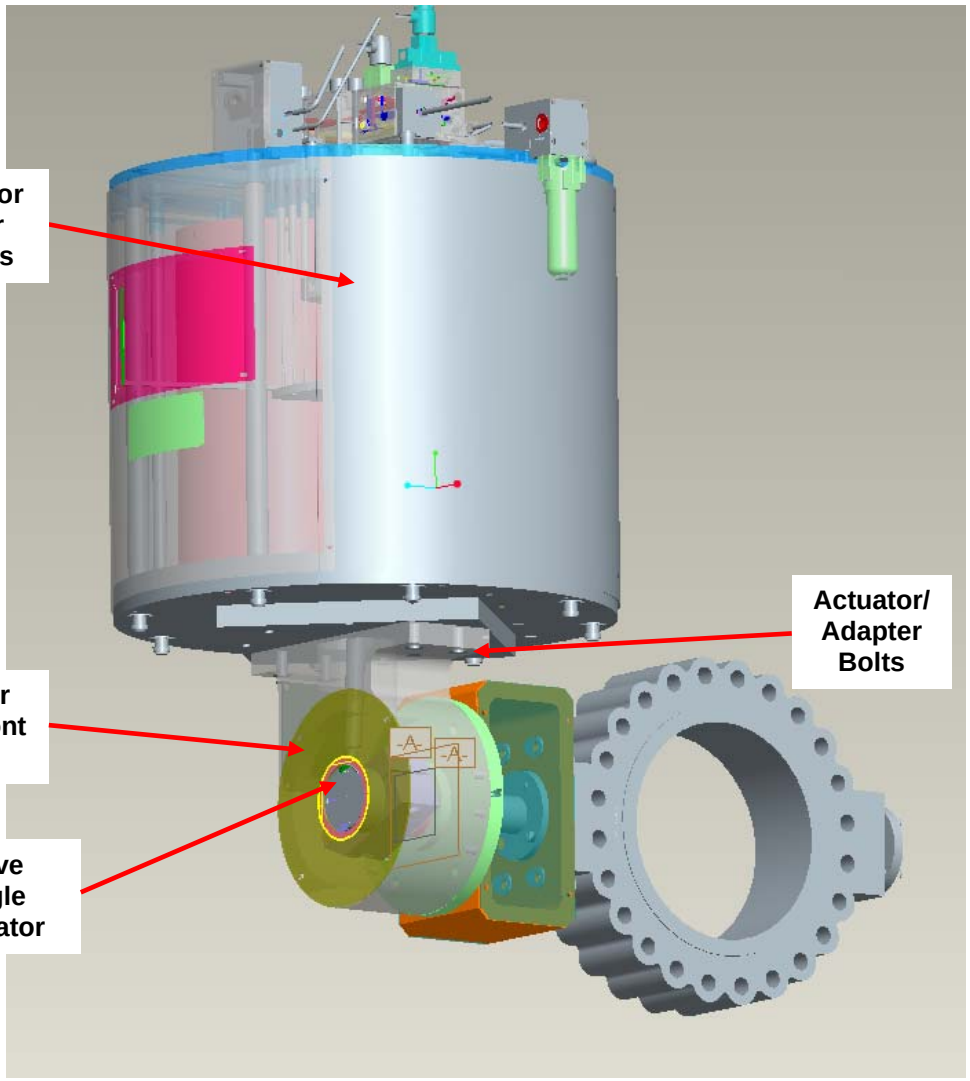


Figure 3-10. Triple Offset Butterfly Valve

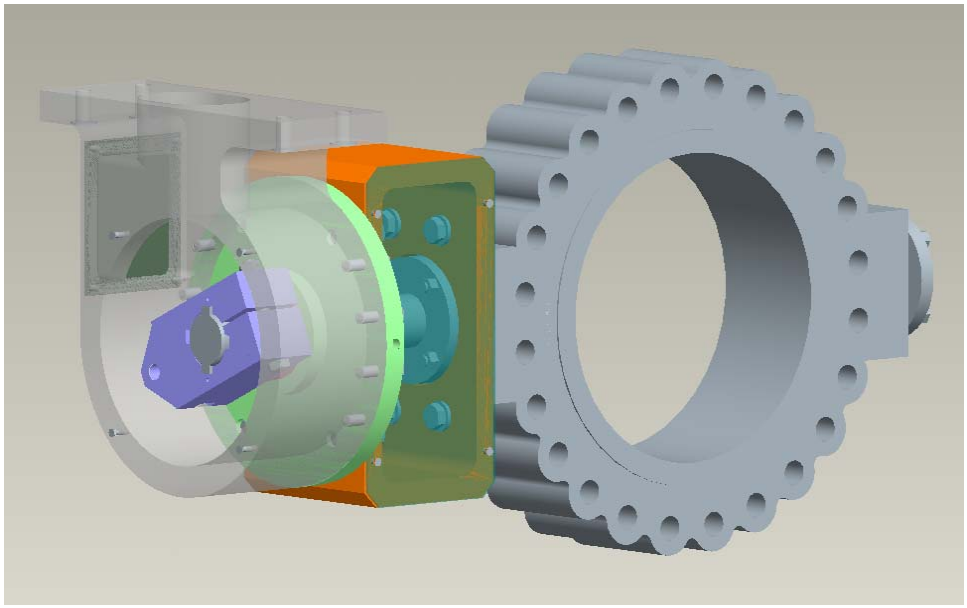
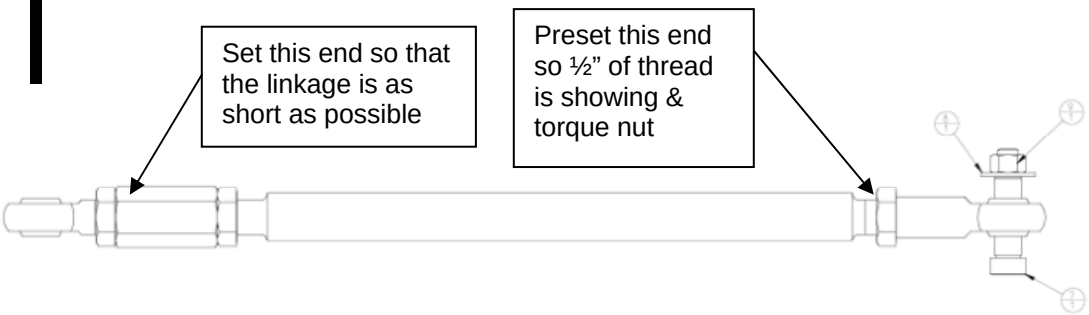


Figure 3-11. Valve with Actuator Removed
(This is as far as the valve can be disassembled and maintain the preset valve gap.)

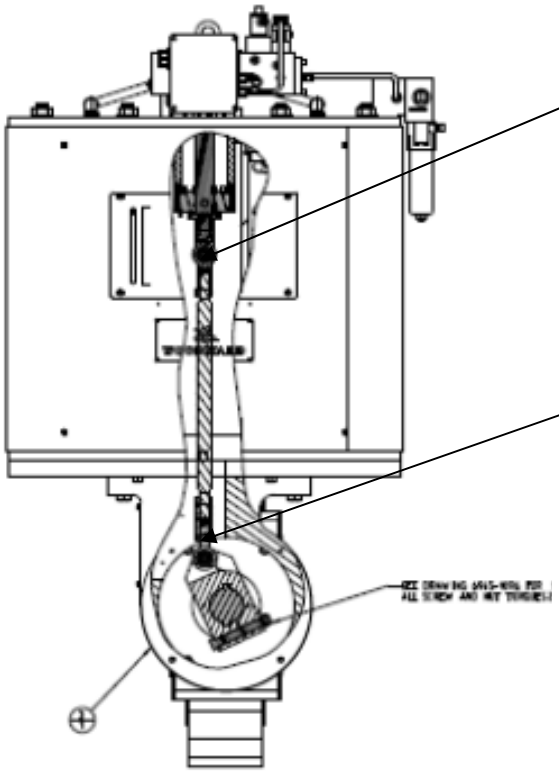
Linkage Adjustment for Valves with Tight Shut-off

This procedure applies to 9H 9904-947 FCV4536A, 7H 9904-914 FCV4536A, and 7H 9904-915 FCV4536B.

The valve is a "pull-to-close" type. The instructions 3.2.7 – 3.2.15 are the initial linkage set-up procedure for installation of the linkage between the valve and actuator. This procedure assumes that the valve is in its full closed position. Before installation of the linkage in the assembly, it must be pre-set.



Once the linkage is pre-set, it can be installed.



Attach the upper rod end to the actuator output clevis, and torque the upper shoulder bolt.

Using the turnbuckle adjustment (hex piece between rod end and main linkage shaft), lengthen the linkage until it is possible to insert the shoulder bolt through the valve input lever and linkage rod end.

Once the linkage is assembled, shorten the linkage using the turnbuckle until all of the slack is taken out (this is the point where the torque required to turn the turnbuckle increases significantly). As further shortening of the linkage is nearly impossible once the slack is taken out, open the valve using the hydraulics at low pressure so that the accumulators do not charge (if they charge and the hydraulics are turned off, the valve will move to its failsafe position). Once the valve is open, the linkage is shortened an addition 1/3 to 1 turn to ensure the actuator is loading the valve seat in its retracted position.

Installation of Rigging Tool on Steam Cooling Butterfly Valves that Require Pre-Set Gaps

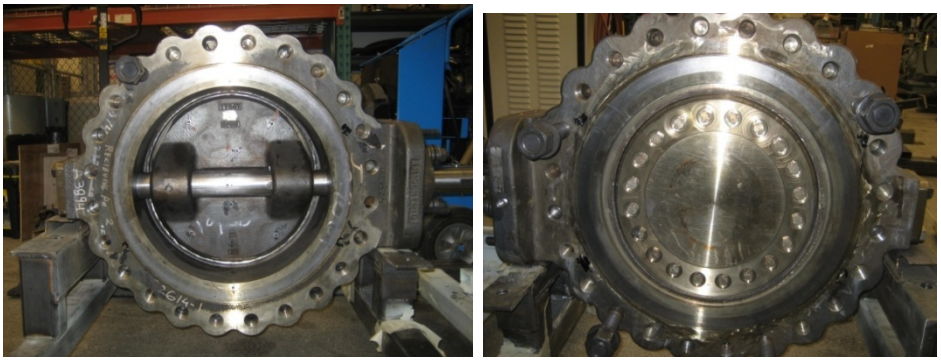


Figure 3-12. Valve Inlet (left), Valve Outlet (right)

Figure 3-13. Adjusting Valve Seat Gap

Block the valve so it is possible to strike the outlet side disk face with a dead blow hammer.

Check the gap between the disk seal ring and the valve body seat using shims in the locations shown in Figure 3-14.

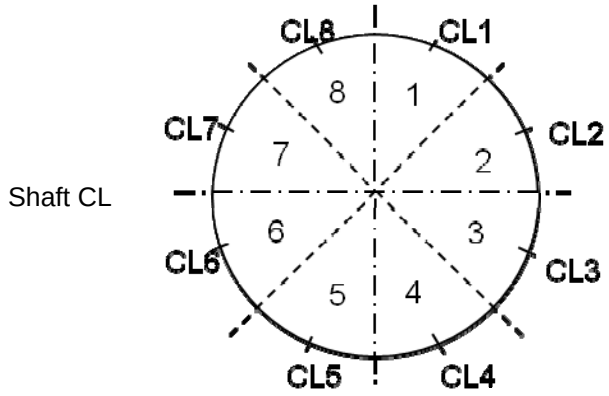


Figure 3-14. Shim Locations

Record the clearance at each location. Assuming an equal length with a clearance equal to the size of the shim, calculate each segment area, add and compare against limits below.

10” Valve Clearance Setting (7H 9904-914 & 9904-915)

RECORD	Clearance		Circumference Length			Calc Area	
CL1		IN	3.5368	IN	=	0	IN2
CL2		IN	3.5368	IN	=	0	IN2
CL3		IN	3.5368	IN	=	0	IN2
CL4		IN	3.5368	IN	=	0	IN2
CL5		IN	3.5368	IN	=	0	IN2
CL6		IN	3.5368	IN	=	0	IN2
CL7		IN	3.5368	IN	=	0	IN2
CL8		IN	3.5368	IN	=	0	IN2

Min Total Clearance Area	:	0.2	IN2
Total Calculated Clearance Area	:		IN2
Expected Total Clearance Area	:	0.2829	IN2
Allowable Max Total Clearance Area	:	0.35	IN2

20” Valve Clearance Setting (7H 9904-917, 9904-918)

RECORD	Clearance		Circumference Length			Calc Area	
CL1		IN	7.0211	IN	=	0	IN2
CL2		IN	7.0211	IN	=	0	IN2
CL3		IN	7.0211	IN	=	0	IN2
CL4		IN	7.0211	IN	=	0	IN2
CL5		IN	7.0211	IN	=	0	IN2
CL6		IN	7.0211	IN	=	0	IN2
CL7		IN	7.0211	IN	=	0	IN2
CL8		IN	7.0211	IN	=	0	IN2

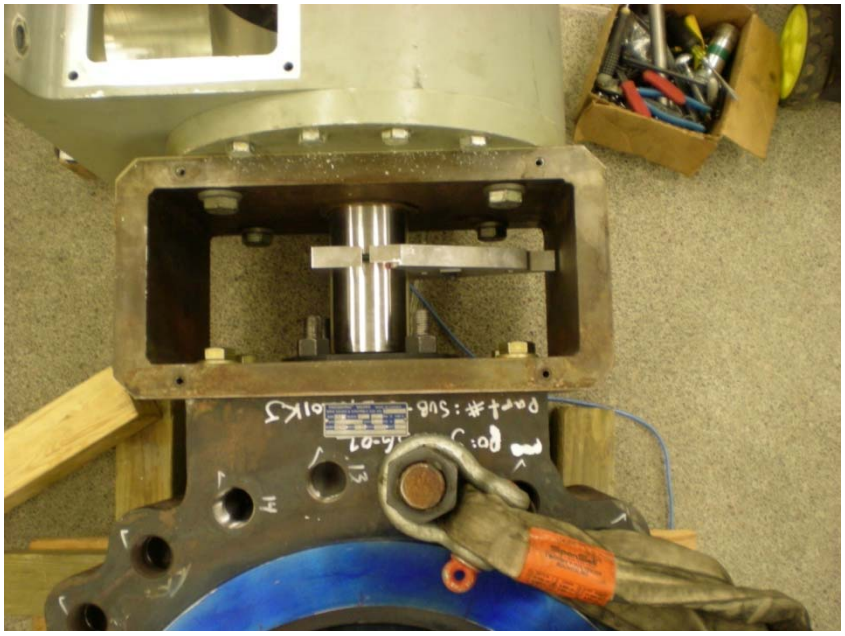
Min Total Clearance Area	:	1.8	IN2
Total Calculated Clearance Area	:		IN2
Expected Total Clearance Area	:	1.9097302	IN2
Allowable Max Total Clearance Area	:	2.5	IN2

24” Valve Clearance Setting (9H 9904-948, 9904-949)

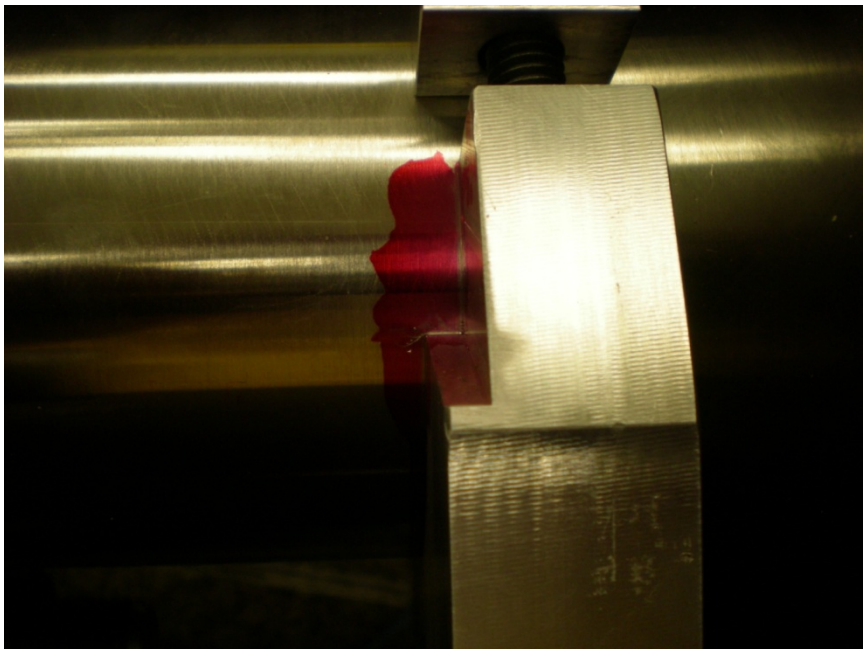
RECORD	Clearance		Circumference Length			Calc Area	
CL1		IN	7.85	IN	=	0	IN2
CL2		IN	7.85	IN	=	0	IN2
CL3		IN	7.85	IN	=	0	IN2
CL4		IN	7.85	IN	=	0	IN2
CL5		IN	7.85	IN	=	0	IN2
CL6		IN	7.85	IN	=	0	IN2
CL7		IN	7.85	IN	=	0	IN2
CL8		IN	7.85	IN	=	0	IN2

Min Total Clearance Area	:	2	IN2
Total Calculated Clearance Area	:		IN2
Expected Total Clearance Area	:	2.1352	IN2
Allowable Max Total Clearance Area	:	2.5	IN2

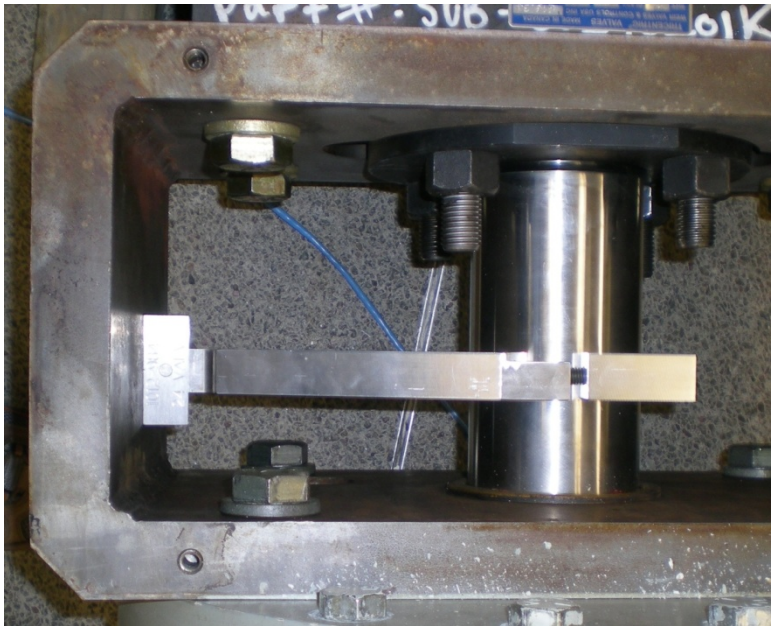
Prior to or immediately following the setting of the gap in the valve, install the valve yoke and transfer case on the valve. Mount the tool in the yoke with the marking end towards the bottom side of the valve. Rigging Tool Numbers 1012-9905=10”, 1012-9846=20”, 1012-9847=24”.



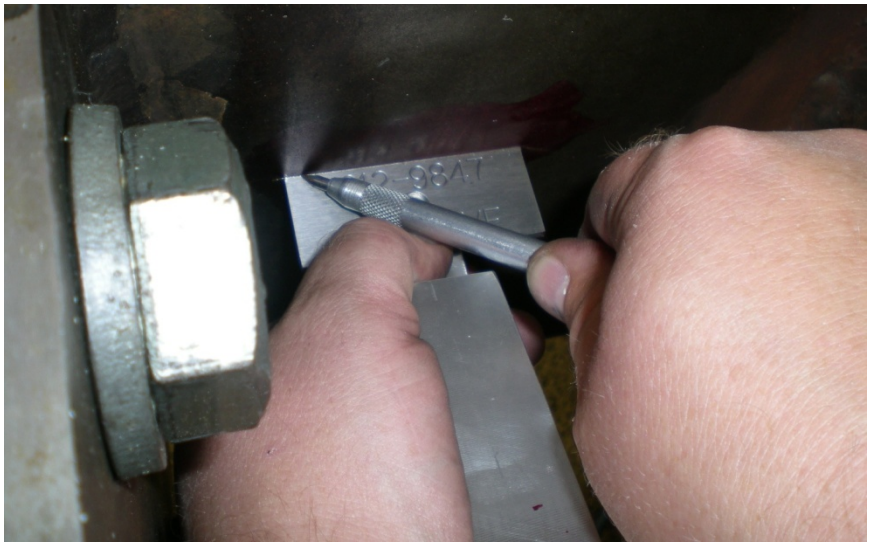
Apply red dykem to the valve shaft in the notched area of the tool. Mark the shaft using a carbide scribing tool.



Apply red dykem to the yoke directly under the end of the tool. Remove the transfer block from the side of the tool. Place it on the flat part of the end of the lever, so that it bridges the gap between the tool and the yoke.



Mark the yoke using a carbide scribing tool.



Mount the marking block back to the side of the tool. The valve is now ready to be rigged to the actuator.

Linkage Adjustment for Valves with Pre-Set Gaps

This procedure applies to 7H FV4525 [9904-916], 7H FV4526 [9904-917], 7H FV4535 [9904-918], 9H FV4526 [9904-948], and 9H FV4535 [9904-949].

This procedure assumes the valve will have the seat gap set and an alignment tool installed on the shaft inside the yoke. There are scribe marks on the yoke that can be used with the alignment tool to set the valve minimum position. This procedure assumes that the actuator to valve linkage has been removed from both actuator and valve, and that the linkage turnbuckle jam nuts have been loosened. It further assumes that the actuator covers have been removed to facilitate linkage installation & shoulder bolt torquing.

1. Mount the valve as received with the yoke and transfer case housing attached into the pipe.
2. Mount the actuator on the valve & torque all bolts per assembly drawing.
3. Install the valve actuation lever, and torque the pinch bolt.
4. Remove the yoke cover plates from both sides of the yoke.
5. Restore all hydraulic & electrical connections.
6. Command the actuator to its fully retracted position.
7. Install the actuator to valve linkage into the upper (actuator) clevis, and torque the shoulder bolt in the upper clevis.
8. Adjust the linkage turnbuckle to make it possible to insert the lever shoulder bolt through the valve actuation lever and linkage rod end.
9. Torque the valve actuation lever shoulder bolt.
10. Stroke the valve to maximum (actuator extend) and back to minimum (actuator retract).
11. Using the extender block attached to the tool mounted on the valve shaft, check the alignment of the scribed line in the yoke and the rigging tool.
12. Adjust the linkage as necessary and repeat steps 10–11 until the scribed line and the edge of the alignment tool match.
13. Torque the upper and lower turnbuckle jam nuts per applicable assembly drawing.
14. Repeat steps 10–11 and adjust the linkage again if necessary.

15. Torque the upper and lower turnbuckle jam nuts again if necessary.
16. Remove the alignment tool from the valve shaft.
17. Replace all covers (yoke, actuator, transfer case).
18. Install valve shaft end pointer.

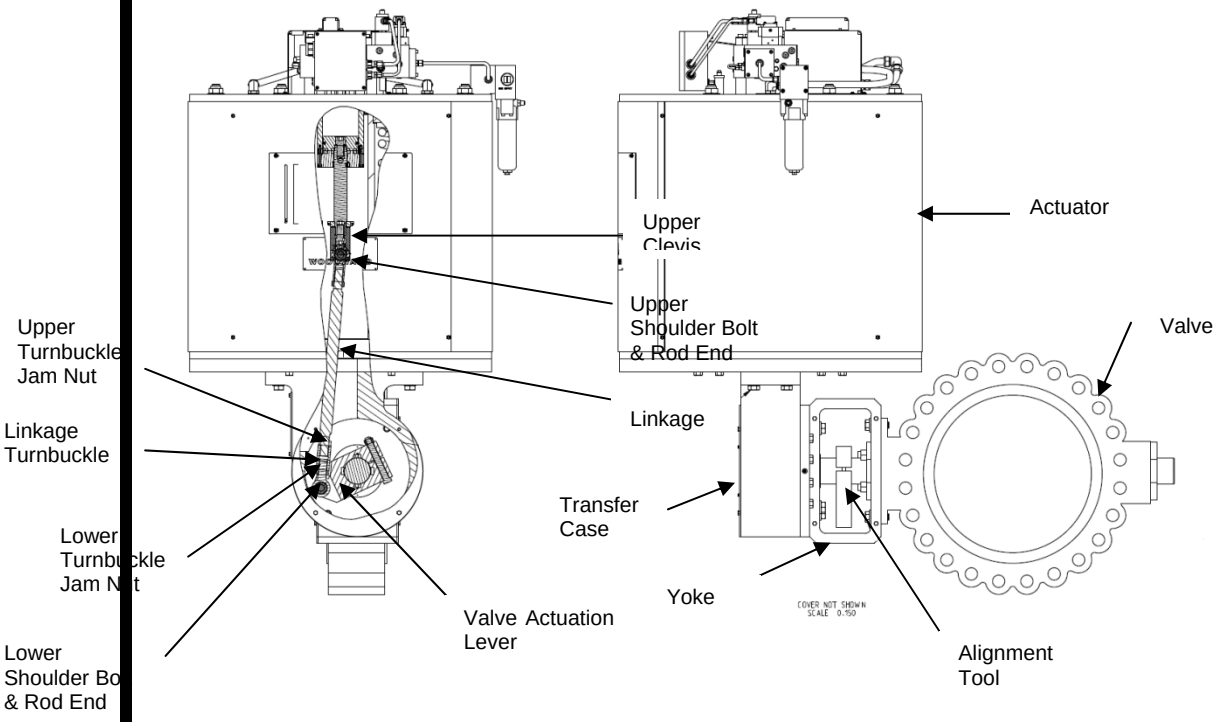


Figure 3-15. Triple Offset Butterfly Valve Assembly

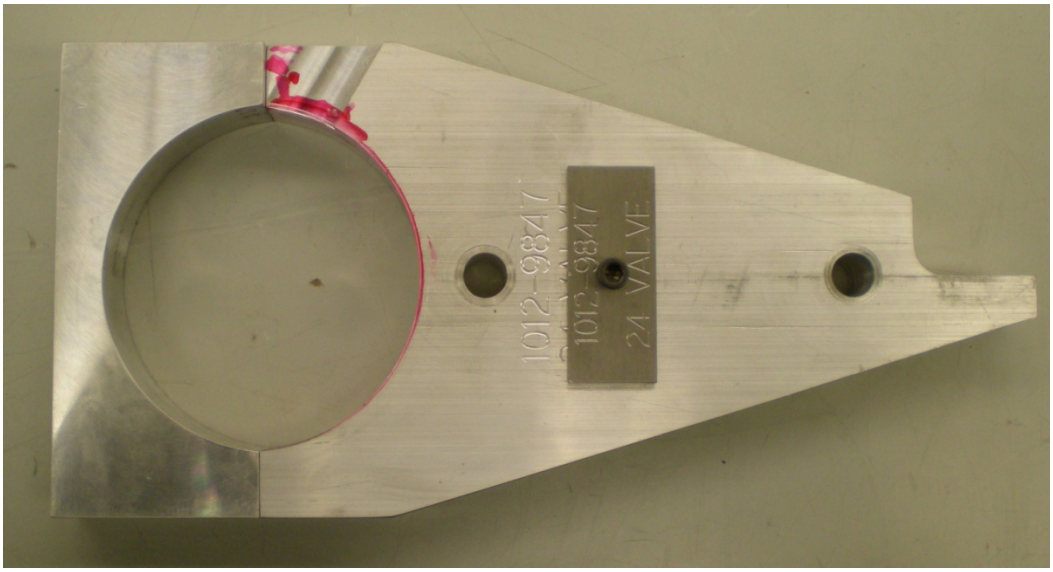


Figure 3-16. TOV Rigging Tool with Extender Block (Not Installed)

Figure 3-17. Aligning Scribe Mark in Yoke with Rigging Tool & Extender Block

Packing Replacement

IMPORTANT **The changing of the packing can be made without removing the actuator if split rings are used. However, if the rings are not split, the actuator will have to be removed from the valve.**

1. De-pressurize the valve.

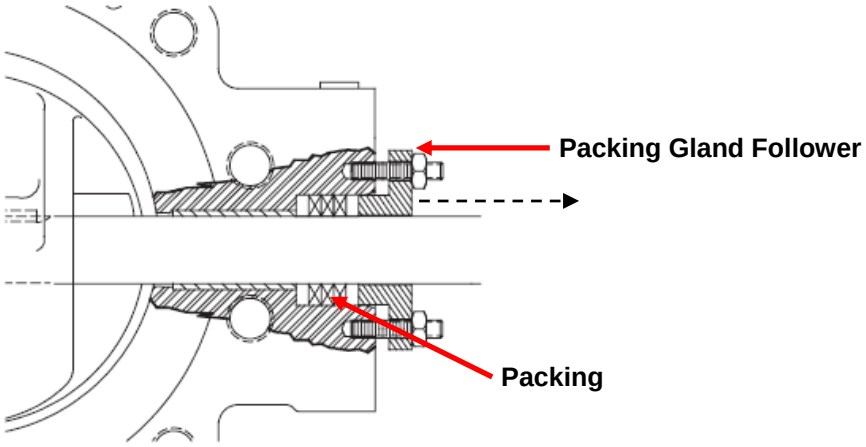


Figure 3-18. Packing Arrangement

2. Remove all the nuts from the studs and pull back the packing gland follower.
3. Remove the packing with a flexible screw hook packing puller. Remove the packing from the bore one layer at a time.

NOTICE **Take care to assure that the packing bore and drive shaft are not damaged during packing removal.**

4. Install the new packing one ring at a time in the same order as removed.

5. Split packing should be installed at 90-degree intervals to minimize any potential leak path.
6. Use the packing gland follower to push each layer of packing evenly into the bore.
7. It is important that the packing gland follower be symmetrically mounted around the shaft. This will prevent galling on the shaft or binding during operations.
8. Once the packing has been installed, the gland can be tightened down with the nuts. The stuffing box studs are to be tightened opposite successively and proportionately, until no leakage can be detected. The gland follower should be checked to determine if it is centered on the shaft diameter during packing consolidation. It is not allowed to contact the shaft at any time.

Disc Seal Replacement

When the sealing system in the Woodward Triple Offset Valve is suspected of unacceptable leakage, the following simple visual checks can be made to determine if the disc seal must be replaced:

- Check for nicks or gouges in the metal laminations.
- Check for damaged, torn or broken fiber laminations.
- Check the seal gasket for damage.
- Check to determine if the seal stack is bent or dented.

➔ **IF ANY OF THE THESE CONDITIONS EXIST, IT IS RECOMMENDED THAT THE SEAL AND GASKET BE REPLACED.**

The following procedure is intended to represent a typical Woodward Triple Offset Valve seal replacement.

IMPORTANT

Before starting the seal stack removal operation, observe the clamp ring and seal stack orientation with respect to the disc. The long axis of the elliptical disc seal has one end that is angled slightly greater than the end located 180 degrees away. This orientation is intended to be located perpendicular to the shaft axis. The valve disc has the same elliptical machined edge as the seal stack, and is assembled in the valve to match the valve seat configuration. This is important to understand, as the seal could be installed upside-down and rotated in the wrong orientation.

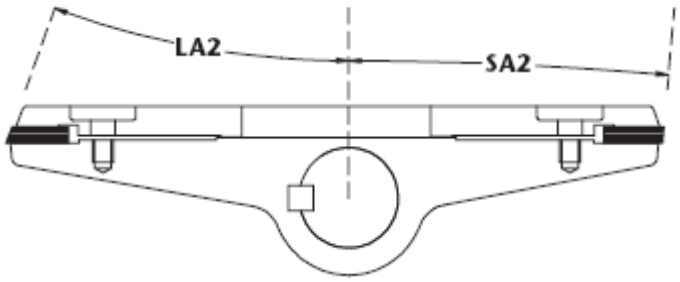


Figure 3-19. Disc Seal Orientation

The following definitions are applicable to all Woodward Triple Offset Butterfly Valves:

- A2: The centerline of the valve, perpendicular to the shaft axis.
- K2: The centerline of the valve, parallel to the shaft axis.

- SA2: The point on the A2 line that is closest to the K2. This position is the shallowest seal angle.
- LA2: The point on the A2 line that is farthest from the K2. This position is the greatest seal angle.
- TK2: The point on the K2 line that is closest to the driven side of the body.
- BK2: The point on the K2 line that is on the non-driven side of the body.

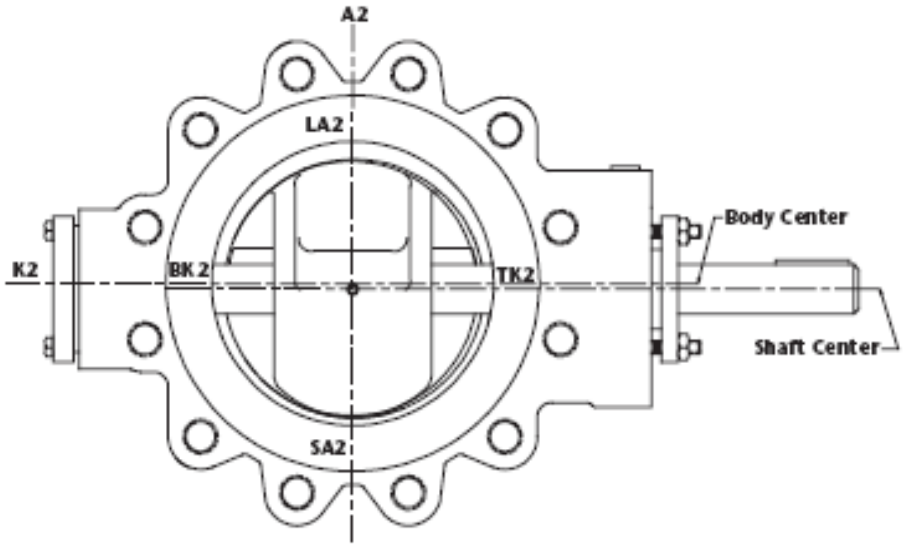


Figure 3-20. Valve Geometry

Both the TK2 and BK2 seal angles are the same.

Prior to seal replacement, the valve should be removed from the pipeline, cleaned, and inspected. The actuator will need to be removed, in most cases.

Disc Position for seal replacement is as follows:

- Position A is the disc assembly rotated as far from closed as the valve body allows.
- Position B is the normal full-open position of the valve.
- Position C is the valve in the full-closed position.
- Normal orientation of the disc is Position B for removal of the clamp ring and seal stack.

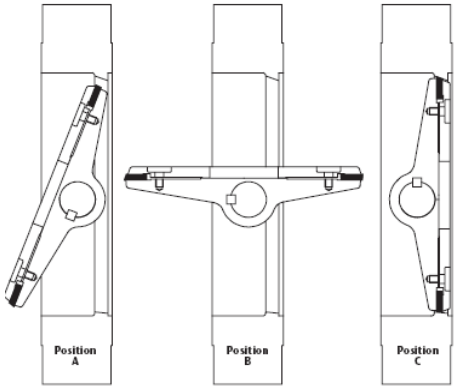


Figure 3-21. Disc Positions

- Various sizes of valves require the disc to be in Position A for seal removal, due to insufficient clearance between the seat and clamp ring.
- A quick visual check of the disc in Position B will indicate if the disc should be rotated to Position A.

IMPORTANT **Any actuator will have to be removed prior to moving the disc to Position A, as this travel path will exceed the limits of the actuator.**

1. With the disc in the closed position, remove all of the disc bolts with the exception of two bolts located on the disc A2 line (perpendicular to the shaft). These bolts should be located 180 degrees apart on this centerline.
2. To remove the clamp ring, the valve disc needs to be in Position A or Position B.
3. When the disc is in position, remove the remaining bolts from the clamp ring.
4. Lift the clamp ring off the seal stack. A flat tool wedged between the clamp ring and seal may be required.
5. Remove the clamp ring from the drive shaft side of the body.
6. DO NOT ATTEMPT TO REMOVE THE CLAMP RING THROUGH THE SEAT SIDE OF THE BODY. CAUTION MUST BE TAKEN TO ASSURE THAT THE VALVE BODY SEAT IS NOT DAMAGED.
7. Remove the seal stack by lifting it away from the steps on the disc and remove the seal stack in the same manner as the clamp ring.
8. The seal stack may be stuck to the gasket located between the seal stack and disc. A flat scraper may be used to assist in removal. In all cases, this gasket must be replaced. For future reference, note the thickness and location of any gasket found in the disc assembly.
9. Remove any gasket material remaining on the disc before a new seal stack is used.

NOTICE **Exercise extreme care in handling and installing the new seal stack, as damage to the seal stack will result in valve leakage.**

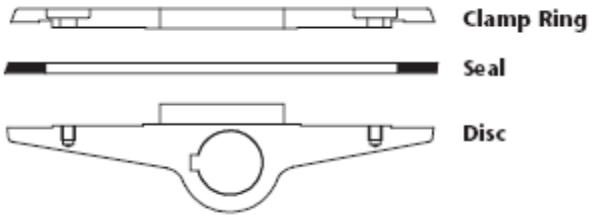


Figure 3-22. Seal Stack

10. It is recommended to position the valve assembly with the body flange faces vertical, with the drive shaft center below the valve center line. Rotate the disc to Position A or Position B. Install the supplied gasket on the disc face.
11. Center the gasket on the hub. Mark the overhang on the gasket and trim the gasket to fit flush with the disc O.D. Any gasket that remains exposed after the seal is installed could interfere with proper seal function.
12. Install the new seal stack in the correct orientation on the disc, centering the seal stack SA2 mark (notch or center punch marks) on the disc SA2.
13. Carefully close the disc manually. Maintain the disc in the closed position.

14. Check the clearance between the seal I.D. and the associated disc hub. There should be clearance completely around the seal stack I.D. This allows the seal to float into place with no mechanical interference from the disc.
15. If diametral clearance on the seal I.D. is 1/16 inch (or less) from the disc hub, remove the seal from the valve and grind an appropriate amount of material from the seal I.D., as stated in step 17. Repeat the process until the gap is greater than 1/16 inch, but no more than 3/32 inch, completely around the seal I.D. Normally this step is not required with new seal stacks.
16. Determine what the new diameter will be and mark a line around the seal I.D. Place the seal in a vise and protect the sealing edge of the disc from damage. With the use of a hand grinder, lightly remove the excess material from the seal I.D., taking care not to overheat the seal stack.

NOTICE

Exercise extreme care in removing material from the seal I.D. Do not allow the seal to overheat. Do not damage the sealing surface of the seal. Thoroughly de-burr all worked areas.

17. When the seal I.D. is correctly sized, re-install the gasket and seal.

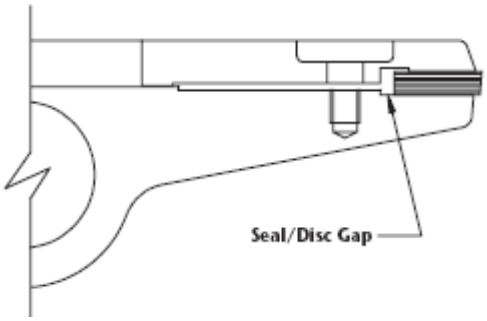


Figure 3-23. Seal/Disc Gap

18. Open and close the valve three or four times, making sure that the valve closes fully each time.
19. On the last closing, hold the disc assembly in the full closed position.
20. Perform a light check (with the light source on the shaft side of the disc) for any gaps between the sealing surfaces.
21. When light indications are present, open the disc and rotate (float) the seal stack slightly, and repeat. Some experimentation will be required to determine the best direction to move the seal stack for centering.
22. When there are no light indications, match-mark the exact location of the seal stack position relative to the disc, on the A2 centerline of the disc.
23. Install the clamp ring.
24. Inspect the clamp ring for full contact with the seal stack.
25. The clamp ring I.D. step must not be allowed to contact the disc hub before the clamp ring O.D. contacts the seal stack face, after compression. (Due to the material thickness variations of replacement seal stacks, the seal may not be thick enough to allow clamping to occur.)
26. When there is a gap between the seal and clamp ring, a gasket needs to be added between the seal stack and clamp ring. Do not add the gasket between the disc and seal stack.
27. Any additional gasket(s) used in construction must be the same material grade as the gasket between the seal stack and the disc, and be trimmed to fit.
28. Lubricate the bearing surfaces and install the bolting and the lock washers. Use a wrench to tighten all bolts in a standard criss-cross pattern.

29. Manually close the valve to Position C. Install the actuator.
30. Apply approximately 1/4 of the rated torque to the valve.
31. Visually confirm that the assembled valve is in the correct configuration, is not binding, that all gaskets are trimmed flush, and that the valve seal stack is light tight.
32. Partially open the valve and torque the disc bolts to the levels indicated in the torque tables using four successive increments of 25%, 75%, 100% and 100%.
33. Close the disc to Position C and apply full rated torque to the valve shaft.
34. Open the valve approximately 5 degrees. Re-torque the bolts to the value listed in the torque tables.
35. Operate the valve from full close to full open several times, applying full rated torque at each close cycle.
36. With the valve fully open, inspect the sealing surfaces for any signs of damage.
37. Close the valve until the sealing members contact only, and place a flat ground bar across the A2 centerline on the valve face closest to the clamp ring.
38. On the bolt circle at the points LA2 and SA2, measure from the bar to the clamp ring face.
39. Acceptance is as follows:
    a) LA2 and SA2 measurement are the same.
    b) SA2 from 1/16 inch less than LA2 to 1/16 inch greater than LA2
40. When the difference in measurements is not within the above range, perform the following:

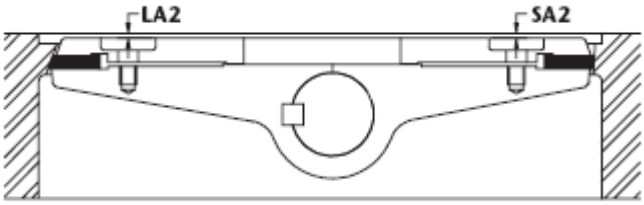


Figure 3-24. Seal Stack Markers

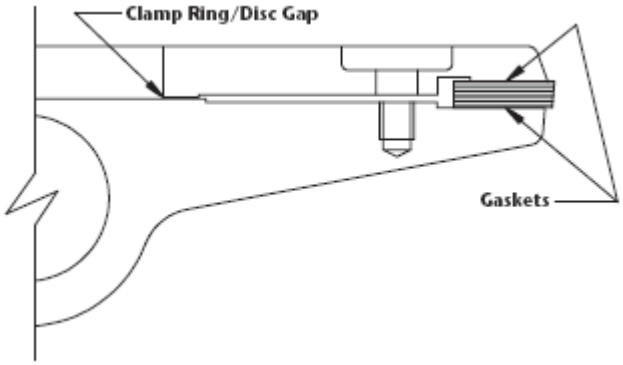


Figure 3-25. Seal Stack Gasket

41. SA2 exceeds 1/16 inch greater than LA2: Remove the seal stack disc gasket. Replace with the next largest nominal gasket thickness. Repeat all applicable steps. (Any clamp ring gasket previously installed may now have to be removed and discarded.)

42. SA2 exceeds 1/16 inch less than LA2: Remove the seal stack disc gasket. Replace with the next smallest nominal gasket thickness. Repeat all applicable steps. (Additional clamp ring gaskets may now be required.)
43. Perform a bluing check of the sealing surface by applying a thin coat of Prussian Bluing to the seat surface, closing the valve at full torque, and inspecting the resulting pattern.
44. No bluing indication left by the seal stack on the area of the seat that is located by the shaft bores means that the gasket used between the seal stack and the disc is not thick enough to allow the seal stack and seat machined cones to meet when the valve is closed. This is due to variations in the material thickness of the seal stack.
45. If this condition exists, replace the gasket with the next available thickness and repeat all of the previous steps.
46. Acceptance criteria for the bluing pattern is a 75% complete pattern. No interruption of a single laminate is allowed. Additionally, some damage to the valve seat would be acceptable, provided the damaged areas do not cross the seal pattern.
47. Bench testing / Calibration of the assembly is recommended after disc seal replacement.

Valve Disassembly

1. Place the valve on a bench or other suitable working surface with the drive shaft side of the valve up. Remove the dowel pin from the disc.
2. Restrain the disc assembly from opening by clamping or bolting, a suitably sized square bar across the flange face directly above the edge of the disc that is furthest away from the center of the drive shaft. This bar should be perpendicular to the drive shaft.
3. Choose a correct length for a jackscrew or hydraulic jack to place between the disc and bar. Place the jackscrew in position and apply enough force to mechanically maintain the disc in place. It is not necessary to apply excessive force to maintain position. Remove the actuator from the drive shaft.
4. On the non-driven end of the shaft, remove the bolts, cover plate, and the O-ring from the valve body.
5. On the driven end of the valve shaft, remove the hex nuts and the gland follower. Remove the packing rings. Place an appropriate sized block between each side of the disc ear and the valve I.D. to prevent lateral movement.
6. With a soft rod or hammer, move the shaft towards the non-driven end of the valve body until the annular key is free. The annular key is a split ring installed in a groove machined on the end of the shaft. Because it is split, the annular key can fall away from the drive shaft easily. Caution should be taken so that the annular key does not become lost.
7. Remove the disc ear drive keys as the shaft moves.
8. Most valves contain more than one drive key. Do not attempt to force the drive shaft out too fast as the clearance for drive key removal is small.
9. When all of the keys are removed, the shaft may now be withdrawn from either side of the valve body.
10. Remove any devices that were used to maintain the disc assembly in position during shaft removal.
11. Locate the SA2 edge of the disc. Carefully push down on the disc assembly at this point until the seal stack partially disengages from the seat. This will be moving the disc assembly in the open direction. Carefully lift the disc assembly and guide the disc assembly so that no damage can occur to the disc seal stack.

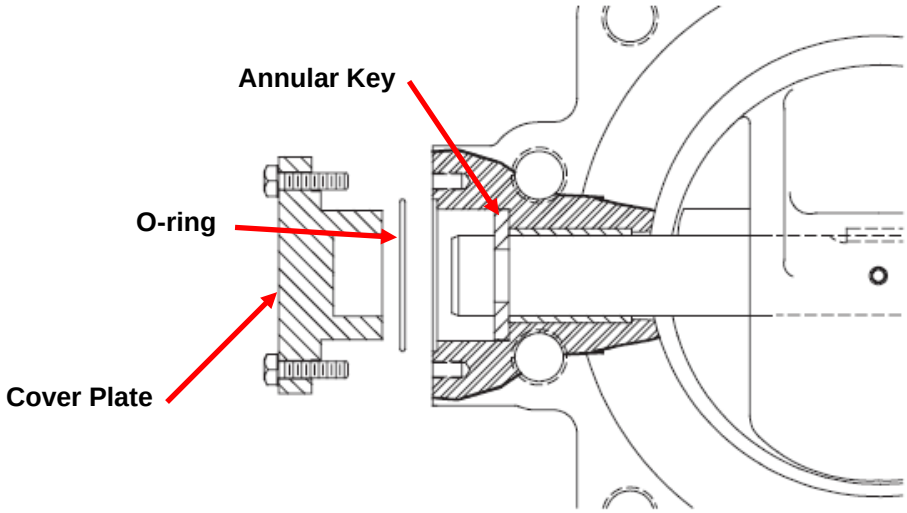


Figure 3-26. Annular Key

12. The disc assembly should be lifted at a greater angle than the closed position of the disc. A strap thru the ear bores to lift the disc assembly from the body may be utilized.

NOTICE

This will cause the disc assembly to move in a manner that tends to close the disc. Take great care to prevent this movement. It is suggested that a crew of two be used when a disc is removed from the valve.

13. Unless there is evidence that the bearing I.D. is damaged, it is suggested that the bearings remain in the valve. If the bearings are to be removed from the valve body, use a soft rod and hammer from the body center out.

Table 3-2. Valve Parts List

ITEM NO.	DESCRIPTION	QTY PER VALVE
1	Body	1
2	Disc	1
3	Clamp Ring	1
**4	Laminated Seal	1
5	Hex Head Cap Screw	as req'd
6	Lock Washer	as req'd
8	Cover Plate	1
**9	O-Ring	1
10	Hex Head Cap Screw	2
**12	Annular Key	1
**13	Bearing	2
16	Shaft	1
17	Spiral Pin	1
18	Disc Key	2
**19	Packing	5
20	Gland	1
21	Stud	2
22	Hex Nut	2
33	Actuator Key	1

**Recommended Spare Parts

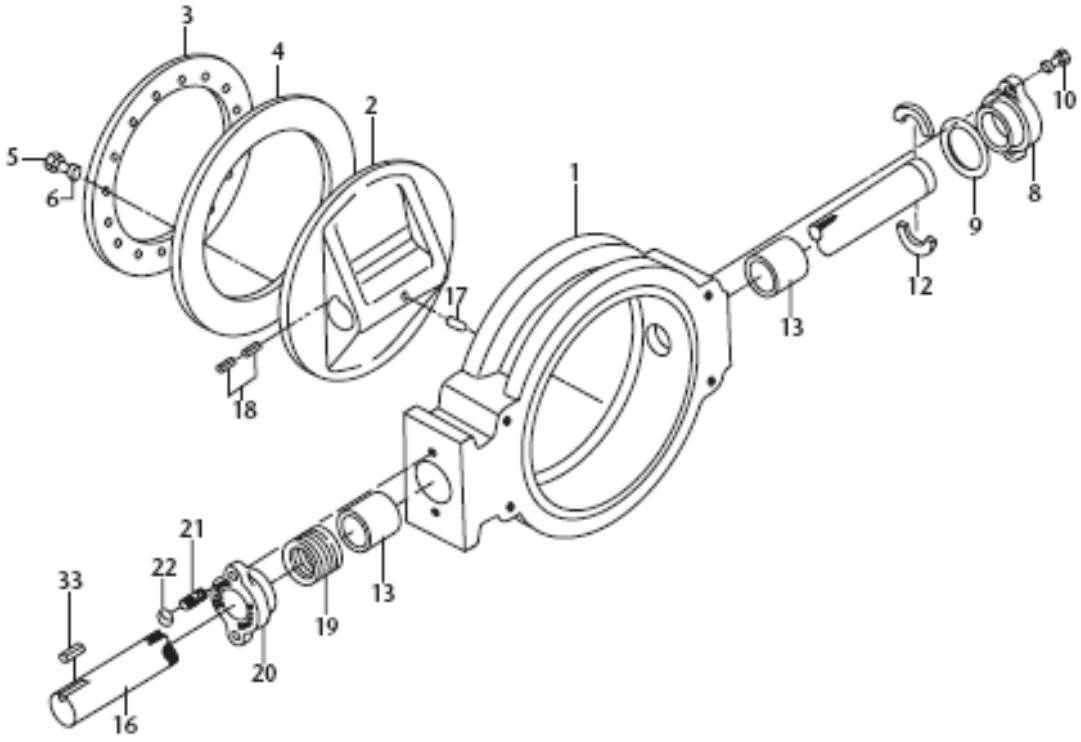


Figure 3-27. Exploded View

Valve Assembly

1. Clean all valve components.
2. Inspect all components for damage before starting to assemble. Look especially for damage to the seal stack and valve body seating surface, and wear in the bearing areas of the body (or the bearing I.D. if not removed from the valve) and drive shaft.
3. Place the valve body on a suitable working surface with the seat side down.
4. With a soft rod or hammer, install the bearings toward the inside of the body until they seat fully against the bore shoulder. Note: Some valves have bearings of unequal lengths. Depth of bearing bores in the valve body should match the bearing lengths.
5. Carefully place the disc assembly into the valve body. It is recommended to install the disc assembly in a partially open orientation until the seal stack contacts the seat somewhere in the area of the shaft bores.
6. Insert the annular key end of the drive shaft thru the driven body bearing and disc bores into the non-driven side of the valve.
7. Assure that the disc assembly is closed. Place appropriate sized blocks between the disc ear and the body I.D.
8. Place the annular key in the shaft groove. Reverse the direction of shaft travel. Install the disc ear keys as the shaft moves and seat both the annular key and shaft keys at the same time.
9. When the annular key is fully seated, check the alignment of the dowel pin hole in the disc with the corresponding hole in the shaft. Adjustments to the disc position may be required.
10. Adjustments to the disc position can be accomplished by loosening the disc bolts, floating the seal stack, and repositioning the disc at the same time.

11. On the non-driven side of the body, install the O-Ring, the cover plate, the bolts and lock washers. Lubricate the bearing areas of the bolts and lock washers prior to assembly.
12. Torque the bolts to the level indicated in the torque tables in a standard criss-cross pattern.
13. Install the new packing, one ring at a time, rotating the splices at 90 degree intervals to avoid setting up a leak path.
14. Use the gland follower to push the packing evenly into the bore.
15. Once the packing has been completely installed, run the gland follower studs into the tapped holes, if removed during disassembly, and tighten by lightly locking two of the correct size nuts together at the outside end of the stud. Use these nuts to tighten the stud until they slip on the studs. Install the follower.
16. Tighten the gland follower down with the nuts, in a cross bolt method, until snug.
17. It is important that the packing gland be symmetrically mounted around the shaft. This will prevent the shaft or gland from binding or galling when the valve is operated.
18. The final packing adjustment can only be accomplished when the valve is pressurized.

Chapter 4. Troubleshooting

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.
	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 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.
	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 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 5.
Product Support

To order parts or replaceable assemblies, Woodward requires the following information:

- Serial Number
- Part Number
- Description of Item
- Quantity of each part being ordered

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 26362B.

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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.

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