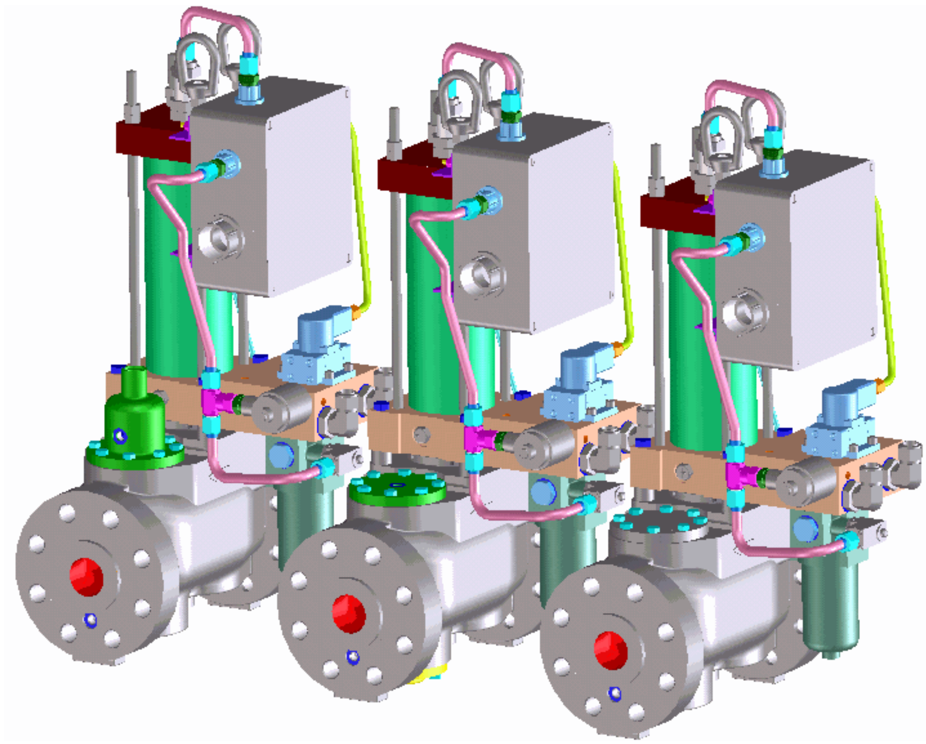
WOODWARD

Product Manual 26606
(Revision A, 3/2015)
Original Instructions



Stainless Steel LFV (Liquid Fuel Valves): Liquid Fuel Throttle Valve Liquid Fuel Bypass Control Valve

Installation and Operation Manual

General Precautions	**Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.** **Practice all plant and safety instructions and precautions.** **Failure to follow instructions can cause personal injury and/or property damage.**

Revisions	**This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:** **www.woodward.com/publications** **The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.**

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

Translated Publications	**If the cover of this publication states "Translation of the Original Instructions" please note:** **The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.**

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

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Illustrations and Tables

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Important Definitions

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

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

WARNING

Overspeed / Overtemperature / Overpressure

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

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

WARNING

Personal Protective Equipment

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

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

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

WARNING

Start-up

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

WARNING

Automotive Applications

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

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

Electrostatic Discharge Awareness

NOTICE **Electrostatic Precautions**	**Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:** • **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).** • **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.** • **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.** **To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.**

Follow these precautions when working with or near the control.

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

Regulatory Compliance

European Compliance for CE Marking:
These products are not CE Marked.

North American Compliance:
Suitability for use in North American Hazardous Locations is the result of compliance of the individual components:

Junction Box:	Certified for Class I, Zone 1, Group II Ex e II and Aex e II hazardous locations for use in North America by UL E203312.
Hydraulic Filter Switch:	Certified for Class I, Division 2, Groups A, B, C, and D hazardous locations for use in North America by UL E227041, when wired in accordance with wiring instructions in this manual.
DCDT:	Certified for Class I, Division 2, Groups A, B, C, and D hazardous locations for use in North America by ETL J98034305-001.
Servovalve: (Parker)	Certified for Class I, Division 2, Groups B, C, and D hazardous locations for use in North America by ETL 3014206-005. Must be supplied by a Class 2 source.
Servovalve: (Moog)	Certified for Class I, Division 2, Groups A, B, C, D, for use in Canada by CSA 1072373 and for use in the United States by Factory Mutual 4B9A6.AX.
Trip Relay Solenoid:	Certified for Class I, Division 2, Groups A, B, C, and D for use in Canada and the United States by CSA 1260548.

Special Conditions for Safe Use:
Wiring must be in accordance with North American Class I, Division 2, or European Zone 2, Category 3 wiring methods as applicable, and in accordance with the authority having jurisdiction.

Field Wiring must be suitable for at least 93 °C.

The filter must be installed in accordance with the following parameters:
V = 48 V (dc), Current = 15 mA, Conductance = 0 µF, Inductance = 0 mH

⚠WARNING

EXPLOSION HAZARD—Do not remove covers or connect/disconnect electrical connectors unless power has been switched off or the area is known to be non-hazardous.

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

⚠AVERTISSEMENT

RISQUE D’EXPLOSION—Ne pas enlever les couvercles, ni raccorder/débrancher les prises électriques, sans vous en assurez auparavant que le système a bien été mis hors tension; ou que vous situez bien dans une zone non explosive.

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

Chapter 1. General Information

Introduction

The LFV Liquid Fuel Valve family includes a Liquid Fuel Throttle Valve (TV) and a Liquid Fuel Bypass Control Valve (BCV).

The Liquid Fuel Throttle Valve controls the flow rate of liquid fuel to various stages of an industrial gas turbine combustion system. The unique design integrates the valve and actuator into a cost-effective, compact assembly. The valve is designed to provide an accurate flow-versus-stroke characteristic. The integral actuator is a single-acting spring-loaded design that will quickly close the valve upon loss of electrical or hydraulic signals. An onboard hydraulic filter is designed into the manifold to augment the reliability of the servovalve and actuator. The servovalve is an electrically redundant dual-coil design. A dc-powered LVDT (DCDT) provides feedback for the actuator.

The Liquid Fuel Bypass Control Valve controls the liquid fuel system pressure of an industrial gas turbine combustion system. The unique design integrates the valve, actuator, and a cavitation control regulator into a cost-effective, compact assembly. The valve is designed to bypass fuel from the discharge side of the positive displacement pump in order to control system pressure. The integral regulator allows the valve to operate with a low outlet pressure and a high differential pressure without cavitation damage. The valve uses the same integrated actuator design as the other liquid valves but with a normally-open valve configuration. Below the regulator pressure, the valve will not flow.

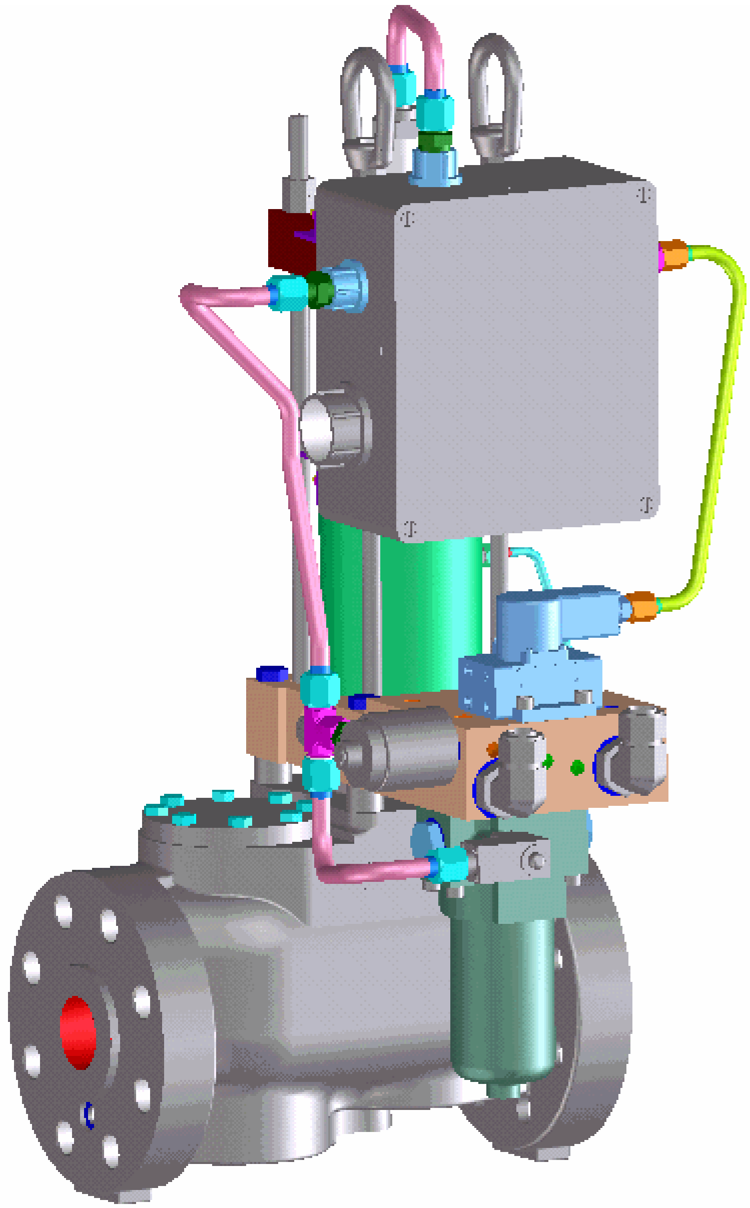

Figure 1-1a. Liquid Fuel Throttle Valve

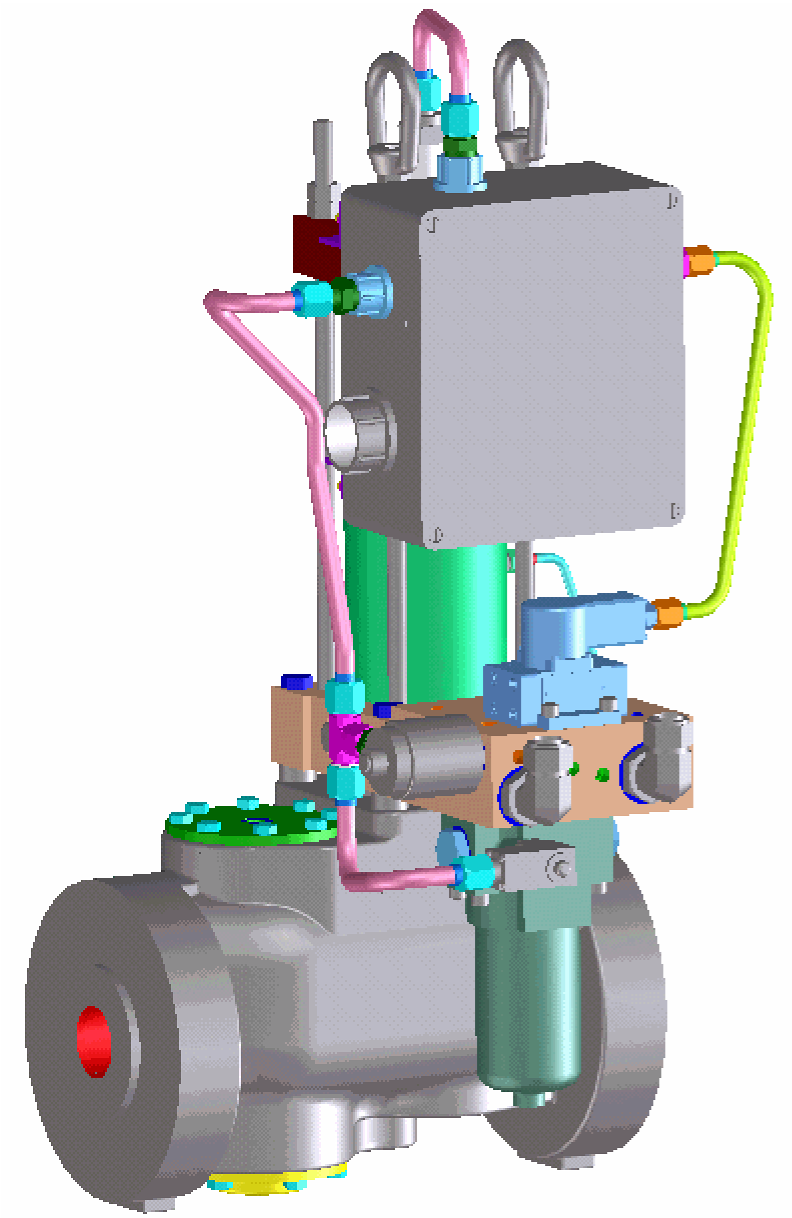

Figure 1-1b. Liquid Fuel Bypass Control Valve

Valve Function Characteristics

Liquid Fuel Throttle Valves—ANSI Class 900

Functional Requirement	Liquid Fuel Throttle Valve—High Pressure Version
Valve Type	Two way—globe style, plug guided metering valve
Trim Configuration	Approximate Equal Percentage Flow Curve
Type of Operation	Run—valve open Trip—valve closed
Number of Throttle Valves	3 per engine (one Pilot Stage and two A/B Stage)
Fluid Ports	ANSI Class 900 flanges Size 2" (51 mm), DN = 50 mm
Flowing Media	#2 Fuel Oil CF8M stainless steel bodies, stainless steel stem and trim currently used
Maximum Fuel Pressure (see valve housing mat.)	Valve housing material ASME SA-351 stainless steel, Grade CF8M 14 892 kPa (2160 psig)
Valve Proof Pressure Level (see valve housing mat.)	Valve housing material ASME SA-351 stainless steel, Grade CF8M 22 339 kPa (3240 psig) per ANSI B16.34, ANSI B16.37/ISA S75.19 (Prod Test)
Minimum Valve Burst Pressure (see valve housing mat.)	Valve housing material ASME SA-351 stainless steel, Grade CF8M 52 124 kPa (7560 psig) based on 3.5 times max working pressure (Proto. Test)
Fuel Filtration	25 µm absolute at 75 beta requirement
Fuel Temperature	0 to +52 °C (32 to 125 °F)
Valve Max Cv Values (approx. equal percentage)	Pilot—Cv Max = 6.4 Stage A & B—Cv Max = 20
Flow Characteristics	±5 % Cv deviation of Full Scale or ±3 % Cv deviation from tabulated values with characterization
Valve Ambient Temperature	–29 to +93 °C (–20 to +200 °F)
Shutoff Classification	Class IV per ANSI B16.104/FCI 70-2 (0.01 % of rated valve capacity at full travel measured with US MIL-C-7024 Type II Calibrating Fluid at 345 kPa/50 psid) (Prod Test)
External Leakage	None (Prod Test)
Inter-seal Vent Leakage	None (Prod Test)
Combined Influence of Hysteresis, Linearity, and Repeatability	±0.5 % of full scale with closed loop PI control (Proto. Test)
Hydraulic Fluid Type	Petroleum based hydraulic fluids as well as fire resistant hydraulic fluids such as Fyrquel or Quaker Quintolubric 822-300CM
Maximum Hydraulic Supply Pressure	8274 to 15 996 kPa (1200 to 2320 psig) (design at 15 996 kPa/2320 psig)
Production Proof Hydraulic Test Fluid Pressure Level	23 995 kPa (3480 psig) minimum per SAE J214 (Prod. Test)
Minimum Design Actuator Burst Pressure	39 990 kPa (5800 psig) minimum per SAE J214 (Proto. Test)
Fluid Filtration Required	10–15 µm absolute
Hydraulic Fluid Temperature	0 to 82 °C (32 to 180 °F)
Vibration	Woodward random test profile RV5 is based on US MIL-STD-810D, Method 514.3, category 1; Shock to 30G (Proto. Test)
Trip Mechanism	Electric solenoid, 90 V to 140 V (dc) / 125 V (dc) nominal
Trip Time	Less than 0.250 seconds and greater than 0.100 seconds N/A if no trip option
Slew Time	5 % to 95 % in less than 0.40 s at 2320 psig (Prod. Test) 95 % to 5 % in less than 0.40 s at 2320 psig (Prod. Test)

Functional Requirement	Liquid Fuel Throttle Valve—High Pressure Version
DCDT Position Transducer Feedback	Single Feedback
Hydraulic Fluid Connections	Supply pressure: 0.750 tube fitting, 90° positionable elbow Drain pressure: 0.750 tube fitting, 90° positionable elbow
Fuel Vent Connection	0.4375-20 UNF straight thd port (-4)
Sound Level	< 100 dB at full flow conditions
Approximate Dry Weight	112 kg (248 lb)

Bypass Control Valves—ANSI Class 900

Functional Requirement	Liquid Fuel Bypass Control Valve—High Pressure Version
Valve Type	Two way—globe style, plug guided metering valve with integrated cavitation control regulator
Trim Configuration	Custom Flow Curve
Type of Operation	Run—valve closed Trip—valve open
Number of Valves	1 per engine
Fluid Ports	ANSI Class 900 flanges Size 2" (51 mm), DN = 50 mm
Flowing Media	#2 Fuel Oil CF8M stainless steel bodies, stainless steel stem and trim currently used
Maximum Fuel Pressure (see valve housing mat.)	Valve housing material ASME SA-351 stainless steel, Grade CF8M 14 892 (2160 psig)
Valve Proof Pressure Level (see valve housing mat.)	Valve housing material ASME SA-351 stainless steel, Grade CF8M 22 339 kPa (3240 psig) per ANSI B16.34, ANSI B16.37/ISA S75.19 (Prod Test)
Minimum Valve Burst Pressure (see valve housing mat.)	Valve housing material ASME SA-351 stainless steel, Grade CF8M 521 24 kPa (7560 psig) based on 3.5 times max working pressure (Proto. Test)
Fuel Filtration	25 µm absolute at 75 beta requirement
Fuel Temperature	0 to +52 °C (32 to 125 °F)
Valve Max Cv Values (approx. equal percentage)	Cv Max = 22 (at 2068 kPa / 300 psig min) Below regulator back pressure, effective Cv = 0
Regulator Back Pressure	1034 to 1551 kPa (150 to 225 psid)
Flow Characteristics	±5 % Cv deviation of full scale (at 1724 kPa / 250 psid)
Valve Ambient Temperature	–29 to +93 °C (–20 to +200 °F)
Shutoff Classification	10 gal(US)/min at 1000 psig (38 L/min at 6895 kPa) measured with US MIL-C-7024 Type II Calibrating Fluid (Prod Test)
External Leakage	None (Prod Test)
Inter-seal Vent Leakage	None (Prod Test)
Combined Influence of Hysteresis, Linearity, and Repeatability	±0.5 % of full scale with closed loop PI control (Proto. Test)
Hydraulic Fluid Type	Petroleum based hydraulic fluids as well as fire resistant hydraulic fluids such as Fyrquel or Quaker Quintolubric 822-300CM
Maximum Hydraulic Supply Pressure	8274 to 15 996 kPa (1200 to 2320 psig) (design at 15 996 kPa/2320 psig)
Production Proof Hydraulic Test Fluid Pressure Level	23 995 kPa (3480 psig) minimum per SAE J214 (Prod. Test)

Functional Requirement	Liquid Fuel Bypass Control Valve—High Pressure Version
Minimum Design Actuator Burst Pressure	39 990 kPa (5800 psig) minimum per SAE J214 (Proto. Test)
Fluid Filtration Required	10–15 µm absolute
Hydraulic Fluid Temperature	0 to 82 °C (32 to 180 °F)
Vibration	Woodward random test profile RV5 is based on US MIL-STD-810D, Method 514.3, category 1; Shock to 30G (Proto. Test)
Trip Mechanism	Electric solenoid, 90 V to 140 V (dc) / 125 V (dc) nominal
Trip Time	Less than 0.250 seconds and greater than 0.100 seconds N/A if no trip option
Slew Time	5 % to 95 % in less than 0.40 s at 2320 psig (Prod. Test) 95 % to 5 % in less than 0.40 s at 2320 psig (Prod. Test)
Hydraulic Fluid Connections	Supply pressure: 0.750 tube fitting, 90° positionable elbow Drain pressure: 0.750 tube fitting, 90° positionable elbow
Fuel Vent Connection	0.4375-20 UNF straight thd port (-4)
Sound Level	< 100 dB at full flow conditions
Approximate Dry Weight	115 kg (254 lb)

Liquid Fuel Throttle Valves—ANSI Class 1500

Functional Requirement	Liquid Fuel Throttle Valves—High Pressure Version
Valve Type	Two way—globe style, plug guided metering valve
Trim Configuration	Approximate Equal Percentage Flow Curve
Type of Operation	Run—valve open Trip—valve closed
Number of Throttle Valves	3 per engine (one Pilot Stage and two A/B Stage)
Fluid Ports	ANSI Class 1500 flanges Size 2” (51 mm), DN = 50 mm
Flowing Media	#2 Fuel Oil CF8M stainless steel bodies, stainless steel stem and trim currently used
Maximum Fuel Pressure	22 753 kPa (g) (3300 psig)
Valve Proof Pressure Level	34 129 kPa (g) (4950 psig) per ANSI B16.34, ANSI B16.37/ISA S75.19 (Prod Test)
Minimum Valve Burst Pressure	79 634 kPa (g) (11 550 psig) based on 3.5 times max working pressure (Proto. Test)
Fuel Filtration	25 µm absolute at 75 beta requirement
Fuel Temperature	0 to +93 °C (32 to 200 °F)
Valve Max Cv Values (approx. equal percentage)	Pilot—Cv Max = 6.8 Stage A & B—Cv Max = 20.9
Flow Characteristics	±5 % Cv deviation of Full Scale or ±3 % Cv deviation from tabulated values with characterization
Valve Ambient Temperature	–29 to +93 °C (–20 to +200 °F)
Shutoff Classification	Class IV per ANSI B16.104/FCI 70-2 (0.01 % of rated valve capacity at full travel measured with US MIL-C-7024 Type II Calibrating Fluid at 345 kPa (g)/50 psid) (Prod Test)
External Leakage	None (Prod Test)
Inter-seal Vent Leakage	None (Prod Test)
Combined Influence of Hysteresis, Linearity, and Repeatability	±0.5 % of full scale with closed loop PI control (Proto. Test)
Hydraulic Fluid Type	Petroleum based hydraulic fluids as well as fire resistant hydraulic fluids such as Fyrquel or Quaker Quintolubric 822-300CM
Maximum Hydraulic Supply Pressure	8274 to 15 996 kPa (g) (1200 to 2320 psig) (design at 15 996 kPa (g) /2320 psig)

Functional Requirement	Liquid Fuel Throttle Valves—High Pressure Version
Production Proof Hydraulic Test Fluid Pressure Level	23 995 kPa (g) (3480 psig) minimum per SAE J214 (Prod. Test)
Minimum Design Actuator Burst Pressure	39 990 kPa (g) (5800 psig) minimum per SAE J214 (Proto. Test)
Fluid Filtration Required	10–15 µm absolute
Hydraulic Fluid Temperature	0 to 82 °C (32 to 180 °F)
Vibration	Woodward random test profile RV5 is based on US MIL-STD-810D, Method 514.3, category 1; Shock to 30 G (Proto. Test)
Trip Mechanism	Electric solenoid, 90 V to 140 V (dc) / 125 V (dc) nominal
Trip Time	Less than 0.250 seconds and greater than 0.100 seconds N/A if no trip option
Slew Time	5 % to 95 % in less than 0.40 s at 2320 psig (Prod. Test) 95 % to 5 % in less than 0.40 s at 2320 psig (Prod. Test)
DCDT Position Transducer Feedback	Single Feedback
Hydraulic Fluid Connections	Supply pressure: 0.750 tube fitting, 90° positionable elbow Drain pressure: 0.750 tube fitting, 90° positionable elbow
Fuel Vent Connection	0.4375-20 UNF straight thd port (-4)
Sound Level	< 100 dB at full flow conditions
Approximate Dry Weight	112 kg (248 lb)

LFV Operating Range: The LFV is a contoured plug valve. Actuation forces for this type of valve are a function of inlet pressure, pressure ratio, and valve position. Actuation forces can become very large if the downstream pressure is higher than **19 305 kPa (g) (2800 psig)** at valve closed position (0% of travel). **These large forces tend to open the valve at sealed condition**.

The above conditions are not expected to occur when this valve is used to meter water flow to a turbine. This operating range should be considered if the valve is used for some other application.

Bypass Control Valve—ANSI Class 1500

Functional Requirement	Liquid Fuel Bypass Control Valve—High Pressure Version
Valve Type	Two way—globe style, plug guided metering valve with integrated cavitation control regulator
Trim Configuration	Custom Flow Curve
Type of Operation	Run—valve closed Trip—valve open
Number of Valves	1 per engine
Fluid Ports	ANSI Class 1500 flanges Size 2" (51 mm), DN = 50 mm
Flowing Media	#2 Fuel Oil CF8M stainless steel bodies, stainless steel stem and trim currently used
Maximum Fuel Pressure	22 753 kPa (g) (3300 psig)
Valve Proof Pressure Level	34 129 kPa (g) (4950 psig) per ANSI B16.34, ANSI B16.37/ISA S75.19 (Prod Test)
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Fuel Filtration	25 µm absolute at 75 beta requirement
Fuel Temperature	0 to +93 °C (32 to 200 °F)
Valve Max Cv Values (approx. equal percentage)	Cv Max = 22 (at 2068 kPa (g) / 300 psig min) Below regulator back pressure, effective Cv = 0
Regulator Back Pressure	1034 to 1551 kPa (g) (150 to 225 psid)
Flow Characteristics	±5 % Cv deviation of full scale (at 1724 kPa (g) / 250 psid)
Valve Ambient Temperature	–29 to +93 °C (–20 to +200 °F)
Shutoff Classification	10 gal(US)/min at 1000 psig (38 L/min at 6895 kPa (g)) measured with US MIL-C-7024 Type II Calibrating Fluid (Prod Test)
External Leakage	None (Prod Test)
Inter-seal Vent Leakage	None (Prod Test)
Combined Influence of Hysteresis, Linearity, and Repeatability	±0.5 % of full scale with closed loop PI control (Proto. Test)
Hydraulic Fluid Type	Petroleum based hydraulic fluids as well as fire resistant hydraulic fluids such as Fyrquel or Quaker Quintolubric 822-300CM
Maximum Hydraulic Supply Pressure	8274 to 15 996 kPa (g) (1200 to 2320 psig) (design at 15 996 kPa (g) /2320 psig)
Production Proof Hydraulic Test Fluid Pressure Level	23 995 kPa (g) (3480 psig) minimum per SAE J214 (Prod. Test)
Minimum Design Actuator Burst Pressure	39 990 kPa (g) (5800 psig) minimum per SAE J214 (Proto. Test)
Fluid Filtration Required	10–15 µm absolute
Hydraulic Fluid Temperature	0 to 82 °C (32 to 180 °F)
Vibration	Woodward random test profile RV5 is based on US MIL-STD-810D, Method 514.3, category 1; Shock to 30 G (Proto. Test)
Trip Mechanism	Electric solenoid, 90 V to 140 V (dc) / 125 V (dc) nominal
Trip Time	Less than 0.250 seconds and greater than 0.100 seconds N/A if no trip option
Slew Time	5 % to 95 % in less than 0.40 s at 2320 psig (Prod. Test) 95 % to 5 % in less than 0.40 s at 2320 psig (Prod. Test)
Hydraulic Fluid Connections	Supply pressure: 0.750 tube fitting, 90° positionable elbow Drain pressure: 0.750 tube fitting, 90° positionable elbow
Fuel Vent Connection	0.4375-20 UNF straight thd port (-4)
Sound Level	< 100 dB at full flow conditions
Approximate Dry Weight	115 kg (254 lb)

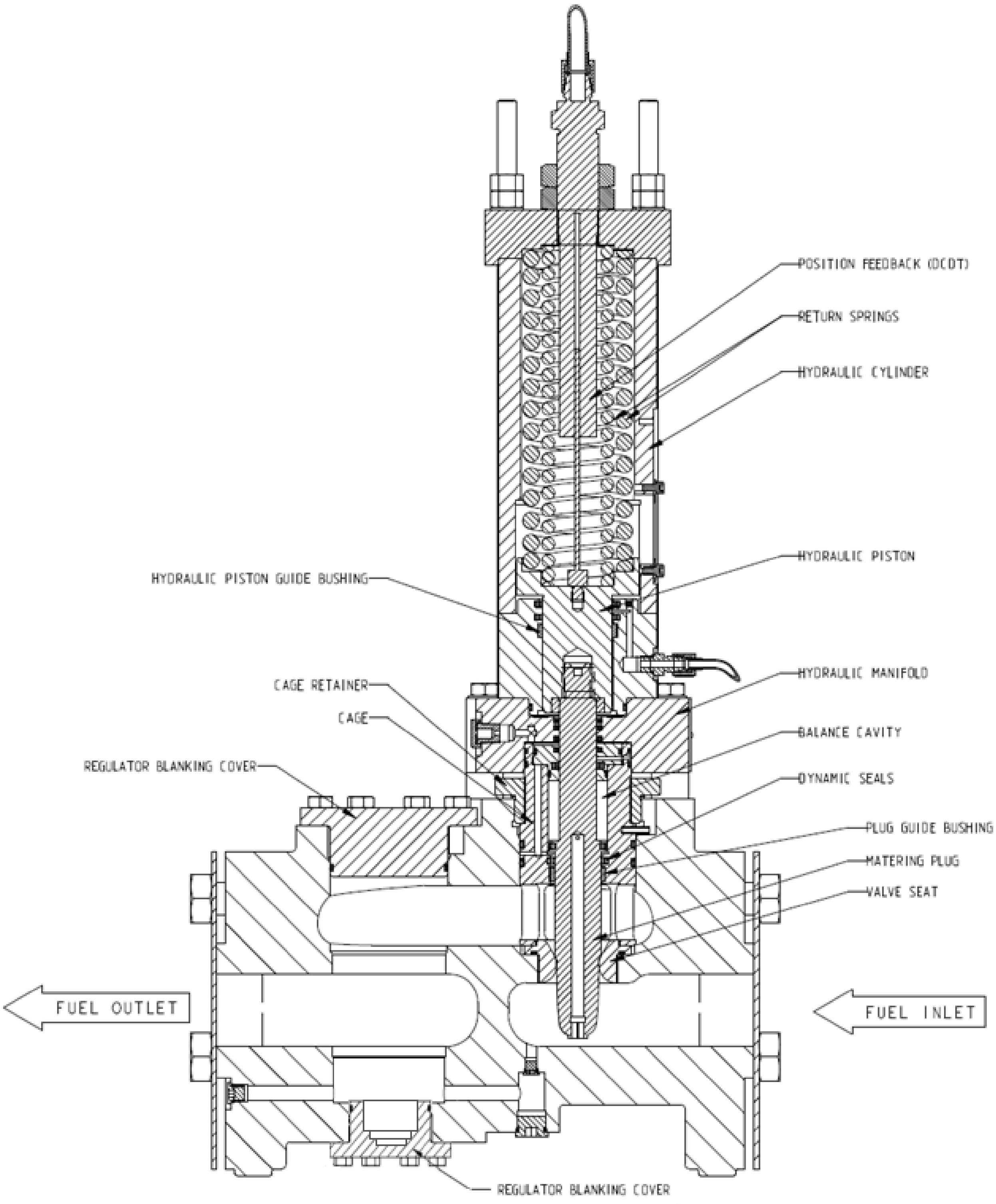

Figure 1-2a. Cutaway, Liquid Fuel Throttle Valve (high-pressure version with CF8M stainless steel valve body)

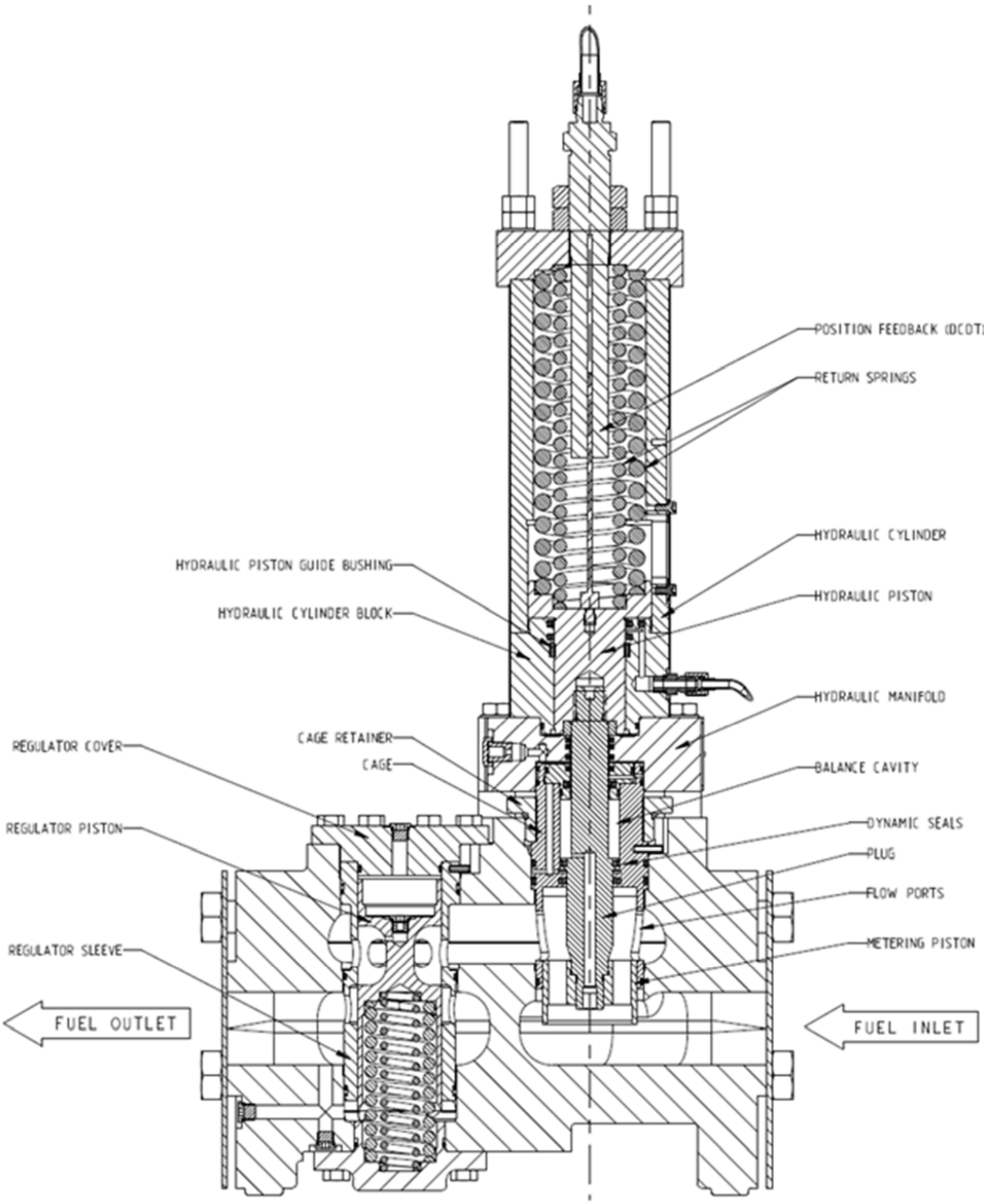

Figure 1-2b. Cutaway, Liquid Fuel Bypass Control Valve (high-pressure version with CF8M stainless steel valve body)

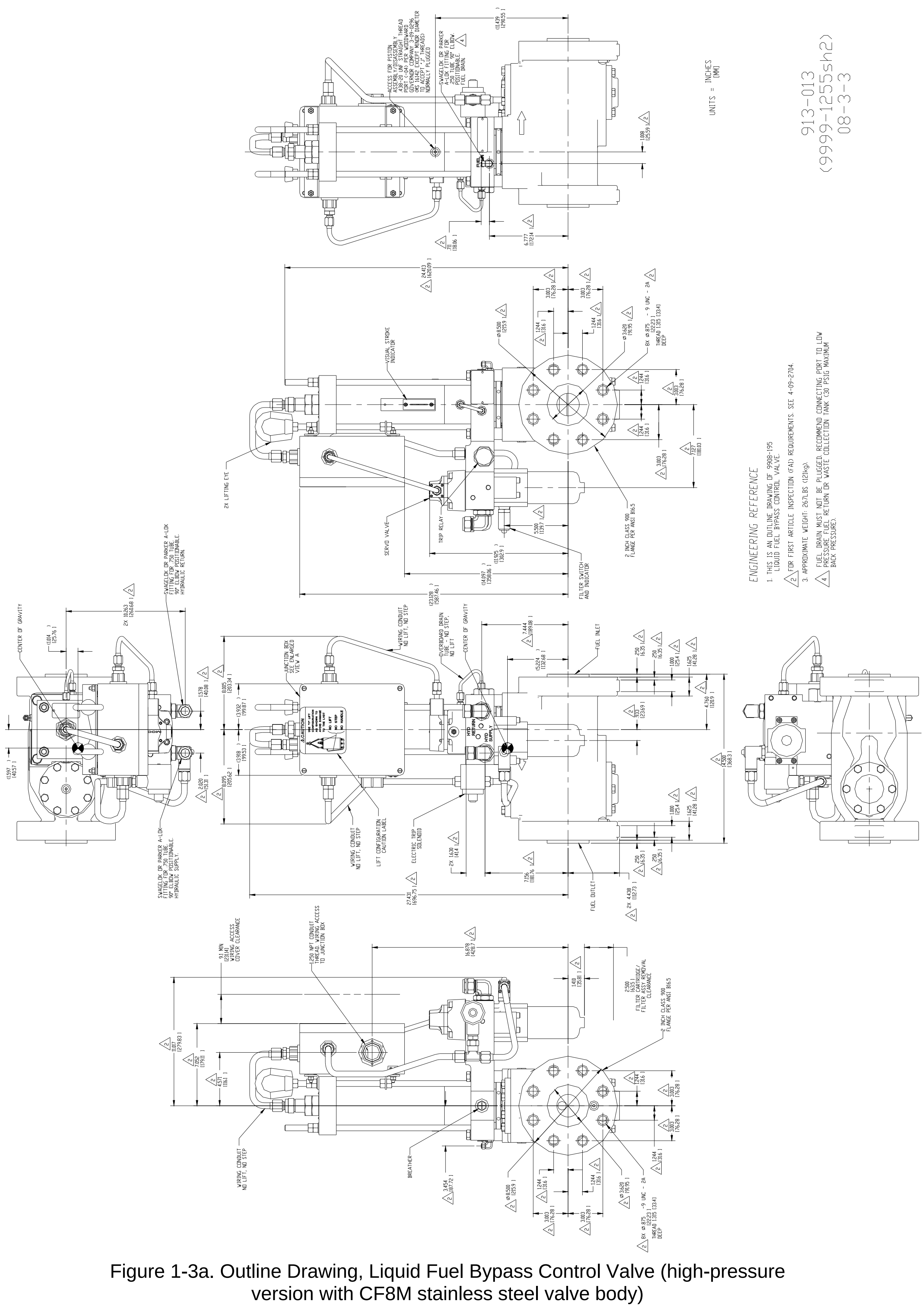

Figure 1-3a. Outline Drawing, Liquid Fuel Bypass Control Valve (high-pressure version with CF8M stainless steel valve body)

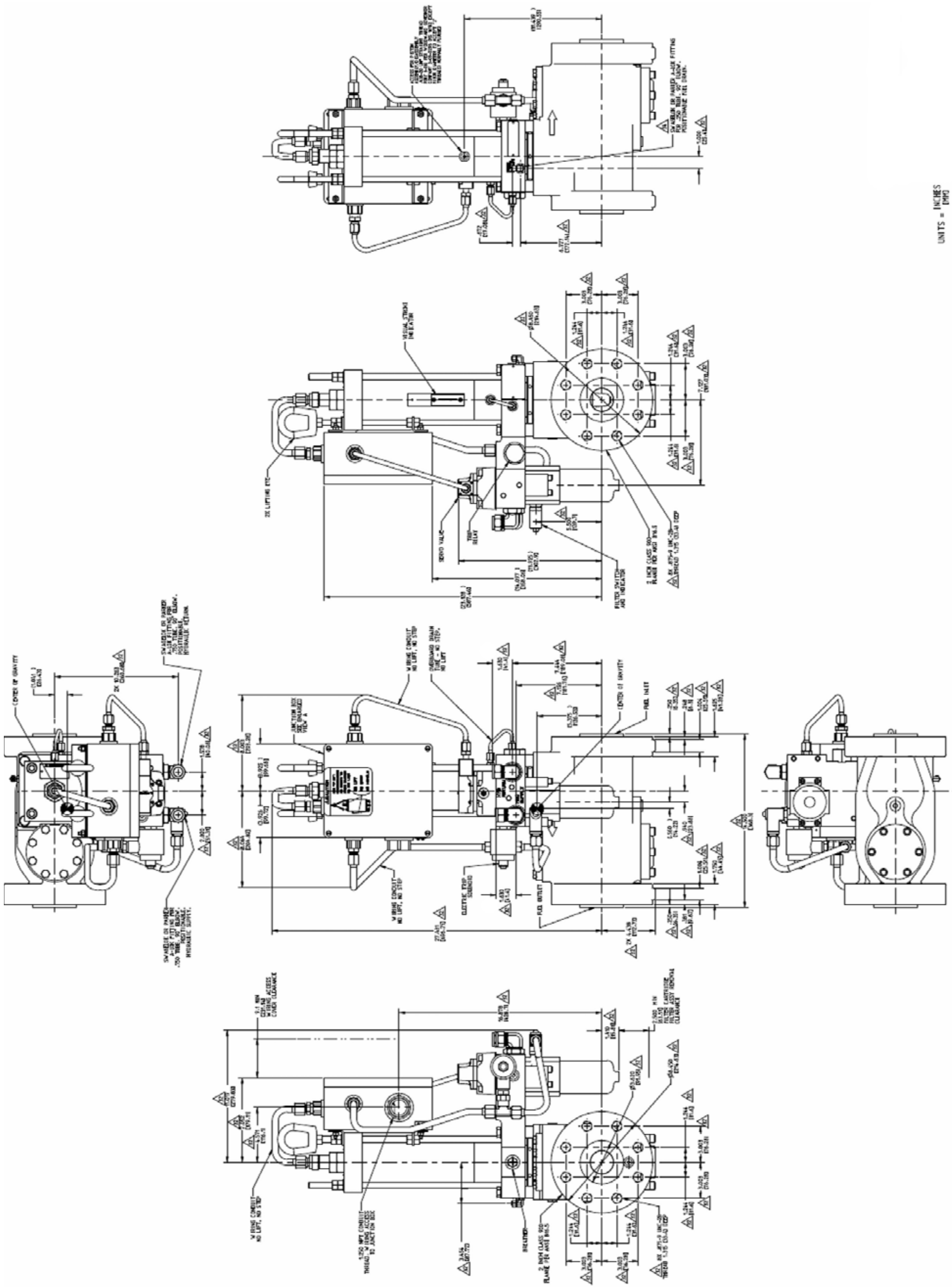

Figure 1-3b. Outline Drawing, Liquid Fuel Pilot Throttle Valve (high-pressure version with CF8M stainless steel valve body)

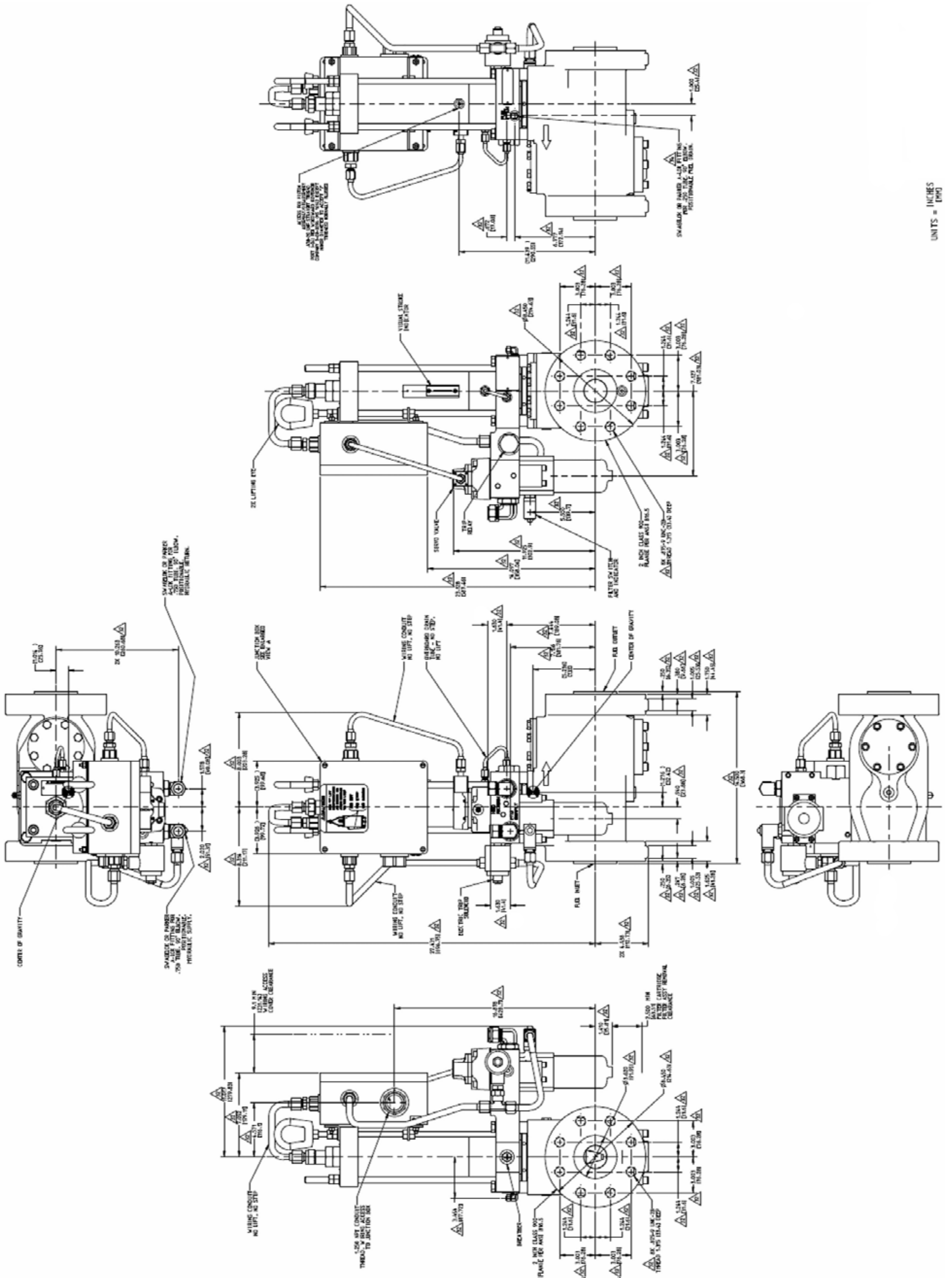

Figure 1-3c. Outline Drawing, Liquid Fuel Pilot Throttle A/B Valve (high-pressure version with CF8M stainless steel valve body)

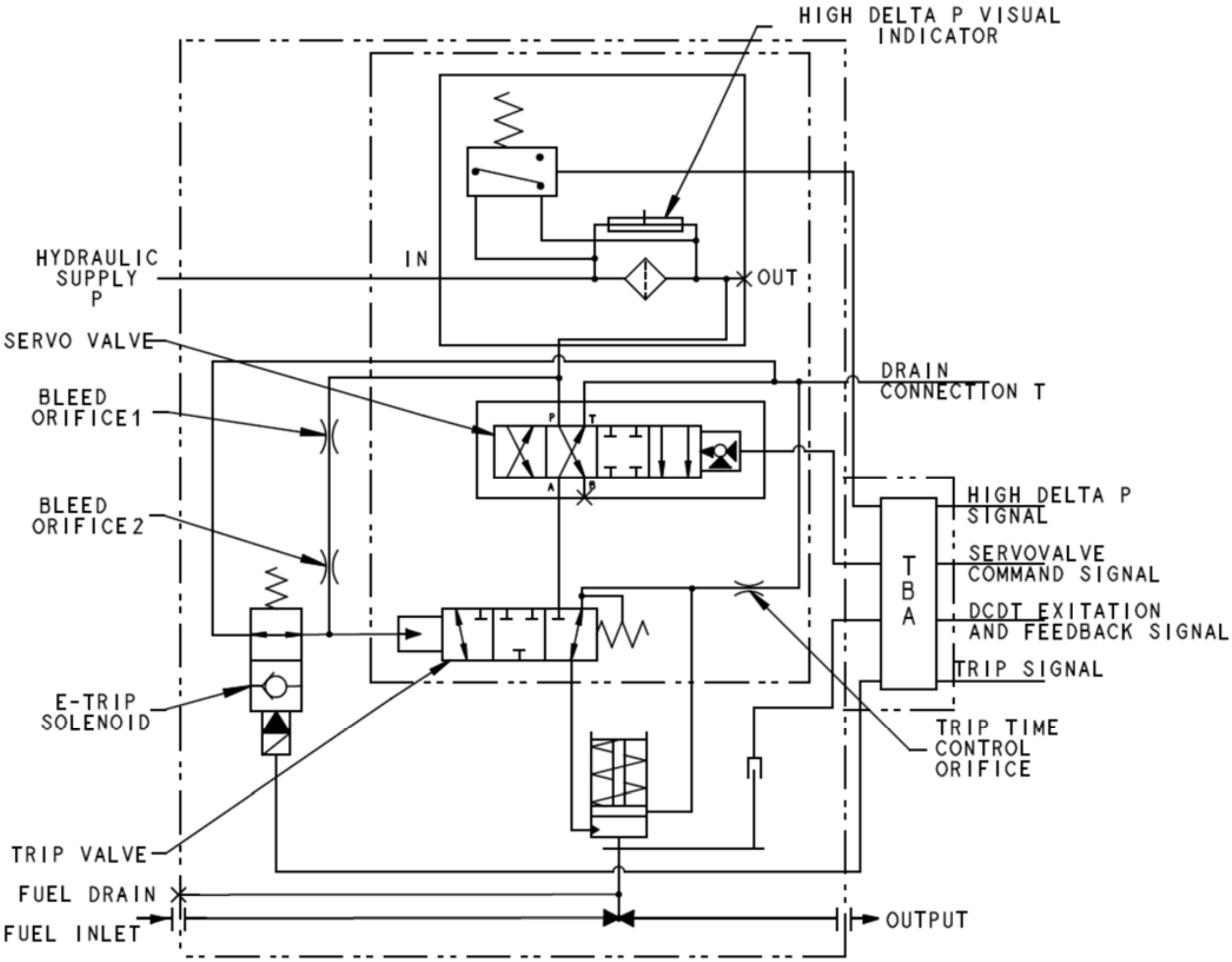

Figure 1-4a. Hydraulic Schematic, Liquid Fuel Throttle Valve (high-pressure version)

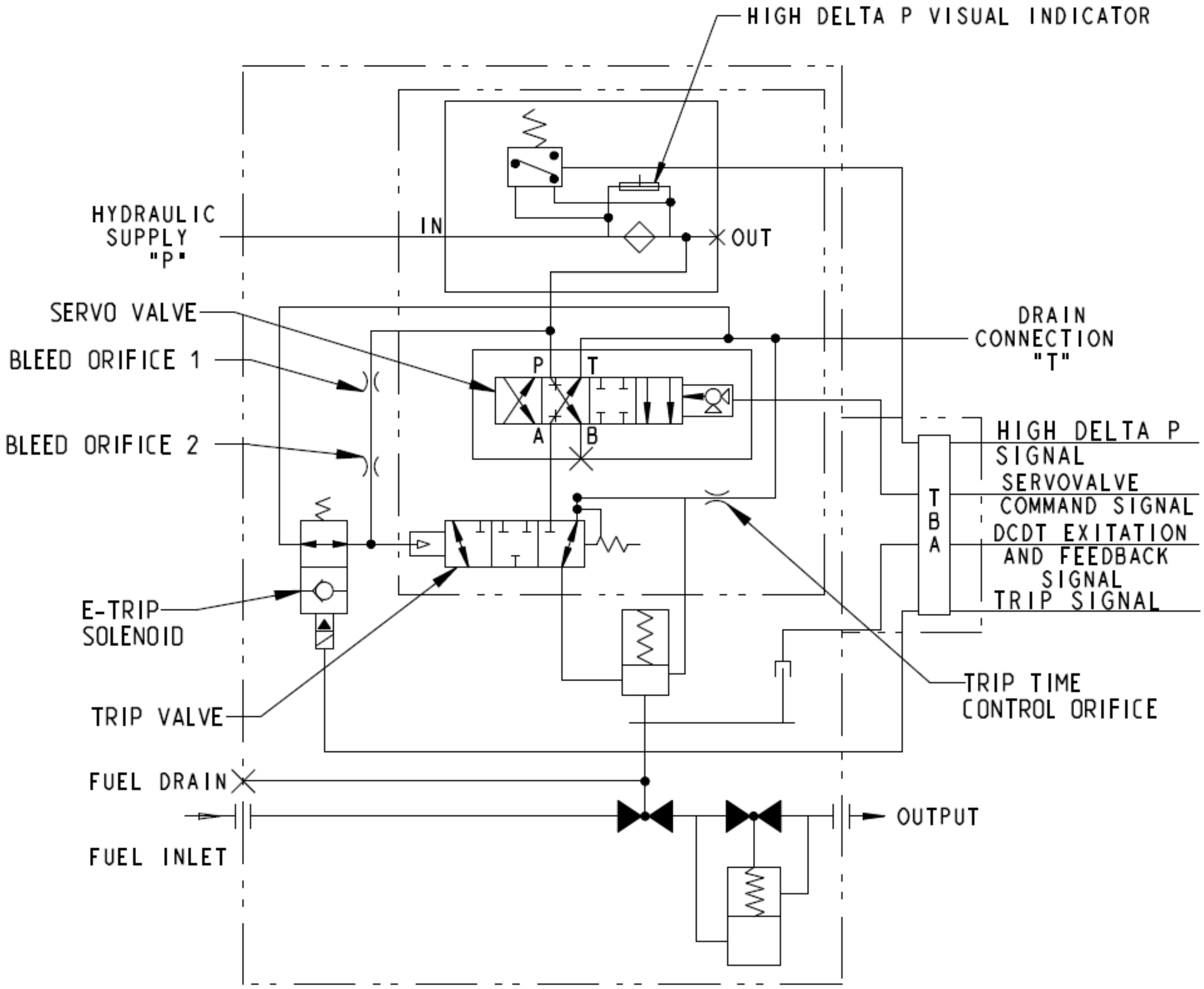

Figure 1-4b. Hydraulic Schematic, Liquid Fuel Bypass Control Valve (high pressure version)

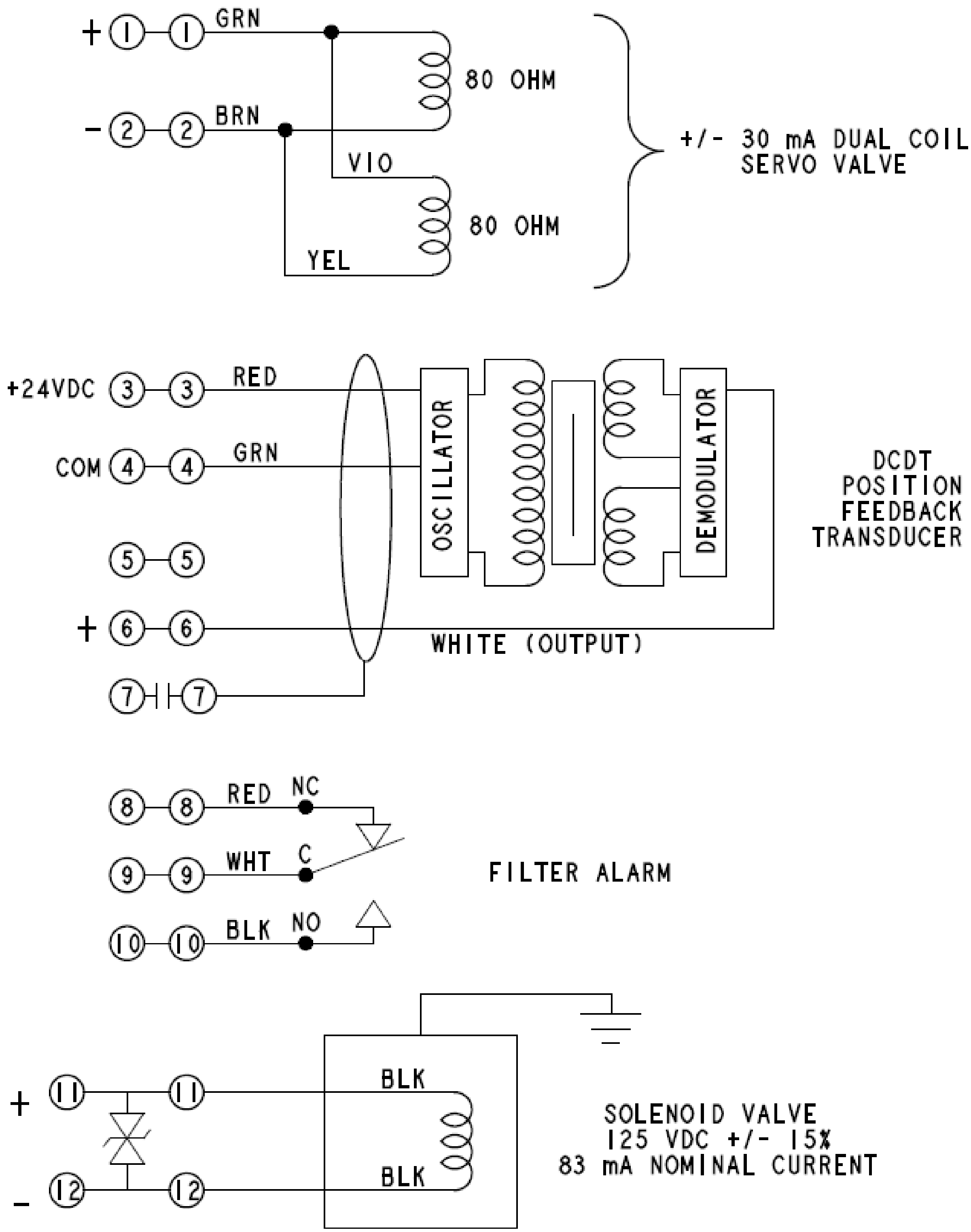

Figure 1-5. Controller Wiring Diagram (high-pressure version)

Chapter 2.
Description

Dual Coil Electrohydraulic Servovalve Assembly

The hydraulic actuator assembly uses a two-stage hydraulic servovalve to modulate the position of the actuator output shaft and thereby control the fuel valves. The first stage torque motor uses a dual-wound coil, which controls the position of the first and second stage valves in proportion to the total electric current applied to the two coils.

If the control system requires a rapid movement of the valve to send more fuel to the turbine, 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 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.

Near 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.

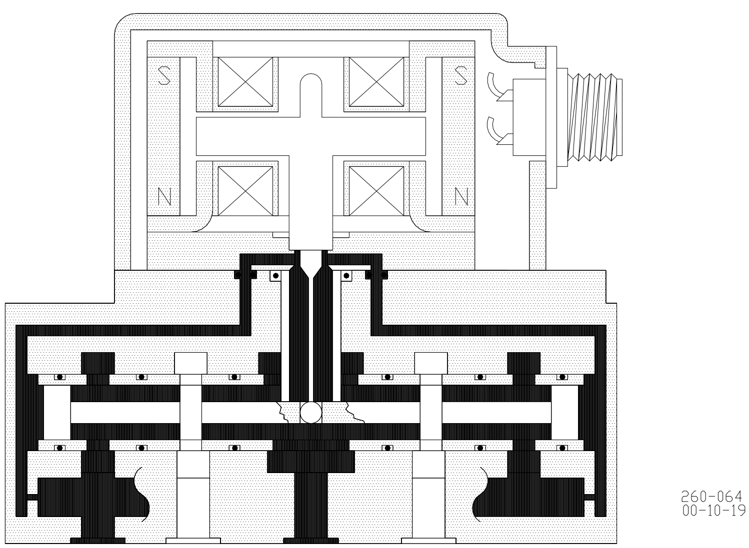

Figure 2-1. Servovalve Cutaway

Trip Relay Valve Assembly

The Liquid Fuel Valves use a solenoid-operated trip relay circuit to operate a high-capacity, three-way, two-position, hydraulically-operated valve which quickly closes the Liquid Fuel Valves. This trip relay circuit consists of four functional elements. These include the trip relay solenoid valve, the trip relay supply orifice, the hydraulically operated trip valve, and the trip relay volume.

In the normal run mode, the trip relay solenoid valve is closed, which prevents the trip relay volume from bleeding to the hydraulic return. As a result, high pressure oil is fed into the trip relay circuit through the supply orifice, which quickly pressurizes the trip circuit to supply pressure. When the trip circuit pressure increases above 1100 kPa (160 psig), the three-way relay valve shifts position so that the common port connects the control port of the servo-valve to the lower piston cavity of the actuator, allowing the servo-valve to position the valve.

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 and high differential pressure switch, to indicate when the recommended pressure differential has been exceeded, and when replacement of the element is necessary.

DC Powered LVDT (DCDT) Position Feedback Sensor

The Liquid Fuel Valves use a DCDT feedback device with integral excitation and demodulation circuitry. The device uses a dc supply voltage to generate a feedback signal. A single V (dc) feedback device is used.

Chapter 3.
Installation

General

See Figures 1-3, 1-4, and 1-5 for:
- Overall dimensions
- Process piping flange locations
- Hydraulic fitting sizes
- Electrical connections
- Lift points and center of gravity

Installation attitude does not affect actuator or Liquid Fuel Valve performance, but a vertical position is generally preferred to conserve floor space as well as for ease of making electrical, fuel, and hydraulic connections and changing the hydraulic filter element. The Liquid Fuel Valves are designed for support by the piping flanges alone—additional supports are neither needed nor recommended. Do not use this valve to provide support to any component other than the piping to which it is directly connected.

The orientation of the visual position indicator may be changed to accommodate surrounding obstructions, if any. See Chapter 4 for instructions to change the orientation.

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

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

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

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

Unpacking

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

Piping Installation

Refer to ANSI B16.5 for details of flange, gasket, and bolt types and dimensions.

This is a globe-style valve. Verify that the process piping face-to-face dimensions meet the requirements of the outline drawings (Figure 1-3) within standard piping tolerances. Use the lifting eye to safely move the valve. 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.

Flange gasket materials should conform to ANSI B16.20. The user should select a gasket material which will withstand the expected bolt loading without injurious crushing, and which is suitable for the service conditions.

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. Once all studs/bolts have been torqued to half the appropriate value, repeat the pattern until the rated torque value calculated per ASME Boiler Pressure Vessel Code Section VIII, Division 1 Appendix 2 is obtained.

Hydraulic Connections

There are two hydraulic connections that must be made to each valve: supply and return oil. The connections to the valve are 0.75 OD tube fittings. The tubing up to the valve must be constructed to eliminate any transfer of vibration or other forces into the valve.

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

The hydraulic supply to the actuator needs to be 19.05 mm (0.750 inch) tubing capable of supplying 38 L/min (10 US gallons/min) at 8274–15 996 kPa (1200–2320 psig).

The hydraulic drain should be 19.05 mm (0.750 inch) tubing and must not restrict the flow of fluid from the valve. The drain pressure must not exceed 207 kPa (30 psig) under any condition.

Electrical Connections

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

NOTICE — **Do not connect any cable grounds to "instrument ground", "control ground", or any non-earth ground system. Make all required electrical connections based on the wiring diagrams (Figures 1-5 and 3-1).**

The use of cable with individually-shielded twisted pairs is required. The DCDT position feedback lines should be shielded to prevent picking up stray signals from nearby equipment. Connect the shield at the control system side ***and*** to the appropriate terminal in the LFV junction box as specified by the system wiring diagram. DO NOT attempt to ground the DCDT feedback shield directly to earth on the LFV side, or a ground loop will occur.

Installation Notes

- Wires exposed beyond the shield should be as short as possible, not exceeding 50 mm (2").
- The shield termination wire (or drain wire) should be kept as short as possible, not exceeding 50 mm (2"); and where possible the diameter should be maximized.
- Installations with severe electromagnetic interference (EMI) may require additional shielding precautions. Contact Woodward for more information.

Failure to provide shielding can produce future conditions which are difficult to diagnose. Proper shielding at the time of installation is required to assure satisfactory operation of the product.

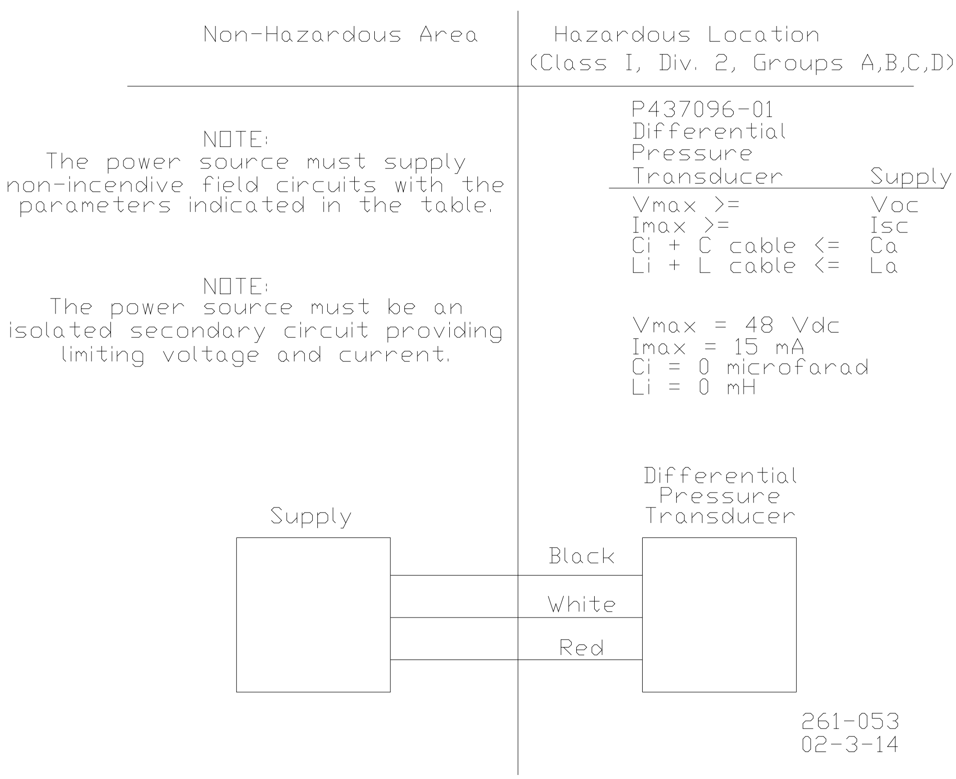

Figure 3-1. Wiring for Non-Incendive Pressure Indicator Switch

Fuel Vent Port

NOTICE

There is a fuel vent port provided that must be vented to a safe location. In normal operation, this vent should have zero leakage. However, if excessive leakage is detected from this port, contact a Woodward representative for assistance.

Rigging Procedure

Inside the electrical enclosure of the valve, there is an adhesive label that contains the appropriate valve position (as a percent of full stroke), the physical stroke (inches), and the corresponding DCDT feedback signals.

Once the control system is connected to the valve and control of the valve is established, de-energize the trip solenoid valve to ensure that the valve moves to the closed position. Measure the feedback voltage from the DCDT. Adjust the offset in the feedback loop until the feedback voltage matches the documented value on the label inside the electrical enclosure for the 0 % position. Set the 100 % position demand, measure the actual physical travel position, and adjust the span of the control channel so that the physical travel matches the value on the label inside the electrical enclosure. Use Woodward Tool part number 1008-4446, installed in place of the visual position indicator, and an accurate position indicating device to measure the physical travel of the valve (see Figure 3-2). Verify that the valve moves to the proper positions by commanding the control to 0 % and 100 %, and recheck the physical positions.

IMPORTANT

The DCDT feedback voltage, measured at the terminals in the electrical enclosure, should be approximately as listed on the label.

Figure 3-2. LFV Piston Rig Tool

Chapter 4. Maintenance and Hardware Replacement

Maintenance

The Liquid Fuel Valves require no maintenance or adjustment for operation.

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

Woodward recommends routine checks of the overboard fuel leakage. If the valve has excessive overboard fuel leakage, the seals need to be replaced.

In the event that any of the standard components of the valve become inoperative, field replacement is possible. Contact a Woodward representative for assistance.

Hardware Replacement

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

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

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

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

To facilitate field replacement of items, spare parts should be kept on-site. See the outline drawings (Figure 1-3) for the locations of items. Contact Woodward for a complete list of field-replaceable parts and additional instructions for their replacement.

Hydraulic Filter Assembly/Cartridge

The hydraulic filter is located on the hydraulic manifold. It is hanging directly under the servovalve.

Replacement of Filter Assembly:

1. Remove the cover to the electrical junction box.
2. Disconnect the filter alarm switch wires from the connector blocks labeled 8–10.
3. Loosen the conduit fittings from the electrical box, the filter alarm switch, and the tee fitting in between.
4. Carefully remove the conduit from the filter alarm switch and pull the wiring out of the conduit.
5. Remove the four 0.312-18 socket head cap screws.
6. Remove the filter assembly from the manifold block. ***The filter will contain a large amount of hydraulic fluid. Be cautious when handling.***
7. Verify that two O-rings are present in the interface between the filter and the manifold.
8. Obtain a new filter assembly from Woodward.
9. Verify that two new O-rings are present in the new filter assembly.
10. Install the filter assembly onto the manifold. Be sure to place the filter in the correct orientation. See the outline drawings (Figure 1-3).
11. Install the four 0.312-18 cap screws through the filter and torque to 244–256 lb-in (27.6–28.9 N·m).
12. Install wiring through the conduit and into the electrical box.
13. Connect the conduit to the filter alarm switch and torque to 450–550 lb-in (51–62 N·m).
14. Torque the conduit to the electrical box and the tee fitting to 450–550 lb-in (51–62 N·m).
15. Install wires into the filter alarm switch connector blocks labeled according to Figure 1-5. 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. Check for external leakage upon pressurizing the hydraulic system.

Replacement of Filter Cartridge:

1. Using a 1-5/16" (~33+ mm) wrench, loosen the bowl from the filter assembly.
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 from Woodward.
5. Lubricate the O-ring on the inside diameter 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. Install the filter bowl onto the assembly. Tighten only by hand. Do not torque the bowl.
8. Check for external leakage upon pressurizing the hydraulic system.

Trip Relay Valve Cartridge

The trip relay valve cartridge is located in the hydraulic manifold block.

1. Using a 1-1/2 inch wrench (~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 from Woodward.
4. Verify that all O-rings are present on the new cartridge.
5. Lubricate the O-rings with hydraulic fluid or petroleum jelly.
6. Install the cartridge into the manifold housing.
7. Torque to 40–58 lb-ft (54–79 N·m).
8. Check for external leakage upon pressurizing the hydraulic system.

Trip Relay Solenoid Valve

The trip relay solenoid valve is located on the side of the hydraulic manifold opposite the trip relay cartridge valve. See the outline drawing (Figures 1-3).

1. Remove the cover to the electrical junction box.
2. Disconnect the solenoid valve wires from the connector block labeled according to Figure 1-5.
3. Loosen the conduit fittings from the electrical box, the solenoid valve, and the tee fitting in between.
4. Carefully remove the conduit from the solenoid valve and pull the wiring out of the conduit.
5. Using a 1-1/4 inch wrench (~32– mm), loosen the solenoid valve from the hydraulic manifold.
6. Slowly remove the solenoid valve form the manifold. ***There could be some hydraulic fluid upon removal. Be cautious when handling.***
7. Obtain a new solenoid valve from Woodward.
8. Verify that both O-rings and back-up ring are present on the new valve.
9. Lubricate the O-rings with hydraulic fluid or petroleum jelly.
10. Install the new solenoid valve into the hydraulic manifold.
11. Torque the solenoid valve to 40–58 lb-ft (54–79 N·m).
12. Install wiring through the conduit and into the electrical box.
13. Connect the conduit to the solenoid valve and torque to 450–550 lb-in (51–62 N·m).
14. Torque the conduit to the electrical box and to the tee fitting to 450–550 lb-in (51–62 N·m).
15. Install wires into the solenoid valve connector blocks labeled according to Figure 1-5. If it is necessary to cut the 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. Check for external leakage upon pressurizing the hydraulic system.

Servovalve

The servovalve is located on the hydraulic manifold directly above the filter assembly. See the outline drawings (Figure 1-3).

1. Remove the cover to the electrical junction box.
2. Disconnect the servovalve wires from the connector blocks labeled according to Figure 1-5.
3. Loosen the conduit fittings from the electrical box and the servovalve.
4. Carefully remove the conduit from the servovalve and pull the wiring out of the conduit.
5. Remove the four 0.312-18 UNF 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.
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.
10. Install four 0.312-18 UNF socket head cap screws and torque to 55–57 lb-in (6.2–6.4 N·m).
11. Install wiring through the conduit and into the electrical box.
12. Connect the conduit to the servovalve and torque to 270–300 lb-in (30–34 N·m).
13. Torque the conduit to the electrical box to 270–300 lb-in (30–34 N·m).
14. Install wires into the servovalve connector blocks labeled according to Figure 1-5. 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. Check for external leakage upon pressurizing the hydraulic system.

IMPORTANT

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

DCDT

The DCDT is located on the top of the actuator. See the outline drawings (Figure 1-3).

1. Remove the cover to the electrical junction box.
2. Disconnect the DCDT wires from the connector blocks labeled according to Figure 1-5.
3. Loosen the conduit fittings from the electrical box and the DCDT.
4. Carefully remove the conduit from the DCDT and pull the wiring out of the conduit.
5. Remove the conduit from the electrical box.
6. Remove the protective covers from the four threaded tie rods that hold the actuator together. Remove the two “eye nuts” from the two-tie rods.
7. Remove the four 0.500-13 jam nuts from the tie rods.

8. Remove the two 0.250-20 socket head cap screws that hold the electrical box to the top mounting plate. The cap screws have nuts and washers.

WARNING **To prevent possible serious personal injury, be sure to carefully release the preload on the integral springs of the actuator as explained in step 9.**

9. Slowly remove the four remaining 0.500-13 nuts from the tie rods. This action will release the preload on the integral springs of the actuator. The tie rod studs should be long enough to completely release the preload prior to coming off of the tie rods. Prior to completely removing nuts from tie rods, verify that the preload has been removed from the springs—***failure to comply could result in bodily injury***.
10. The top plate should be free to be removed from the assembly. The DCDT will be removed with the top plate.
11. Remove the springs from the actuator.
12. Using a 0.750" (~19+ mm) crowfoot wrench and an extension, remove the core rod of the DCDT from the actuator piston. Be sure not to mix the old DCDT core rod and body with the replacement parts.
13. Using a 1-1/4 inch (~32– mm) wrench, remove the two 1.125-12 jam nuts from the DCDT housing.
14. Remove the DCDT from the top plate.
15. Install the new DCDT housing into the top plate and replace the two jam nuts. Do not tighten the jam nuts yet; the DCDT will need to be adjusted prior to use.
16. Install the new core rod into actuator piston using the 0.750 crowfoot wrench and an extension. Torque to 70–73 lb-in (7.9–8.2 N·m).
17. Install the springs back into the actuator. Be sure that they are seated in the proper location.
18. Carefully replace the top plate and DCDT housing onto the actuator. Be sure that the DCDT housing is placed properly over the core rod.
19. Replace the electrical enclosure bracket onto the two appropriate studs.
20. Install the four 0.500-13 nuts, one onto each stud. Slowly compress the springs into their cavity.
21. Torque the 0.500 nuts to 420–504 lb-in (47–57 N·m).
22. Install four additional 0.500-13 nuts onto the studs and torque to 216-252 lb-in (24–28 N·m).
23. Install the two 0.250-20 socket head cap screws that hold the electrical box to the top mounting plate. The cap screws have nuts and washers.
24. Torque the two cap screws to 58-78 lb-in (6.6–8.8 N·m).
25. Replace the two "eye nuts" onto the two tie rods closest to the electrical box.
26. Replace the protective covers onto the tie rods.
27. Replace the conduit onto the electrical box.
28. Carefully replace the DCDT wires back through the conduit and into the electrical box.
29. Connect the conduit to the DCDT. Do not tighten.
30. Connect the DCDT wires to the connector blocks labeled according to Figure 1-5.
31. Replace the cover to the electrical box.
32. Verify that all hardware has been replaced onto the actuator and that all external fittings are torqued except for the lock nuts on the DCDT and the conduit on the DCDT.
33. Verify the excitation voltage to the DCDT.
34. Supply the actuator with hydraulics at 2320 psig (15 996 kPa).
35. Measure the DCDT output voltage using a high-quality digital voltmeter (select DC measurement mode).

36. With the actuator at minimum position, the output of the DCDT should be (9.50 ± 0.25) V (dc) for the controller. If the readout is not within these specifications, adjust the DCDT in or out of the actuator by screwing the DCDT housing in or out of the top block. ***NOTE—a small rotation of the DCDT will cause a substantial change in the readout.***
37. Once the proper voltage is obtained, carefully torque the bottom nut to 600–900 lb-in (68–102 N·m). Then torque the remaining nut to 300-450 lb-in (34–51 N·m).
38. Torque the conduit onto the DCDT to 450–550 lb-in (51–62 N·m).
39. Use Woodward tool 1008-4446 and an accurate position indicating device as described and shown previously in the rigging procedure to measure the actual stroke.
40. Set the 100 % position demand, measure the actual physical travel position, and adjust the span of the control channel such that the physical travel matches the value on the label inside the electrical enclosure.
41. Verify correct valve positions by commanding the control to 0 % and 100 %, and recheck the physical positions. (The DCDT feedback voltage, measured at the terminals in the electrical enclosure, should be approximately as listed on the label.)

Troubleshooting

Liquid Fuel Valve not functioning correctly when using customer control system.

Perform steps 33 through 37 of the DCDT replacement procedure earlier in this chapter. A troubleshooting tool (Woodward part number 1008-4446) can be installed in place of the visual indicator to assist in mechanically determining valve stroke (verify that the valve is at the minimum position).

1. Remove two socket head cap screws holding the visual indicator onto the valve actuator.
2. Remove the visual indicator.
3. Using the same two cap screws, attach tool 1008-4446 (available from Woodward) to the actuator. Be sure to place the pin of the sliding piece onto the top of the piston within the actuator housing.
4. Using a customer-supplied travel indicator with a total stroke greater than 1.60 inches (40.6 mm) placed on top of the sliding piece of the tool, attach the indicator to the actuator housing. Zero the indicator.
5. Raise the servovalve current to (8.0 ± 0.5) mA. The valve should move to the full up position (open for Throttle Valve, closed for Bypass Control Valve).
6. The maximum travel should match the value recorded within the electrical enclosure. If this value is not the same, contact Woodward for recommendations.
7. If this value matches the recorded value, check the feedback voltage of the DCDT vs the recorded value in the electrical enclosure.
8. If the feedback voltage does not match, verify that the excitation voltage is correct. If the excitation voltage is correct, and the DCDT output voltage does not match the values listed on the calibration sticker, contact Woodward for a replacement DCDT and follow the steps listed within this document for replacement.
9. If the feedback and physical stroke values match the recorded values supplied with the valve, then the control system is not functioning properly. Refer to the control system manufacturer for troubleshooting assistance.

Troubleshooting Charts

Faults in the fuel control or governing system are often associated with speed variations of the prime mover, but such speed variations do not always indicate fuel control or governing system faults. Therefore, when improper speed variations occur, check all components including the engine or turbine for proper operation. Refer to applicable electronic control manuals for assistance in isolating the trouble. The following steps describe troubleshooting for the liquid fuel valves.

Disassembly of the liquid fuel valves in the field is not recommended due to the 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, return actuator to Woodward for service.
	Dynamic O-ring seal missing or deteriorated	Return valve to 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	Return valve to Woodward for service.
External fuel leakage	Piping flange gaskets missing or deteriorated	Replace gaskets.
	Piping flanges improperly aligned	Rework piping as needed to achieve alignment requirements detailed in Chapter 3.
	Piping flange bolts improperly torqued	Rework bolts as needed to achieve torque requirements detailed in Chapter 3.
	Packing missing or deteriorated	Return valve to Woodward for service.
Valve will not open for Throttle Valve or close for Bypass Control Valve (actuator stroke up)	Servovalve command current incorrect. (The sum of the current through the two coils of the servovalve must be greater than the null bias of the servovalve for the valve to operate.)	Trace and verify that all wiring is in accordance with the electrical schematic (Figure 1-5). Pay special attention to the polarity of the wiring to the servovalve and DCDT.
	Servovalve failure	Replace servovalve.
	Hydraulic supply pressure inadequate	Supply pressure for high-pressure version must be greater than 1200 psig/8274 kPa (2320 psig/15 996 kPa preferred).
	Trip relay cartridge valve failure	Replace cartridge valve.
	Trip relay solenoid valve failure	Replace solenoid valve.
	Filter element plugged	Check filter DP indicator. Replace element if the DP indicator shows red.

Symptom	Possible Causes	Remedies
Valve will not close for Throttle Valve or open for Bypass Control Valve (actuator stroke down)	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 valve to operate.)	Trace and verify that all wiring is in accordance with the electrical schematic (Figure 1-5). Pay special attention to the polarity of the wiring to the servovalve and DCDT.
	Servovalve failure	Replace servovalve.
	DCDT failure	Replace DCDT.
	Springs broken	Return valve to Woodward for service.
	Linkage broken	Return valve to 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	Return valve to 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.
Valve flow inaccurate (Bypass Control Valve only)	Regulator spring out of adjustment	Return valve to Woodward for service.
	Regulator spring broken	Return valve to Woodward for service.
	Regulator piston stuck	Return valve to Woodward for service.
	Regulator worn	Return valve to Woodward for service.

Chapter 5.
Product Support and Service Options

Product Support Options

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

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

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

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

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

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

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

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

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

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

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

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in "like-new" condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

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

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

- return authorization number;
- name and location where the control is installed;
- name and phone number of contact person;
- complete Woodward part number(s) and serial number(s);
- description of the problem;
- instructions describing the desired type of repair.

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

Contacting Woodward's Support Organization

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

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

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
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

Products Used in Engine Systems

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

Products Used in Industrial Turbomachinery Systems

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

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 __________

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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 A—

- Updated ANSI Class 900 Bypass Control Valve table (Chapter 1)
- Added ANSI Class 1500 tables (Chapter 1)

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26606A.

B26606:A

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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.