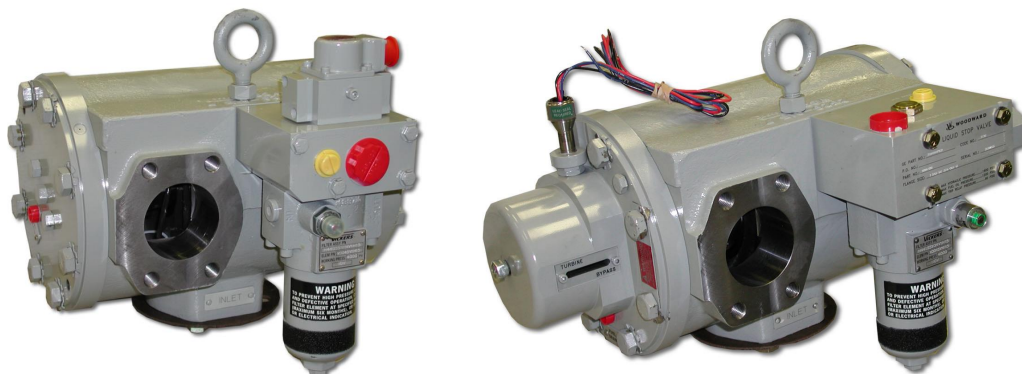




Product Manual 26088
(Revision J, 1/2025)
Original Instructions



Liquid Bypass and Stop Valves

Three-way Fuel Oil Bypass Control Valve
Three-way Fuel Oil Stop Valve

Installation and Operation Manual



General Precautions

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

Practice all plant and safety instructions and precautions.

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



Revisions

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

[Woodward Industrial Support: Get Help](#)

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



Proper Use

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



Translated Publications

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

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

[Woodward Industrial Support: Get Help](#)

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

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

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

Woodward reserves the right to update any portion of this publication at any time. Information provided by Woodward is believed to be correct and reliable. However, no responsibility is assumed by Woodward unless otherwise expressly undertaken.

Contents

WARNINGS AND NOTICES.....	2
ELECTROSTATIC DISCHARGE AWARENESS	3
REGULATORY COMPLIANCE	4
CHAPTER 1. GENERAL INFORMATION.....	5
Three-way Fuel Oil Bypass Control Valve	5
CHAPTER 2. STANDARD COMPONENT DETAILS	13
Triple Coil Electrohydraulic Servo Valve Assembly	13
Trip Relay Valve Assembly	13
Position Indicator Switch Assembly	13
Hydraulic Filter Assembly.....	13
CHAPTER 3. INSTALLATION AND MAINTENANCE	14
Installation	14
Long Term Storage	15
Maintenance.....	15
Replacement of Standard Components	16
CHAPTER 4. PRODUCT SUPPORT AND SERVICE OPTIONS	20
Product Support Options.....	20
Product Service Options	20
Returning Equipment for Repair	21
Replacement Parts.....	22
Engineering Services	22
Contacting Woodward's Support Organization	22
Technical Assistance	23
REVISION HISTORY	24

Illustrations and Tables

Figure 1-1. Three-way Fuel Oil Bypass Control Valve.....	5
Figure 1-2. Three-way Fuel Oil Stop Valve.....	7
Figure 1-3a. Hydraulic Schematic Circuit—Bypass Valve	9
Figure 1-3b. Hydraulic Schematic Circuit—Stop Valve	9
Figure 1-4a. Wiring Diagram—Bypass Valve Servo.....	10
Figure 1-4b. Wiring Diagram—Stop Valve Proximity Switch	10
Figure 1-5a. Outline Drawing—Bypass Valve.....	11
Figure 1-5b. Outline Drawing—Stop Valve	12
Figure 3-1. Aluminum Filter Bowl.....	17
Figure 3-2. Steel Filter Bowl.....	17
Table 1-1. Fuel Oil Bypass Valve Technical Specifications	6
Table 1-2. Fuel Oil Stop Valve Technical Specifications	8

Warnings and Notices

Important Definitions



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

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

WARNING

**Overspeed /
Overtemperature /
Overpressure**

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

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

WARNING

**Personal Protective
Equipment**

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

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

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

WARNING

Start-up

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

IMPORTANT

External wiring connections for reverse-acting controls are identical to those for direct-acting controls.

Regulatory Compliance

Three-Way Fuel Bypass Control Valve

Other European Compliance

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

IECEEx: Where IECEEx compliance is claimed, suitability is the result of IECEEx compliance of the individual components as follows:
 Junction box per IECEEx PTB 08.0006X for Ex db eb ia [ia] mb IIC T4, T5, T6, Gb
 Servo valve per IECEEx KEM 10.0041X for Ex nA IIC T3
 LVDT per IECEEx SIR 11.0084X for Ex ec IIC T4 Gc
 Refer to individual component certificates for special conditions of safe use.

North American Compliance

Suitability for use in North American Hazardous Locations is the result of compliance of the individual components. These listings are limited only to those units with components bearing the FM, CSA, and UL agency identifications.

Servo Valve: FM Certified for Class I, Div. 2, Groups A, B, C, D. For use in the United States per FM 4B9A6.AX
 CSA Certified for Class I, Div. 2, Groups A, B, C, D. For use in Canada per CSA 1072373. Versions with electrical connectors are certified as components only for use in other equipment subject to acceptance by CSA or Inspection Authority having jurisdiction.

Three-Way Fuel Oil Stop Valve

North American Compliance

Suitability for use in North American Hazardous Locations is the result of compliance of the individual components. These listings are limited only to those units with components bearing the FM, CSA, and UL agency identifications.

Proximity Switch: UL Certified for Class I, Div. 2, Groups A, B, C, D. For use in the United States and Canada per UL certificate 20180202-E79070

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

Field Wiring must be suitable for at least 82°C.



WARNING

EXPLOSION HAZARD—Do not connect or disconnect while circuit is live unless area is known to be non-hazardous.

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



AVERTISSEMENT

RISQUE D'EXPLOSION—Ne pas raccorder ni débrancher tant que l'installation est sous tension, sauf en cas l'ambiance est décidément non dangereuse.

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

Chapter 1. General Information

Three-way Fuel Oil Bypass Control Valve

The Three-way Fuel Oil Bypass Control Valve is used to control the flow of liquid fuel to a gas turbine. The valve contains no feedback device, so it relies on external flow measurement as a form of feedback to control the flow of fuel to the turbine. Upon loss of electrical command signal or hydraulic pressure, the valve will divert fuel to the bypass port for a safe turbine shutdown. The valve utilizes a fully integrated valve and actuator design. The design is equivalent to a dual acting electrohydraulic actuator and a three-way bypassing valve.

The fluid inlet is to the center portion of a double piston arrangement. Fuel control is accomplished by modulating the actuation/metering piston in the valve metering bushing. The metering cylinder is controlled by the hydraulic control pressures acting on each end of the double piston. The resulting integrating actuator is controlled closed loop via the digital control system by measuring downstream fuel flow out of the valve. A triple coil torque motor servo valve is energized by the gas turbine electronic control to modulate the hydraulic control pressures across the actuation pistons. Control pressure 1 (PC1) acts on one side of the piston, while control pressure 2 (PC2) acts on the other side of the piston. When the piston moves to the right, the valve opens and sends the fuel to the turbine port. When the piston moves to the left, the valve closes and sends the fuel to the bypass port. The metering ports in the valve/actuator bushing are precision cut using a wire EDM. This ensures that the desired Cv profile is maintained without the deadband and non-linearities associated with drilled cages.

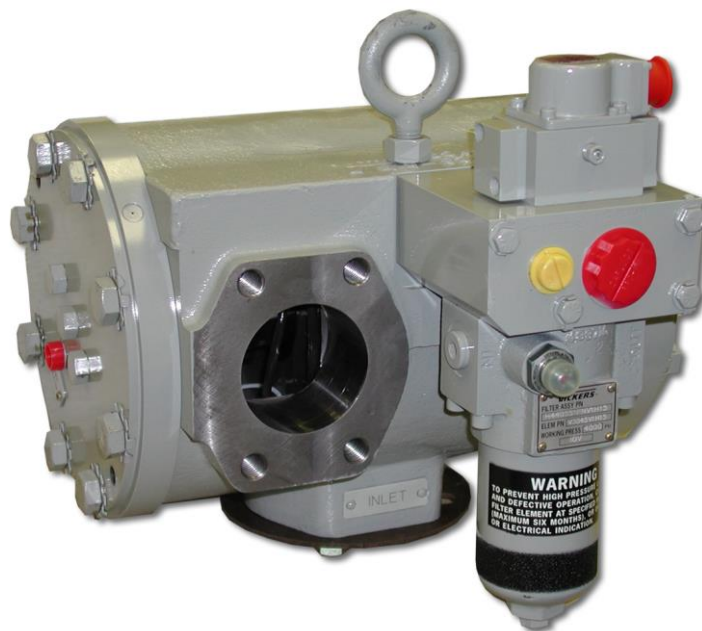


Figure 1-1. Three-way Fuel Oil Bypass Control Valve

The fuel oil inlet is through the bottom of the valve, and the bypass and turbine ports are out the side of the valve. All inlet and outlet ports are 3000# SAE flanges per SAE J518 Code 61. All seals between the fuel oil and hydraulic oil are of a dual seal design with a vent port between the two seals. This arrangement prevents any fuel oil from leaking into the hydraulic oil as well as prevents any hydraulic oil from leaking into the fuel oil. All external seals are static elastomeric seals so there is no danger of fluid leakage to the ambient environment.

The internal metering cage and sliding metering piston are made from hardened stainless steel materials and electroless nickel plated and hardened materials respectively for wear and corrosion resistance.

Table 1-1. Fuel Oil Bypass Valve Technical Specifications

Functional Requirement	Three-way Bypass Control Valve (3") (9904-510 & similar)
Valve Type	Three Way—Modulating Metering Plug
Trim Configuration	Linear—Diverging
Type of Operation	Trip—Plug Left—Inlet to Bypass Run—Plug Right—Inlet to Turbine
Number of Control Valves	1 per Engine
Fluid Ports	76.2 mm (3 inch) Ports per SAE J5-18 Code 61 (13 790 kPa / 2000 psi working pressure rating)
Flowing Media	Light Distillate Fuel SG= 0.82 to 0.85 Viscosity = (1.8 to 10) cST / (32 to 58 SSU)
Maximum Fluid Supply Pressure	8274 kPa / 1200 psig
Proof Test Fluid Pressure Level	12 411 kPa / 1800 psig minimum for 2 minutes per ANSI B16.34
Minimum Burst Fluid Pressure	41 370 kPa / 6000 psig minimum for 1 minute
Fuel Filtration Standard	25 μ m at Beta 200
Fuel Temperature	(−18 to +93) °C / (0 to +200) °F
Ambient Temperature	(+10 to +66) °C / (+50 to +150) °F
Storage Temperature	(−40 to +66) °C / (−40 to +150) °F
Dry Weight	approx. 113 kg (250 lb)
Maximum Fluid Flow Rate	1136 L/min (300 US gal/min) (inlet to either outlet port)
Flow Characteristic	Cv \pm 3 % of Point (see installation drawing) (5 % to 100 % of stroke for turbine port) (0 % to 80 % of stroke for bypass port)
Failure Mode	To Bypass
Shut-off Classification	Less than 7.6 L/min (2 US gal/min) to turbine port at 1448 kPa (210 psig). Less than 19 L/min (5 US gal/min) to bypass port at 6736 kPa (977 psig).
Hydraulic Filtration	10 to 15 μ m at Beta 75 (or 10 μ m at Beta 200)
Hydraulic Pressure	(8274 to 11 032) kPa / (1200 to 1600) psig
Proof	(16 548 kPa (2400 psig)
Burst	(55 160 kPa (8000 psig) (except servo)
Hydraulic Fluid Temperature	(+10 to +82) °C / (+50 to +180) °F
Servo Input Current Rating	(−7.2 to +8.8) mA; null bias (0.8 \pm 0.32) mA
Slew Time	1.1 to 1.5 seconds in either direction (at 11 032 kPa / 1600 psig hydraulic pressure)
Design Availability Objective	Better than 99.5 %
Noise Emission	78 dB(A) to 91.3 dB(A) from 80 % to 5 % open

Three-way Fuel Oil Stop Valve

The Three-way Fuel Oil Stop Valve is a two position valve used to shut off the flow of liquid fuel to the turbine and divert it to the fuel pump suction. The valve position is controlled by a low level trip pressure acting on the pilot operated trip circuit integrated into the valve. The valve uses a failsafe spring to ensure the shutoff of fuel from the turbine on loss of hydraulic control pressure or hydraulic actuation pressure. The valve utilizes a fully integrated valve and actuator design. This design is equivalent to a single acting hydraulic actuator and a three-way shut-off valve.

The fluid inlet is to the center portion of a double piston arrangement. Fuel shut-off control is accomplished by shuttling the actuation/metering piston in the metering bushing. The piston is actuated via the hydraulic pressure acting on one side of the piston and the failsafe spring acting on the other. When the piston moves to the left, the valve opens and sends the fuel to the turbine port. When the piston moves to the right, the valve closes and sends the fuel to the bypass port. The metering ports in the valve/actuator bushing are precision machined to ensure the desired Cv profile.

The return spring forces the piston to move to the bypass position upon loss of hydraulic trip pressure or hydraulic supply pressure. The actuator control interface is accomplished through the hydraulic trip circuit. When the trip oil pressure drops below (152 ± 41) kPa / (22 ± 6) psid relative to hydraulic return pressure, the three-way pilot operated valve shuttles to dump the oil from the actuation side of the piston to drain. This removes the force opposing the spring and allows the spring to force the valve to full bypass position. The check valve and orifice assembly allows the valve to have a controlled rate of opening and a faster controlled rate of closing.

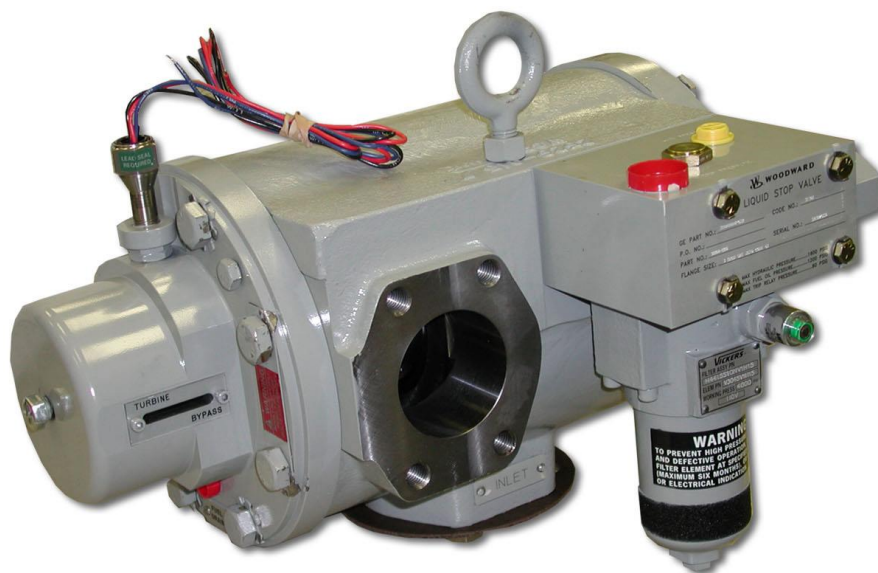


Figure 1-2. Three-way Fuel Oil Stop Valve

The fuel oil inlet is through the bottom of the valve, and the bypass and control are out the side of the valve. All inlet and outlet ports are 3000# SAE flanges per SAE J518 Code 61. All seals between the fuel oil and hydraulic oil are of a dual seal design with a vent port between the two seals. This arrangement prevents any fuel oil from leaking into the hydraulic oil as well as prevents any hydraulic oil from leaking into the fuel oil. All external seals are static elastomeric seals so there is no danger of fluid leakage to the ambient environment.

The internal metering cage and sliding metering piston are made from hardened stainless steel materials and electroless nickel plated and hardened materials respectively for wear and corrosion resistance.

Table 1-2. Fuel Oil Stop Valve Technical Specifications

Functional Requirement	Fuel Oil Stop Valve (3") (9904-518)
Valve Type	Three Way—Two Position Metering Plug
Trim Configuration	On/Off
Type of Operation	Trip—Plug Right—Inlet to Bypass Run—Plug Left—Inlet to Turbine
Number of Control Valves	1 per Engine
Fluid Ports	76.2 mm (3 inch) Ports per SAE J518 Code 61 (13 790 kPa / 2000 psi working pressure rating)
Flowing Media	Light Distillate Fuel SG= 0.82 to 0.85 Viscosity = (1.8 to 10) cST / (32 to 58) SSU
Maximum Fluid Supply Pressure	8274 kPa (1200 psig)
Proof Test Fluid Pressure Level	12 411 kPa (1800 psig) minimum for 2 minutes per ANSI B16.34
Minimum Burst Fluid Pressure	41 370 kPa (6000 psig) minimum for 1 minute
Fuel Filtration Standard	25 μ m at Beta 200
Fuel Temperature	(–18 to +93) °C / (0 to +200) °F
Ambient Temperature	(+10 to +66) °C / (+50 to +150) °F
Storage Temperature	(–40 to +66) °C / (–40 to +150) °F
Dry Weight	approx. 136 kg (300 lb)
Maximum Fluid Flow Rate	1514 L/min (400 US gal/min) (48 kPa / 7 psid) (inlet to either outlet port)
Flow Characteristic	Cv of 140 minimum (inlet to either outlet port)
Failure Mode	To Bypass
Shut-off Classification	Class IV per ANSI B16.104 between turbine and inlet port in both flow directions. Less than 38 L/min (10 US gal/min) from inlet to bypass at 6392 kPa (927 psig).
Hydraulic Filtration	10 to 15 μ m at Beta 75
Hydraulic Pressure	(8274 to 11 032) kPa / (1200 to 1600) psig
Proof	16 548 kPa (2400 psig)
Burst	55 160 kPa (8000 psig) (except servo)
Hydraulic Fluid Temperature	+50 to +180 °F (+10 to +82 °C)
Slew Time	1.5 to 2.0 seconds—Opening (at 11 032 kPa / 1600 psig hydraulic pressure) 0.25 to 0.4 seconds—Closing
Trip Pressure (relative to hydraulic return pressure)	(165 \pm 41) kPa / (24 \pm 6) psid—Pickup (152 \pm 41) kPa / (22 \pm 6) psid—Dropout
Hydraulic Pressure to Actuate	690 kPa (100 psig)
Switch Rating	2 A @ 240 V (ac), 0.5 A @ 125 V (dc) resistive
Design Availability Objective	Better than 99.5 %

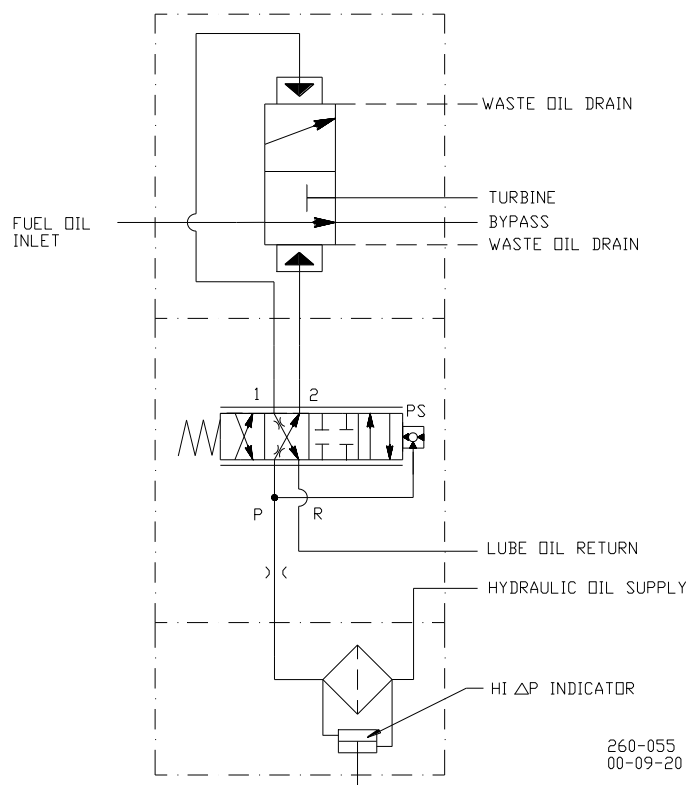


Figure 1-3a. Hydraulic Schematic Circuit—Bypass Valve

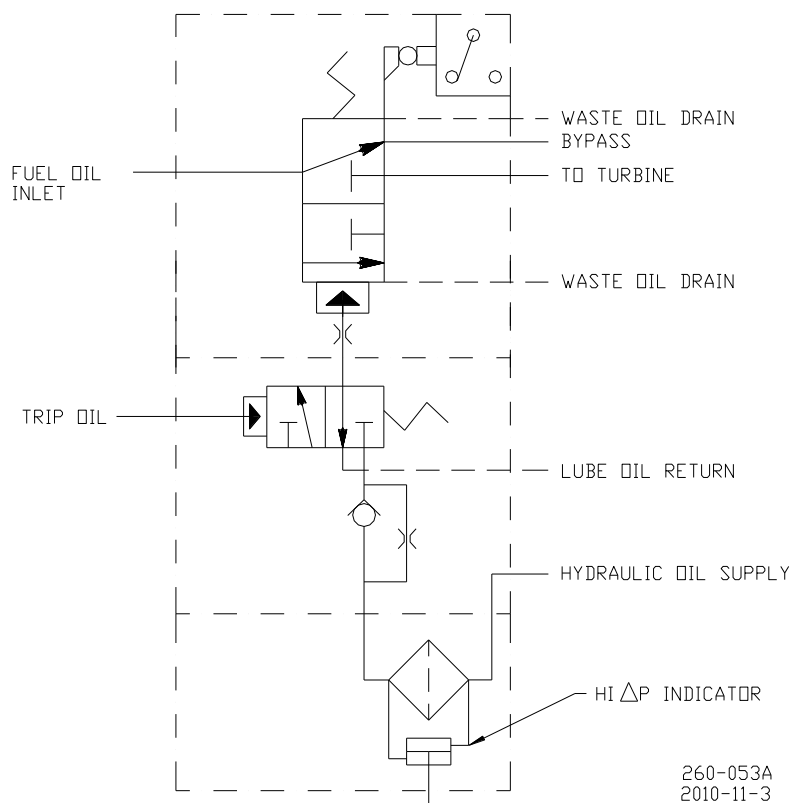


Figure 1-3b. Hydraulic Schematic Circuit—Stop Valve

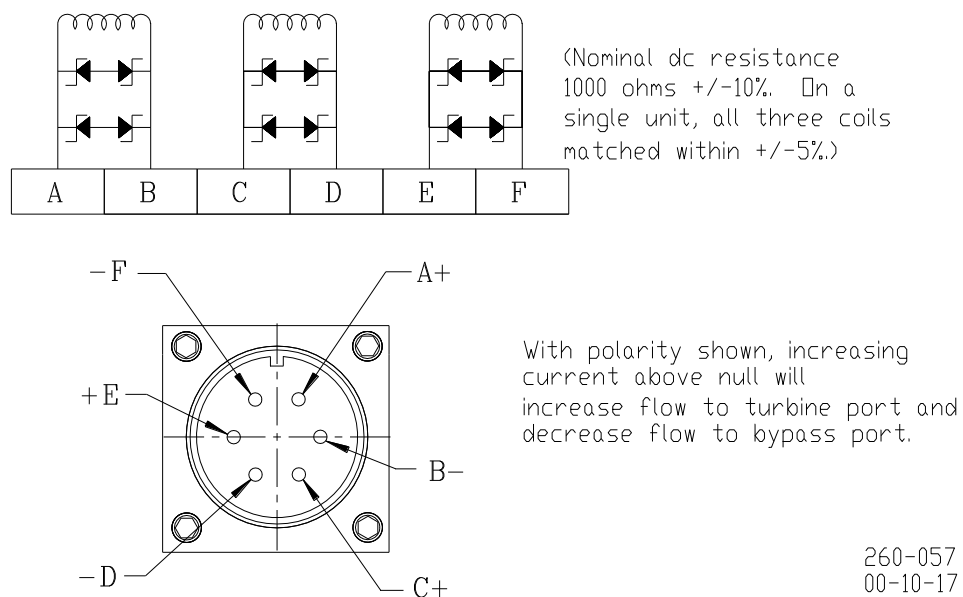


Figure 1-4a. Wiring Diagram—Bypass Valve Servo

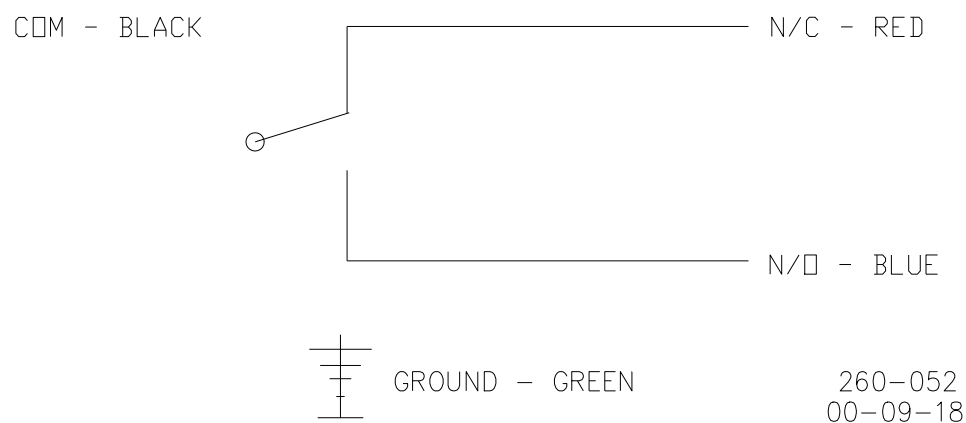


Figure 1-4b. Wiring Diagram—Stop Valve Proximity Switch

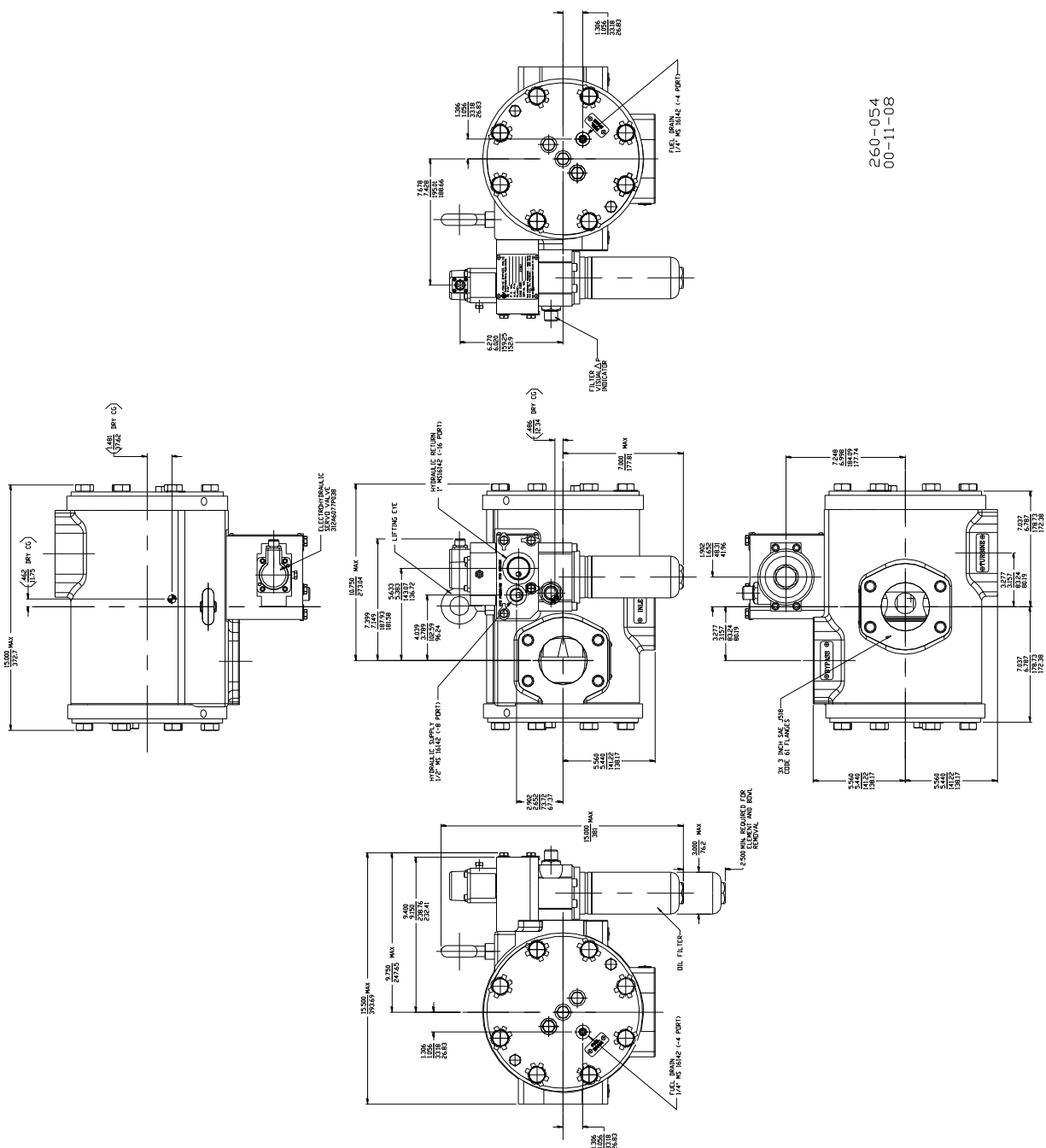


Figure 1-5a. Outline Drawing—Bypass Valve

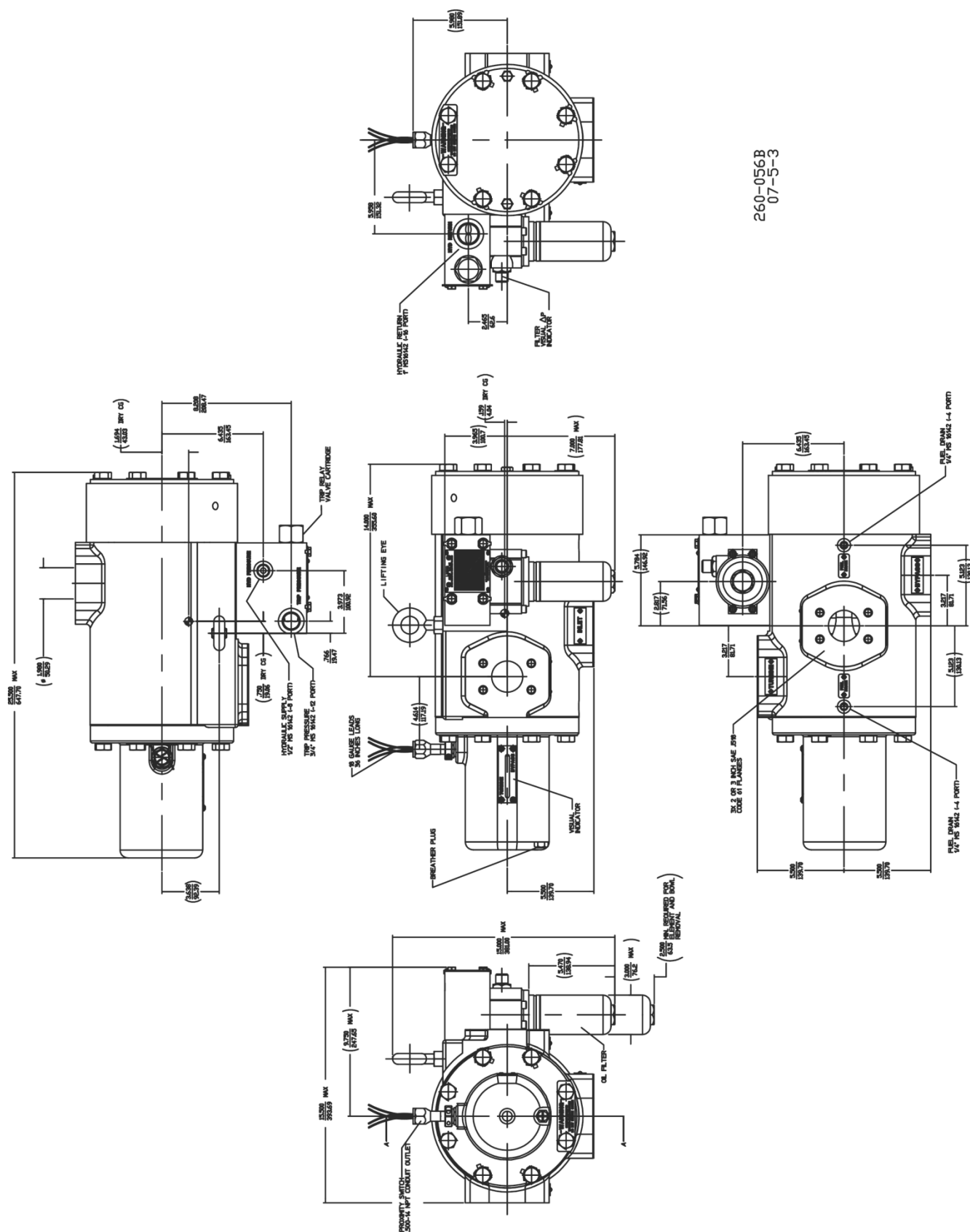


Figure 1-5b. Outline Drawing—Stop Valve

Chapter 2.

Standard Component Details

Triple Coil Electrohydraulic Servo Valve Assembly

The Three-way Bypass Control Valve utilizes a two stage hydraulic servo valve to modulate the position of the metering piston. The first stage torque motor utilizes a triple-wound coil which controls the position of the first and second stage valve in proportion to the total electrical current applied to the three coils.

If the control system requires a rapid movement of the piston to send more fuel to the turbine, the total current would be increased well above the null current. In such a condition, control port PC1 is connected to supply pressure, and control port PC2 is connected to the hydraulic drain circuit. The flow rate delivered to the left 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 above the null point.

If the control system requires a rapid movement of the piston to bypass more fuel, the total current is reduced well below the null current. In such a condition, port PC1 is connected to the hydraulic drain circuit, and port PC2 is connected to the hydraulic supply. The flow rate delivered to the right piston cavity of the actuator 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. The flow rate and closing velocity of the actuator is in this case proportional to the total current below the null point.

Near the null current, the four landed valve nearly isolates both control ports PC1 and PC2 from the hydraulic supply and drain, and the left and right piston pressures are balanced to maintain a constant position. The control system, which regulates the amount of current delivered to the coils, modulates the current supplied to the coil to obtain proper closed loop operation of the system.

Trip Relay Valve Assembly

The Fuel Oil Stop Valve utilizes a three-way, two-position, hydraulically operated valve to switch the position of the stop valve. When the trip circuit pressure increases above (165 ± 41) kPa / (24 ± 6) psid relative to hydraulic return pressure, the three way trip relay valve shifts position such that the common port is connected to supply pressure through a rate-limiting orifice, and isolated from the hydraulic drain circuit. Actuation pressure is routed from the control pressure circuit of the trip relay valve to the piston cavity of the actuator. This moves the piston from the fuel bypass position to the running position.

As the trip circuit supply pressure reduces below (152 ± 41) kPa / (22 ± 6) psid, the three-way trip relay valve shifts position such that the common port is connected to the hydraulic drain circuit through a rate limiting orifice, and is isolated from the hydraulic supply. As the pressure falls within the piston cavity, the return spring returns the valve plug to the bypass position within 0.4 to 0.5 second, switching the fuel circuit from the running position to the bypass position.

Position Indicator Switch Assembly

The Fuel Oil Stop Valve requires a position indication at the full bypass position. The limit switch is magnetically actuated when the ferrous target on the piston comes within the switch's sensing range.

Hydraulic Filter Assembly

The valves are 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 indicating that replacement of the element is necessary.

Chapter 3. Installation and Maintenance

Installation

See the outline drawings (Figure 1-5) for overall dimensions, installation hole locations, hydraulic fitting sizes, and electrical connections.

Installation attitude does not affect valve performance. A vertical position of the hydraulic filter is recommended for ease of making electrical, fuel, and hydraulic connections, and changing the hydraulic filter element. Additionally, a vertical position will prevent retention of fuel in the overboard drains.

These valves are designed for support by the piping flanges alone; additional supports are neither needed nor recommended.



WARNING

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



CAUTION

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



CAUTION

To prevent possible personal injury, always lift or move the valve using the lifting eye and a proper lifting device.



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

To prevent possible equipment failure, the valve must not be subjected to impact or shock loads.

NOTICE

There are two fuel drain ports on each of the Bypass and Stop valves (one port on each end) that must be vented to a safe location. During normal operation, these vents should have less than 2 cm³/min leakage.

Hydraulic Fluid

Make provisions for proper filtration of the hydraulic fluid that supplies the valves. A 10 µm (nominal) metal filter is recommended and must be installed in the supply line to the valves. The filter included with the valves is not meant to provide adequate filtration over the life of the valves. The absolute rating of the filter should not exceed 30 µm.

Make all hydraulic connections as shown in the outline drawing (Hydraulic Supply and Hydraulic Drain). The hydraulic supply pressure should be (8274 to 11 032) kPa / (1200 to 1600) psig. The drain pressure should not exceed 172 kPa (25 psig).

Electrical Connection

Make all electrical connections that are required based on the wiring diagrams (Figure 1-4).



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

Long Term Storage

In order to protect the valve from damage caused by rust or corrosion, certain storage procedures must be followed when the valves must be stored for long periods.

Use rust- and oxidation-inhibiting oil such as Texaco Regal R & O oil, or other oil that meets US MIL-H-17672 (hydraulic fluid, petroleum inhibited) specifications, to coat all internal surfaces of the device. If the valve is operated with oil other than rust- and oxidation-inhibiting oil, flush the unit with rust- and oxidation-inhibiting oil during operation before storage.

Plug all external openings to prevent contamination by solvents, cleaning agents, moisture, or other elements.

Wrap the valve in a cushioning material to prevent projections, sharp corners, and sharp edges from damaging the barrier bag.

Enclose the valve in a barrier bag just large enough to fully enclose it. Enclose the valve in a second heat-sealed barrier bag of the same material as the inner bag with the calculated amount of desiccant.

Calculate the amount of desiccant required by using the following formula:

$$U = AC + DX$$

where:

U = The number of units of desiccant required

A = Area (square inches) of barrier material to be used

C = 0.011

D = The number of pounds of packing material, other than metal, used within the barrier

X = 8 for cellulosic material, including wood, use as packing material. See US MIL-P-116 for other materials.

Use desiccants which meet the requirements of US MIL-D-3464 Type I or Type II. One producer of such desiccants is the Eagle Chemical Company, Inc.

Position the desiccant in bags of standard unit size and in appropriate locations in order to expose all voids in the valve to the dehydrating action of the desiccant.

Use a heat-sealable barrier bag that meets the requirements of Type I material per US MIL-B-22191 (latest revision).

Visually inspect the barrier material to see if the heat seal is complete and that no tears or damages are present. Pad the storage or shipping crate sufficiently to prevent tearing the barrier material.

Maintenance

The Bypass and Stop valves require no maintenance or adjustment for operation. However, if excessive leakage is detected from either of the fuel drain ports, consider valve replacement or overhaul by an authorized Woodward repair facility.

Woodward recommends routine checks of the DP gauge on the filter assembly to verify that the filter is not partially clogged. If the DP indicator shows red, the filter element needs to be replaced.

If any of the standard components (see Section 2) of the valve become inoperative, field replacement is possible. See the detailed replacement instructions that follow.

Replacement of Standard Components



To prevent possible personal injury, do NOT remove the spring cover (which is spring-loaded to 4448 N / 1000 lb force).



To prevent possible serious injury, be sure all electric power, hydraulic pressure, and fuel pressure has been removed from the valve before maintenance or repairs are to begin.

See the outline drawing (Figure 1-5) for the location of items.

Hydraulic Filter Assembly/Cartridge

The hydraulic filter on both valves is located on the bottom of the hydraulic manifold (Figure 1-5).

Replacement of Filter Assembly:

1. Remove the four .312-18 socket head cap screws.
2. Remove the filter assembly from the manifold block. The filter will contain 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.
5. Verify that two new O-rings are present in the new filter assembly.
6. Install the filter onto the manifold assembly. Be sure to place the filter in the correct orientation (Figure 1-5).
7. Install four .312-18 cap screws through the filter and torque them into the manifold to 18-22 lb-ft. (24.4 - 29.8 N·m)

Replacement of Filter Cartridge:

1. Loosen and remove the bowl from the filter assembly by turning counter clockwise (CCW).
2. The filter bowl will contain a large amount of hydraulic fluid—be cautious when handling.
3. Remove the filter element by pulling straight down from the rest of the assembly.
4. Obtain a new filter element.
5. Lubricate the O-ring on the ID of the cartridge with hydraulic fluid.
6. Install the cartridge into the assembly by sliding the open end of the cartridge onto the nipple.
7. Re-install the filter bowl onto the assembly by turning clockwise (CW). For steel filter bowls (Western or Donaldson) see Figure 3-2, tighten the bowl by hand only. For aluminum filter bowls with face seal O-ring see Figure 3-1, tighten the bowl to 30-35 lb-ft.



Figure 3-1. Aluminum Filter Bowl



Figure 3-2. Steel Filter Bowl

Trip Relay Valve Cartridge

The trip relay valve cartridge of the stop valve is located in the hydraulic manifold block (Figure 1-5).

1. Using a 1-1/2 inch wrench (approx. 38+ mm), loosen the trip relay valve from the hydraulic manifold.
2. Slowly remove the cartridge from the manifold. There could be a substantial amount of hydraulic fluid upon removal—be cautious when handling.
3. Obtain a new trip relay valve cartridge and verify the part number and revision with the existing unit.
4. Verify that all O-rings and backup rings are present on new cartridge (kit available, including all cartridge O-rings and backup rings, if required).
5. Lubricate the O-rings with hydraulic fluid or petroleum jelly.
6. Install the cartridge into the manifold housing.
7. Torque to (108 to 122) N·m / (80 to 90) lb-ft.

Servo Valve

The servo valve of the liquid bypass valve is located on the hydraulic manifold directly above the filter assembly (Figure 1-5).

1. Disconnect the servo valve connector.
2. Remove the four #10-32 UNF socket head cap screws holding the servo valve to the manifold.
3. Verify that all four O-rings are removed from the interface between the manifold and the servo valve.
4. Obtain a replacement servo valve and verify the part number and revision with the existing unit.
5. Remove the protective plate from the replacement servo valve and verify that there are O-rings on all four counter bores of the servo valve.
6. Place the replacement servo valve onto the hydraulic manifold. Be sure to orient the servo valve to match the original orientation. Be sure that all four O-rings remain in their proper location during assembly.
7. Install four #10-32 UNF socket head cap screws and torque to (3.6 to 4.0) N·m / (32 to 35) lb-in.
8. Connect the servo valve connector.

Position Indicator Switch

The position indicator switch of the stop valve is located on the spring end of the valve (Figure 1-5).

1. Disconnect the switch wires from the closest field connection point.
2. Holding the switch hex with a 1 inch wrench (approx. 25+ mm) loosen the conduit from the switch.
3. Carefully remove the conduit from the switch and pull the wiring out of the conduit.
4. Loosen the #10-32 UNF socket head cap screw clamping the locking collar and save for reuse with the new switch.
5. Using a 1 inch wrench (approx. 25+ mm), remove the switch.
6. Remove the locking collar from the switch and save for reuse on the replacement switch.
7. Obtain replacement switch and verify part number and revision with existing unit.
8. Remove two 0.625-18 jam nuts from the switch, and discard.
9. Reinstall the locking collar onto the new switch to the top of the threads by hand tightening only. The locking collar must be as high as possible on the switch to ensure that the switch can be installed to the correct depth.
10. Look into the switch port (using a flashlight or other illuminating source) and ensure that the piston step covers at least half of the port diameter. If the port diameter is not at least half covered, the stop valve is not fully closed and should be returned for factory service and repair.
11. Apply Loctite 242 to the switch threads where the threads will enter the switch port.
12. Install the replacement switch all the way into the switch port by hand tightening only until it contacts the piston step.
13. Back the switch out 3/4 turn to correctly set the sensing distance.
14. Hold the switch with a 1 inch wrench to ensure that it does not rotate during the following steps.
15. Screw the locking collar down until it contacts the housing.
16. Insert the Allen wrench into the locking collar #10-32 UNF socket head cap screw and by using the Allen wrench as a lever tighten the locking collar against the housing.
17. Torque the locking collar #10-32 UNF socket head cap screw to (3.6 to 4.0) N·m / (32 to 35) lb-in.
18. Using a 1 inch wrench (approx. 25+ mm), torque the switch to (34 to 41) N·m / (25 to 30) lb-ft. Ensure that the switch does not move more than one quarter turn while torquing. The switch's final position must be between one half and three quarters of a turn away from the piston step to ensure proper switch functioning and proper valve operation.



WARNING

If the switch is less than one half turn away from the piston step, the valve could fail to close when commanded, possibly resulting in personal injury or damage to equipment.

19. Install wiring through the conduit to the field connection point.

20. Hold the switch with a 1 inch wrench (approx. 25+ mm) to ensure that it does not rotate. Connect the conduit to the switch and torque to 203 N·m (150 lb-ft) max. Ensure that the switch does not move while being torqued. The switch's final position must be between one half and one turn away from the piston step to ensure proper switch functioning and proper valve operation.



If the switch is less than one half turn away from the piston step, the valve could fail to close when commanded, possibly resulting in personal injury or damage to equipment.

21. Reconnect the switch wires to the closest field connection point.

Chapter 4.

Product Support and Service Options

Product Support Options

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

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

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

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

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

A current list of Woodward Business Partners is available at:

<https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner>

Product Service Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

When shipping the item(s), attach a tag with the following information:

- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

When ordering replacement parts for controls, include the following information:

- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

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

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will 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 one of the Full-Service Distributors listed at <https://www.woodward.com/en/support/industrial/service-and-spare-parts/find-a-local-partner>

Contacting Woodward's Support Organization

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

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

Products Used in Electrical Power Systems

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

Products Used in Engine Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 8818 5515
Germany -----	+49 (711) 78954-510
India -----	+91 (124) 4399500
Japan -----	+81 (43) 213-2191
Korea -----	+82 (51) 636-7080
The Netherlands -----	+31 (23) 5661111
United States -----	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

<u>Facility</u>	<u>Phone Number</u>
Brazil -----	+55 (19) 3708 4800
China -----	+86 (512) 8818 5515
India -----	+91 (124) 4399500
Japan -----	+81 (43) 213-2191
Korea -----	+ 82 (51) 636-7080
The Netherlands -----	+31 (23) 5661111
Poland -----	+48 (12) 295 13 00
United States -----	+1 (970) 482-5811

Technical Assistance

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

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number _____

Prime Mover Information

Manufacturer _____

Turbine Model Number _____

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

Power Output Rating _____

Application (power generation, marine,
etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

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

Revision History

Changes in Revision J—

- Revised Regulatory Compliance

Changes in Revision H—

- Replaced the compliance section minus the warning boxes
- Changed torque values in Replacement of Filter Assembly section in Chapter 3
- Changed content in Steps 1 and 7 of the Replacement of Filter Cartridge section in Chapter 3
- Installed Aluminum and Steel Filter Bowl images in Figures 3-1 and 3-2 plus captions

THIS PAGE INTENTIONALLY LEFT BLANK

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication **26088**.



PO Box 1519, Fort Collins CO 80522-1519, USA
1041 Woodward Way, Fort Collins CO 80524, USA
Phone +1 (970) 482-5811

Email and Website—www.woodward.com

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

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