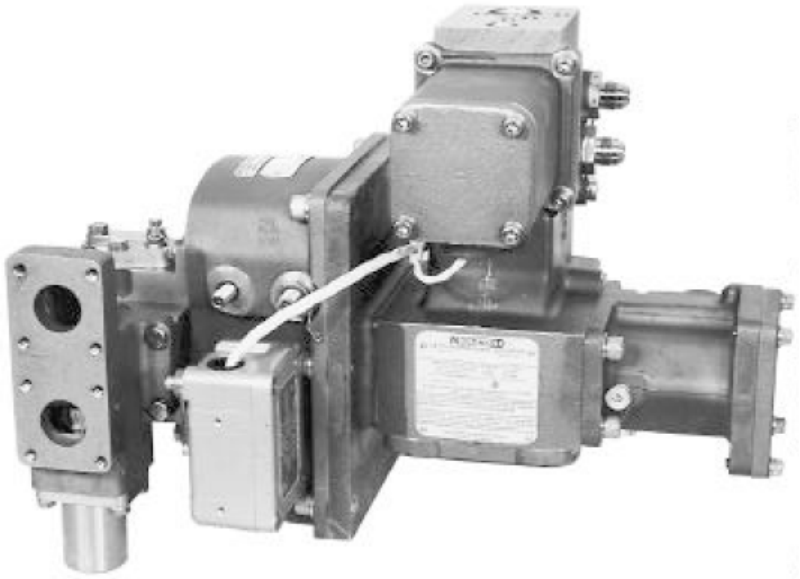
WOODWARD

Product Manual 40132
(Revision D)
Original Instructions



Liquid Fuel Valve and TM-55P Actuator

Installation and Operation Manual

General Precautions

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

Practice all plant and safety instructions and precautions.

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

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, on the *publications page* of the Woodward website:

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Proper Use

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

Translated Publications

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

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26311* , *Revision Status & Distribution Restrictions of Woodward Technical Publications*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

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

Contents

Illustrations and Tables

Warnings and Notices

Important Definitions

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

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

⚠WARNING

Overspeed / Overtemperature / Overpressure

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

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

⚠WARNING

Personal Protective Equipment

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

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

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

⚠WARNING

Start-up

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

⚠WARNING

Automotive Applications

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

NOTICE

Battery Charging Device

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

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

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

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

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

Follow these precautions when working with or near the control.

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

Chapter 1.
General Information

Introduction

This manual describes the liquid fuel valve and interfaced TM-55 proportional actuator.

Liquid Fuel Valve

The liquid fuel valve is a device for metering fuel to the gas turbine. A differential pressure regulator incorporated in the fuel valve maintains a constant pressure drop across the metering port so the fuel flow at a given position of the fuel valve will be unaffected by discharge pressure or inlet flow variations. The fuel valve is available in various flow ranges for different applications. The exact range of each valve is selected to meet the requirements of the installation. The port in the metering valve sleeve is capable of metering fuel from 68 to 11 340 kg/h (150 to 25 000 lb/h).

Fuel Type

The valve is compatible with most types of diesels, kerosenes, gasolines, heavy and light distillates including naphtha, gas turbine fuels and fuel oils, and other liquid fuels such as biodiesel that are compatible with fluorocarbon (FKM) type elastomers and conform to international standards for utility, marine, and aviation gas turbine service. Ultra low sulfur diesels are also acceptable with proper lubricity additives. Other fuels such as ethanol or methanol may be acceptable with internal seal compound substitutions. Contact Woodward for these and other special fuel applications.

Fuel Viscosity

Fuel viscosity must be between 0.5 and 12.0 centistokes.

Fuel Cleanliness

Liquid fuel must be filtered to limit particulate size to 20 µm or smaller. Water content must be limited to 0.1% by volume. Solids, sediment, and particulates must be limited to 1.0 mg per liter of fuel.

TM-55P Actuator

The TM-55 actuator provides the positioning mechanism for the fuel valve. In combination with a Woodward electronic control the actuator can provide exact positioning of the fuel valve for a full range of demands.

The TM-55 has an aluminum case with through hardened stainless steel internal parts.

In operation the electric signal from the control is converted into a hydraulic pressure to cause a mechanical response. An electrical position feed-back transducer may be used to report the exact location of the actuator output shaft and also of the fuel valve.

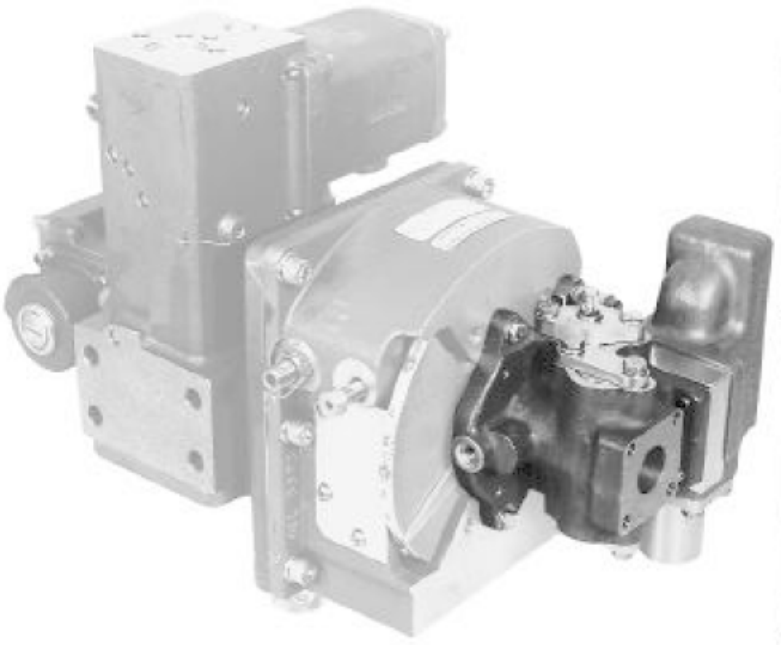

Figure 1-1. Liquid Fuel Valve

The TM-55 actuator is UL Listed for Class I, Division 1, Groups C & D, CENELEC EEx IIb (zone 1 & 2) (pending) requirements, and it is designed for safe operation in hazardous environments.

References

Product Specification 82599, *TM-55 Proportional Actuator*
Manual 82400, *TM-55 Proportional Actuator*
Manual 45002, *1907 Large Liquid Fuel Valve*

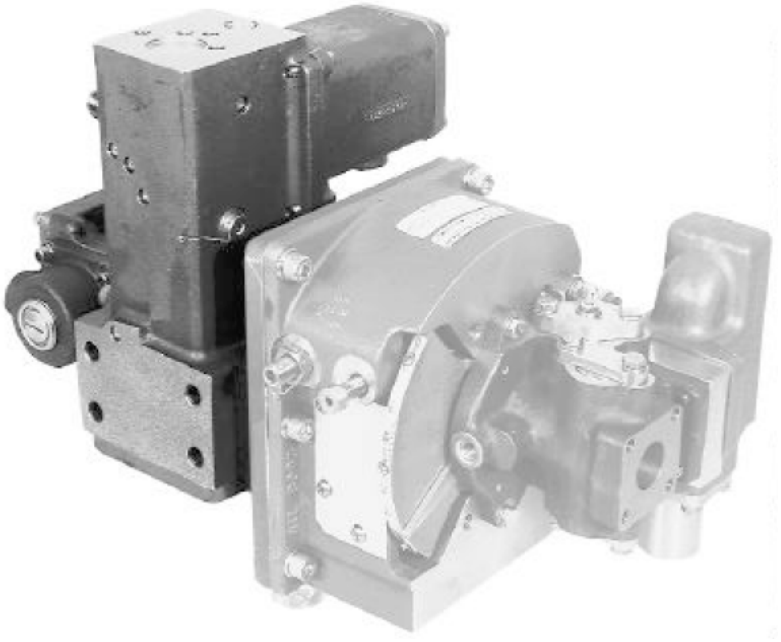

Figure 1-2. TM-55 Actuator

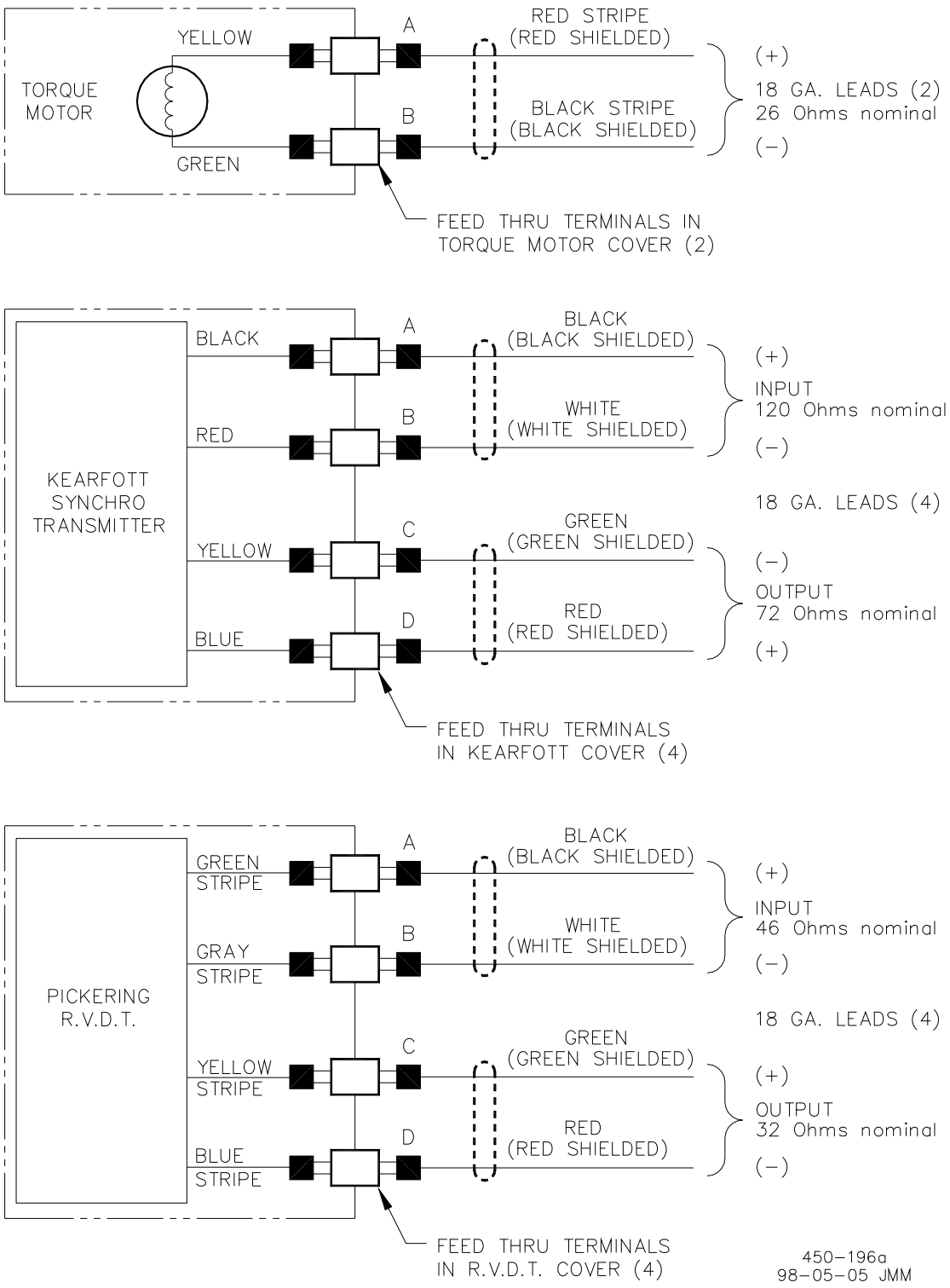

Figure 1-3. Wiring Diagram for TM-55 Actuator

IMPORTANT **On feedback transducers, polarity shown indicates feedback output signal in phase with excitation signal.**

Chapter 2. Installation

Introduction

Use care while handling and installing the valve/actuator. Abuse can damage seals, installation surfaces, and factory adjustments. Hydraulic and fuel connections must be protected by plastic shipping caps or covers whenever the valve/actuator is not connected to the normal service connections. The hydraulic oil inlet fitting in the TM-55 actuator contains a 40 µm (nominal) protective screen and this should not be removed.

⚠WARNING

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.

Receiving

The liquid fuel valve/TM-55 actuator is assembled, calibrated and drained of test fluid at the factory. The assembly is then bolted to a transportation skid and packed in a protective box for delivery to the customer. Additional cleaning or calibration is not necessary prior to installation or operation of the unit.

Storage

The valve/actuator may be stored as received from the factory for a period of time before installation. (See Woodward manual 25075, *Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls*.)

Installation

See the outline drawing, Figure 2-1 for:

- overall dimensions
- installation hole locations
- hydraulic fitting sizes
- adjustment locations
- electrical connections

Installation attitude does not affect actuator or fuel valve performance, but a vertical position is recommended for ease of making electrical, fuel line and hydraulic connections.

Hydraulic Fluid

Make provisions for proper filtration of the hydraulic fluid that will supply the TM-55 actuator. A 10 µm (nominal) metal element filter must be installed in the supply line to the actuator. Hydraulic cleanliness must always be maintained to ISO 4406 20/18/15 or better to ensure proper operation. The absolute rating of the filter should not exceed 30 µm. Keep the immediate area clean and free of dirt and other contaminants.

Make all hydraulic connections that are needed. Supply pressure for the TM-55 actuator can be from either positive displacement or centrifugal type pumps. Woodward recommends the use of a pressure switch to ensure that correct supply pressure is established prior to start-up and continually thereafter.

Make all electrical connections that are required using applicable Woodward electric control manuals. A plant wiring diagram will be supplied upon request. In applications where the Woodward fuel valve and actuator are not being used with a Woodward electric control, electrical input requirements will be supplied.

Specifications

Supply characteristics and requirements of the TM-55 actuator are listed in the following table:

Fluid Types:	Mineral or synthetic based oils, diesel fuels, or kerosenes.
Specific Gravity:	0.6 to 1.0
Recommended Viscosity:	0.6–400 centistokes, 150–200 SSU, ISO 32 Grade
External Filter:	10 µm (nominal)
Hydraulic Cleanliness:	ISO 4406 20/18/15 minimum
Supply Pressure:	2758–8274 kPa (400–1200 psig)
Steady Flow:	1.1 to 1.9 L/min (0.3 to 0.5 US gal/min)
Transient Flow:	9.5 to 10.2 L/min (2.5 to 2.7 US gal/min)

Woodward recommends adequate dither be used on all hydraulic actuators to minimize mA threshold and hysteresis which can result from second stage static friction or hydraulic contamination.

Dither is a low amplitude, relatively high frequency periodic signal that is superimposed on the servovalve input current signal. A typical dither signal generated by a Woodward control is:

- 25 Hz, 0-10 mA (tunable) amplitude
- 25% duty cycle, bipolar, square wave

Adequate dither is defined as that amount which produces no more than 0.013 mm (0.0005 inch) total oscillation in output shaft position.

Null current shifts of up to ±4% of maximum rated current (200 mA) can occur due to variations in the following parameters:

- hydraulic supply and return pressures
- hydraulic fluid temperature
- servovalve and actuator wear

Due to the inherent null shifts and position drift of all hydraulic servovalves and proportional actuators, engine control applications must be designed with these errors in mind.

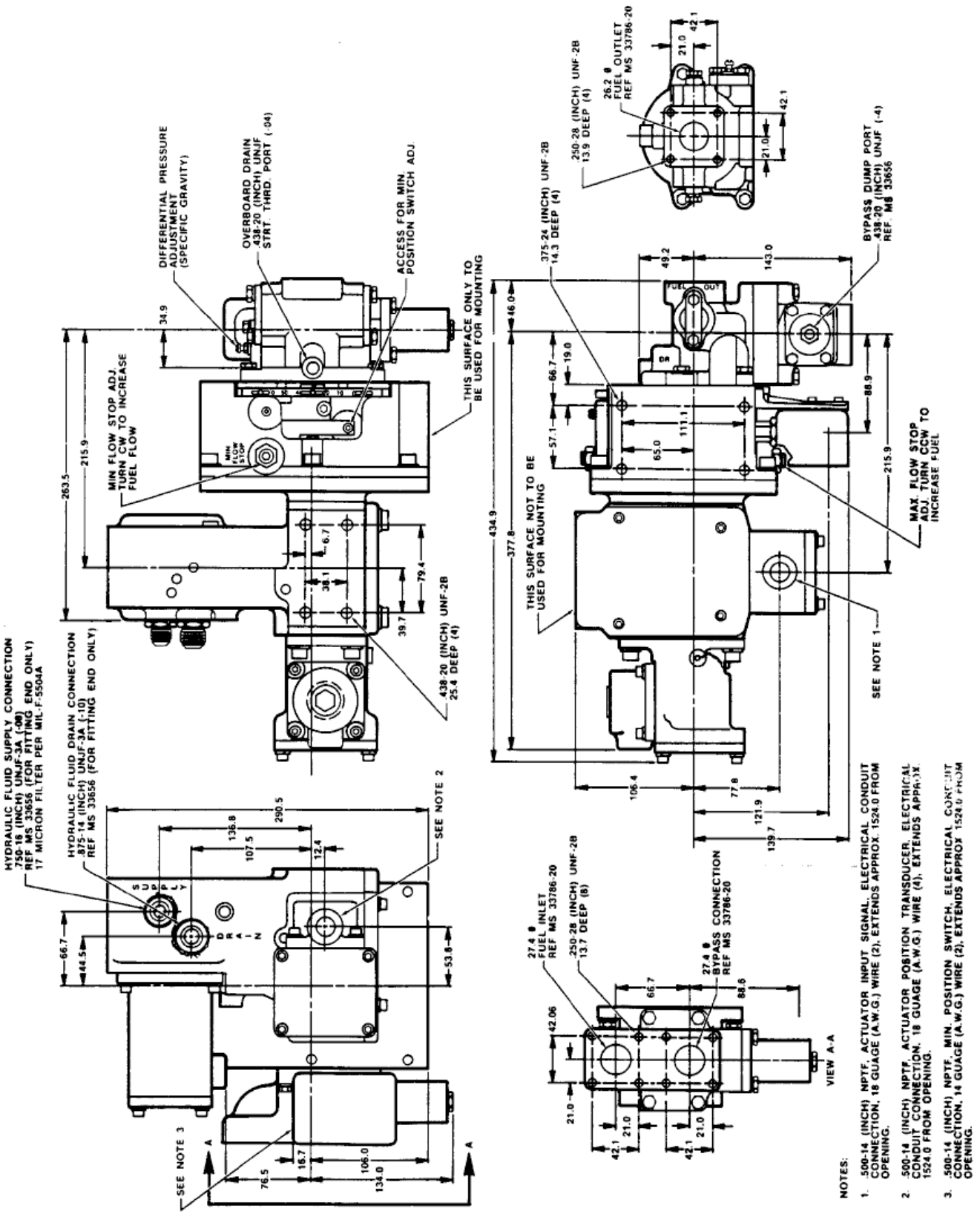

Figure 2-1. Outline of Liquid Valve with Orifice, Relief Valve Assembly, and TM-55 Actuator

Chapter 3.
Operation and Adjustments

Initial Operation

Before initial operation of the valve/actuator, check that all previous installation and hookup steps are successfully accomplished, and that all electrical connections and hydraulic and fuel fittings are secure and properly attached.

Make certain that correct hydraulic supply pressure to the actuator is established before start-up. Consult applicable Woodward manuals for the particular Woodward electric control prior to prime mover operation.

NOTICE

Trapped air within the hydraulic system may cause erratic behavior of the actuator during the first few minutes of initial operation. Trapped air soon dissipates.

⚠WARNING

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.

Adjustment

All operating adjustments are made to the liquid fuel valve/TM-55 proportional actuator during factory calibration according to specifications provided by the customer. The unit should not require further adjustment.

Minimum Flow Stop

The minimum flow stop can be adjusted in the field, should it be necessary. To change the minimum flow:

1. Remove the lock wire.
2. Loosen the jam nut.
3. Turn screw clockwise to increase minimum flow, counterclockwise to decrease minimum flow.

⚠WARNING

Do not adjust the maximum flow setting as an overspeed or runaway could occur with resulting property damage and possible injury or loss of life.

IMPORTANT

Do not attempt adjustment to the actuator unless thoroughly familiar with the proper procedures. The fuel valve cannot be adjusted in the field. Should additional or new calibration be required the unit must be returned to a Woodward facility.

Chapter 4.
Principles of Operation

Liquid Fuel Valve

The liquid fuel valve meters fuel as a function of the angular position of its ported metering sleeve. The metering sleeve is positioned by the rotary output of the TM-55 actuator with which it is interfaced. See Figure 4-1 for a schematic diagram of the liquid fuel valve.

To accurately meter fuel, the valve maintains a constant pressure drop across the fuel metering ports in the metering sleeve. The valve regulates the inlet pressure to maintain this constant pressure differential.

Given the constant pressure differential within the fuel valve the fuel flow through the metering ports is always proportional to the area of the port opening.

Fuel flow through the metering port of the valve is described by the equation: **Fuel flow** = area of port opening x square root of the pressure differential across the valve x a constant which is a combination of fuel specifications and port characteristics.

Under operating conditions, fuel at pump discharge pressure (P1), flows to the metering sleeve, to one side of a bellows, to the bypass valve P3, and to an orifice (O1). Metered fuel at pressure (P2) is directed to the turbine and the opposite side of the bellows.

The bellows takes a position at which the sum of the force from pressure P1 acting on the bellows effective area and the force of spring S1 is equal to the sum of the forces from pressure P2 acting on the bellows' effective area and the force of spring S2. When the balance of forces has been established, the difference between the spring forces (S2-S1) acting on the effective area of the bellows is equal to the difference between the pressures (P1-P2).

By varying the force of spring S1 the pressure difference can be adjusted to suit the requirements of a particular application.

The position of the bellows determines the position of the ball bleed valve. The pressure P4 is regulated to values less than P1 by bleeding the flow from orifice O1 to P2 pressure.

Pressure P4 plus the force of spring S3 closes the bypass valve piston. These are opposed by pressure P1, which opens the bypass valve piston. The bypass valve piston then takes a position at which pressure P1 is equal to the sum of pressure P4 and the force of spring S3 divided by the area of the bypass valve piston. By varying the amount of fuel bypassed, pressure P1 maintained at a constant differential above pressure P2, regardless of variations in pressure P2.

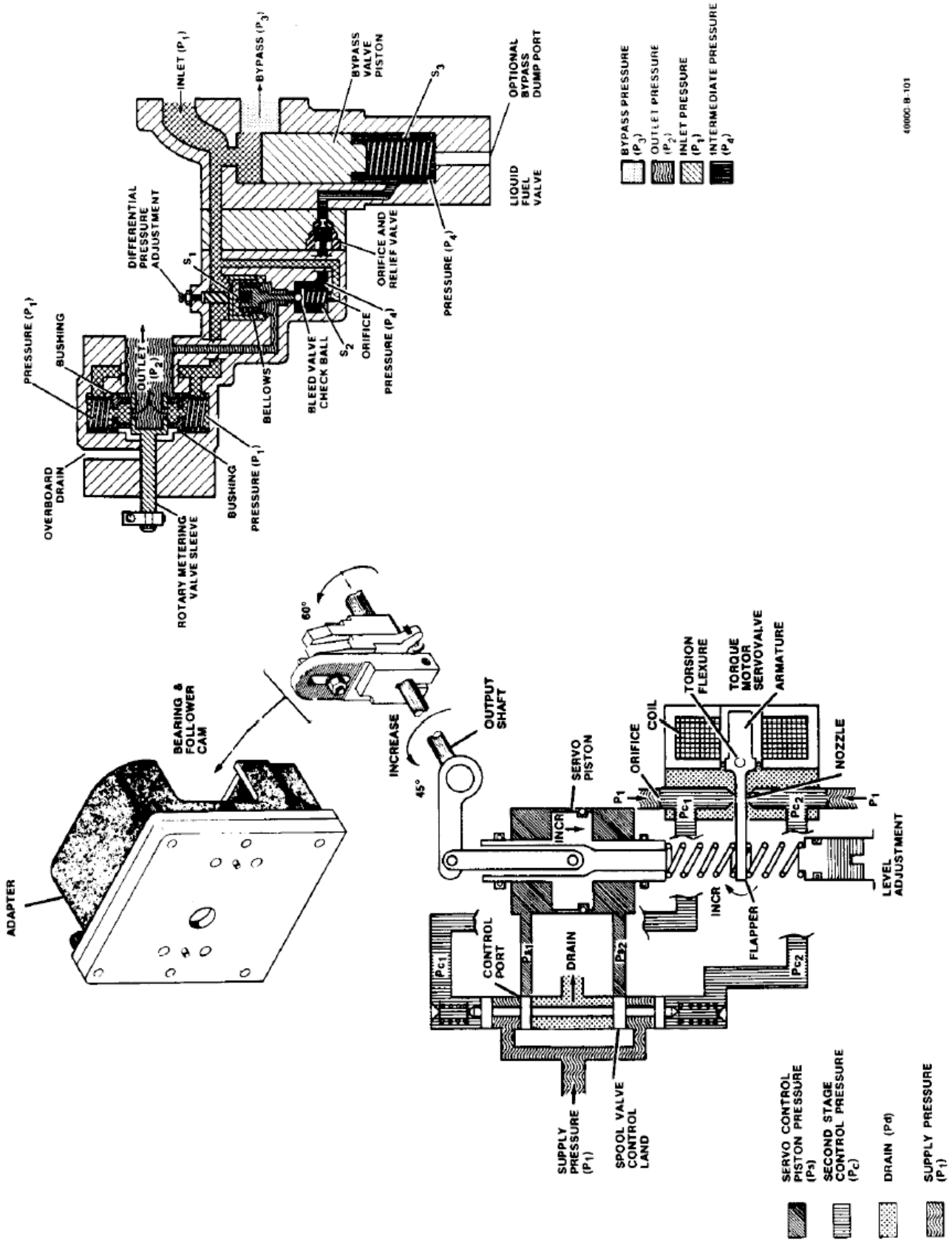

Figure 4-1. Liquid Fuel Valve/TM-55 Actuator Schematic

Opening the metering port to increase fuel flow to the turbine results in an increase in pressure P2. This unbalances the forces across the bellows, increases the force on spring S1 and allows the ball bleed valve to partially close, reducing the rate of fuel flow through the bleed valve. With reduced bleed flow, pressure P4 increases and results in an unbalance of the forces across the bypass valve piston. The piston moves to decrease the bypass flow and direct a greater amount of fuel to the metering port. With more fuel being directed to the metering port, pressure P1 increases until the balance of forces across the bypass valve piston and the bellows is established and further movement of the piston or bellows is stopped.

Closing the metering port to decrease fuel flow to the turbine results in a decrease in pressure P2. The resulting unbalance of forces across the bellows forces the ball bleed valve further off its seat and increases the rate of flow through the orifice. With the resulting decrease in pressure P4, the unbalance in forces across the bypass valve piston causes the piston to move further open and bypass a greater amount of fuel with less fuel directed to the metering port. Pressure P1 then decreases until the balance of forces across the piston and bellows is established and further movement of the piston and bellows is stopped.

The purpose of the orifice in the relief valve in Figure 4-1 is to eliminate bypass valve damping when a sudden increase in bypass flow is needed. The damping is needed for pressure differential stability in normal operation, and when change in stability in normal operation, and when change in inlet or metered outlet flows are relatively small. Damping is provided by an orifice restriction between the ball bleed valve and the bypass valve piston. When large decreases in metered outlet flow occur rapidly it is essential that the bypass valve open immediately to prevent a transient rise in valve inlet pressure. If the pressure drop across this restriction exceeds 345 kPa (50 psi) when the bypass valve is moving in the open direction, the check valve opens to bypass flow around the damping restrictor. This allows the bypass valve to open rapidly, and prevents a high pressure transient which could damage the bellows.

TM-55 Proportional Actuator

A schematic drawing, Figure 4-1 illustrates the working relationships of the various parts of the actuator.

The TM-55 proportional actuator consists of three basic sections:

- A torque motor servo valve
- A spring centered, four-land, spool valve
- A double-sided, equal area, servo piston linked to the rotary output shaft

The basic element of the TM-55 is the torque motor servo valve which uses a double nozzle and flapper to generate a differential pressure to operate the second stage spool valve. The torque motor receives dc current signals from the electric control and applies torque to the single piece armature and flapper which is supported on a torsional flexure. The servo valve flapper acts as a variable flow restrictor that throttles the flow of hydraulic fluid from nozzles on each side of the flapper. The two nozzles are supplied hydraulic fluid from a remote high pressure oil supply via separate, fixed orifices. During steady state operation, the flapper is centered between the nozzles and the two pressures, Pc1 and Pc2, are approximately equal.

Current to the torque motor causes the flapper to move from its normal centered position, restricting hydraulic flow from one nozzle and opening flow from the other nozzle. The resulting differential pressure is applied to the end of the spool valve, moving it from the spring centered, null position.

Moved from its centered position, the spool valve directs supply pressure to one side of the servo piston and simultaneously vents the other side, causing a corresponding movement of the output shaft.

The electrical position transducer provides a voltage signal proportional to the position of the terminal shaft.

Adapter Assembly

The TM-55 proportional actuator provides 45 degrees of terminal shaft movement and the fuel valve input shaft allows 60 degrees of rotation to provide accurate metering over the required flow range.

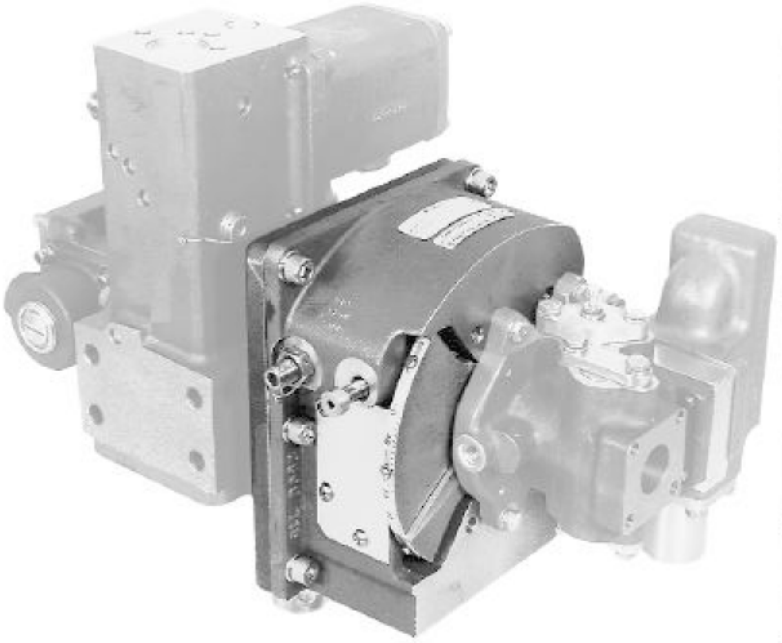

Figure 4-2. Fuel Valve Adapter

This ratio is compensated for within the adapter (Figure 4-2) which connects the two assemblies. A combination of levers in the assembly changes the 45 degrees of actuator output to 60 degrees of fuel valve shaft rotation. This assembly is set up at the factory and because the adjustment of the linkage is critical to accurate fuel-flow scheduling the fuel valve and actuator should not be separated except under test stand conditions.

Also located in the adapter assembly are the minimum and maximum fuel stops, a visual position indicator scale and the minimum position indicator switch.

The four 0.375-24 tapped holes in the assembly provide the best mounting location for the fuel valve/actuator.

Optional Bypass Dump Port Feature

The 1907 large liquid valve is a pressure compensated flow control valve that is intended for use on positive displacement fuel forwarding systems only. The optional bypass dump port allows the 1907 valve to be used with both two-way and three-way engine fuel shut-off valves (SOV). If the 1907 fuel valve is used with a two-way SOV, when the SOV is closed the positive displacement fuel pump could be "dead headed". This could damage the fuel pump, piping, the 1907 fuel valve.

A typical fuel system that uses a three-way SOV is shown in Figure 4-3. In this system when the SOV is actuated to the shut-down position, all of the fuel is bypassed through the SOV back to the tank or to back to the fuel pump.

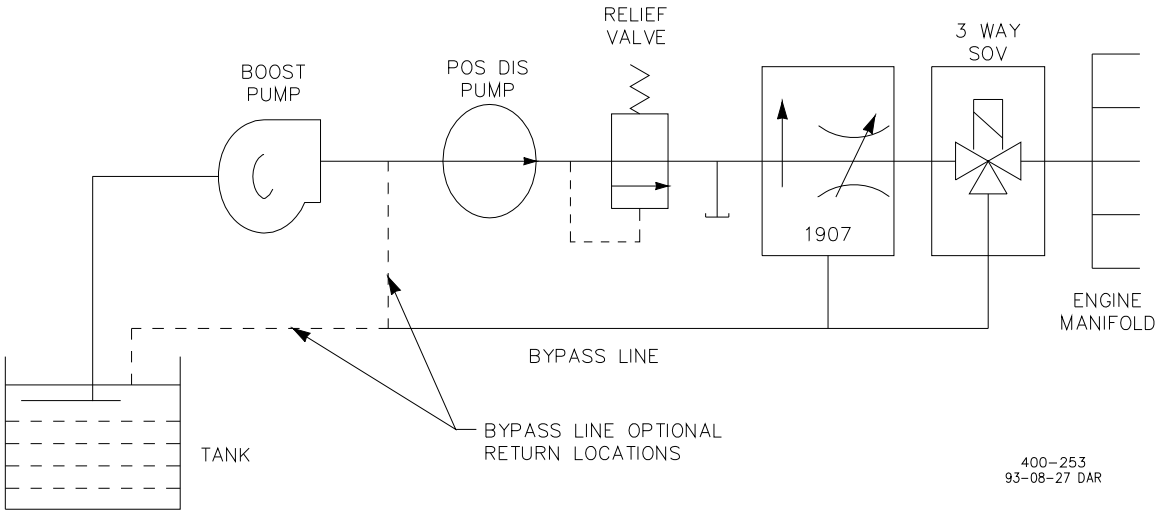

Figure 4-3. 3-Way SOV Fuel System Schematic

Figure 4-4 shows a system that uses a two-way engine fuel SOV. In this system, a normally open SOV is interlocked with a normally closed valve mounted on the optional bypass dump port on the 1907 large liquid valve. When the SOV is closed, the bypass dump valve is opened. The control pressure under the bypass piston is vented back to the tank and the bypass piston moves to its full bypass position. Thus, the bypass dump in combination with a two-way SOV mimics the function of a three-way SOV.

It is important that the valve used to vent the control pressure under the bypass piston be large enough to handle all of the flow with a minimum pressure drop. Residual pressure under the bypass piston will raise the system pressure during a shut-down. See Figure 4-5 to determine the amount of flow the bypass dump valve must pass for a given valve inlet pressure. The valve used for the bypass dump must also be situated a closely as possible to the 1907 valve and no air must get into the line between the bypass dump valve and the 1907 bypass dump port. This assures that the valve bypass will be active and in control as quickly as possible after the bypass dump valve closes.

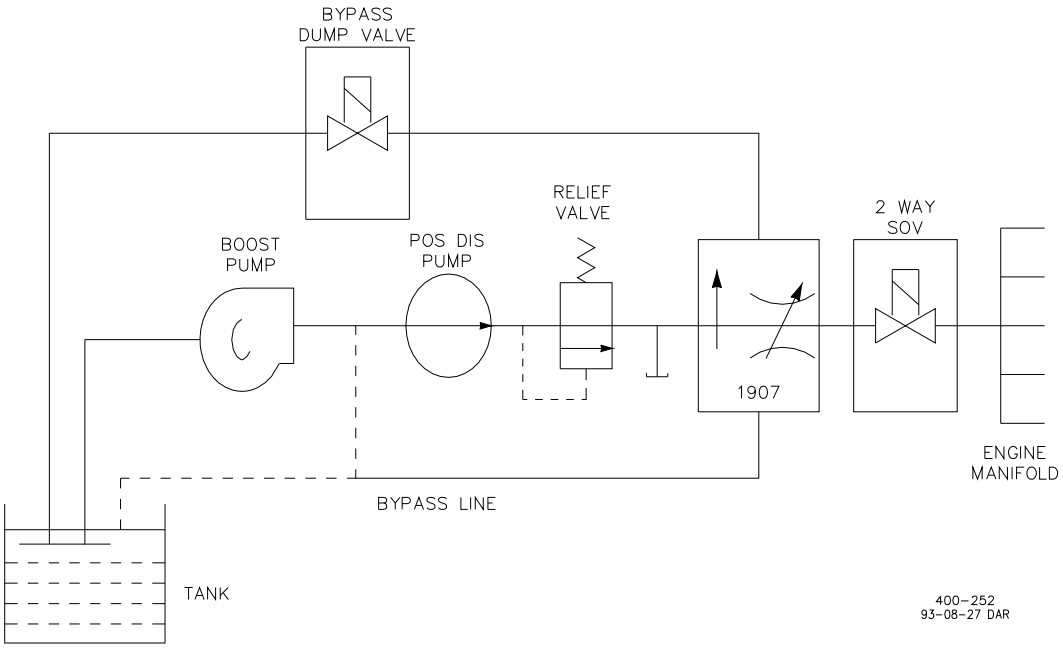

Figure 4-4. 2-Way SOV with Bypass Dump Fuel Schematic

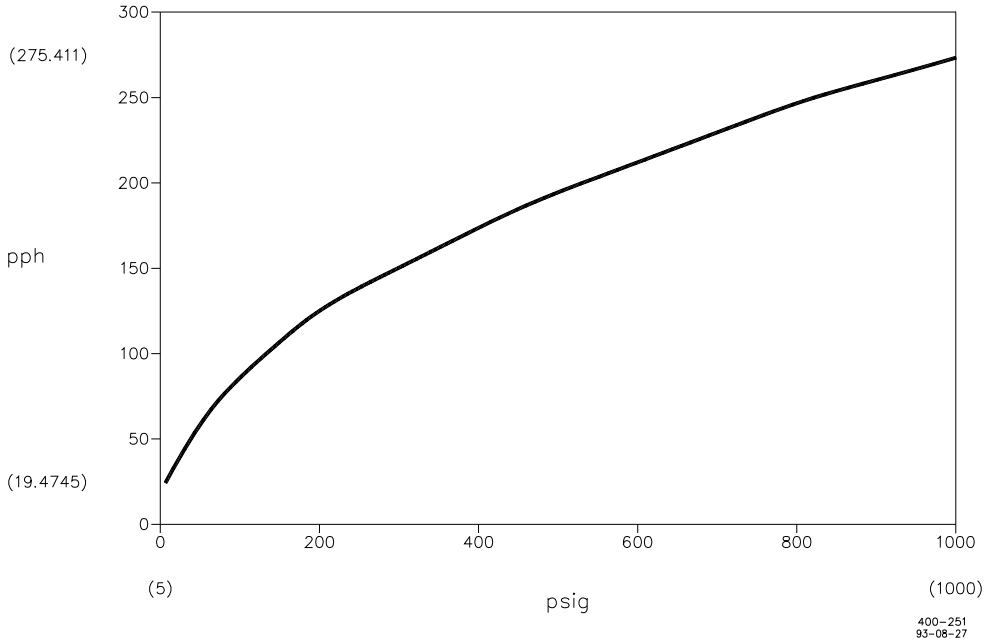

Figure 4-5. Bypass Dump Flow as a Function of Valve Inlet Pressure

Chapter 5. Maintenance

General

Woodward recommends a yearly visual inspection of the bypass housing and bypass sleeve in the area where cavitation is expected due to high differential fuel pressure. Cavitation will be more pronounced on valves that are operated in high pressure applications or are in continuous service. Remove the customer fuel piping from the ”Bypass” flange on the valve and visually inspect the bypass sleeve and internal surfaces of the bypass housing for cavitation and erosion wear. If significant wear is observed, replacement parts can be procured from Woodward.

Filter Cleaning

The TM-55 proportional actuator is equipped with a 40 µm protective filter fitting at the supply inlet. See outline drawing Figure 2-1 for the supply inlet location. Should the filter become clogged, as evidenced by sluggish response, it may be cleaned ultrasonically and back flushed with a light solvent. Be prepared to replace the o-ring (part no. 24, Figure 6-1) after cleaning the filter (part no. 25, Figure 6-1).

The actuator should not be removed from the fuel valve since the liquid flow calibration of the system may be changed if the interfacing adapter is disturbed. (Figure 5-1).

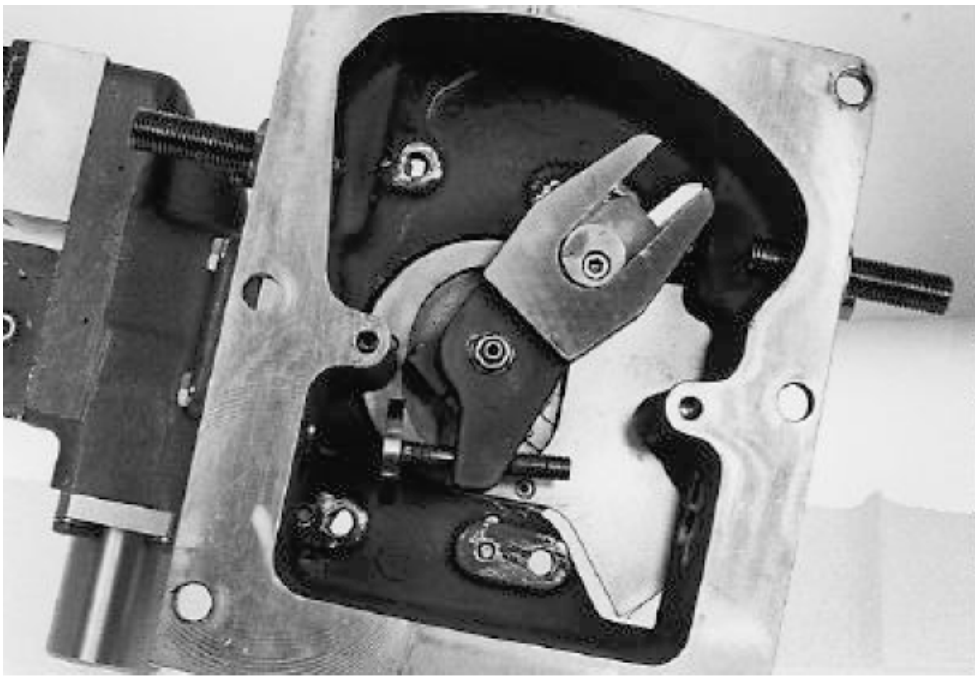

Figure 5-1. Interior of 45/60 Degree Adapter

NOTICE

Do not run the actuator with the inlet filter fitting or the in-line filter removed or bypassed as extensive repairs can be made necessary by only momentary exposure of the interior of the torque motor to contaminants.

Troubleshooting

Faults in the governing system are usually revealed as speed variations of the prime mover, but it does not necessarily follow that such speed variations indicate control system faults. When improper speed variations appear check all components for proper operation and the fuel supply for proper pressure. Refer to applicable Woodward control manuals for assistance in isolating the trouble. If the actuator does not respond to electric control input during the starting sequence check the actuator pressure supply and supply filters.

Disassembly of the TM-55 actuator or the liquid fuel valve in the field is not recommended. Under unusual circumstances, where disassembly becomes necessary, all work and adjustments should be made only 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 liquid valve/actuator in your communication.

Chapter 6.
Replacement Parts

When ordering replacement parts, it is essential to include the following information:

- Serial number and part number shown on the nameplate of the actuator
- Manual number (this is manual 40132)
- Part reference number in parts list and name and description of part

Figure 6-1 illustrates the replacement parts for the TM-55 Proportional Actuator. The numbers assigned are used as reference numbers, and are not specific Woodward part numbers.

IMPORTANT **The liquid fuel valve should not be repaired in the field, so a parts list is not provided.**

Ref. No.	Part Name	Quantity
40132- 1	Screw - 0.375-24 x 1.5004	4
40132- 2	Washer - 0.375 Lockwasher	8
40132- 3	Mounting plate assembly	1
40132- 4	Preformed packing 1.174 ID x 0.103	2
40132- 5	Step seal 0.812 ID	1
40132- 6	Preformed packing 0.924 ID x 0.103	1
40132- 7	Plug - TM-55 shaft seal	1
40132- 8	Bearing assembly	1
40132- 9	Output shaft	1
40132-10	O-ring, furnished with torque motor assy	
40132-11	O-ring, furnished with torque motor assy	
40132-12	Plug - 0.438-20	4
40132-13	Preformed packing 0.351 ID x 0.072	4
40132-14	Feedback spring	1
40132-15	Level spring	1
40132-16	Packing 0.299 ID x 0.103	1
40132-17	Trim spring seat assembly	1
40132-18	Plug	1
40132-19	Pilot valve bushing	1
40132-20	Preformed packing	6
40132-21	Expansion plug	1
40132-22	Spring support assembly	2
40132-23	Preformed packing 0.737 ID x 0.103	1
40132-24	Plunger spring assembly	2
40132-25	Retainer assembly	1
40132-26	Pilot valve plunger	1
40132-27	Preformed packing 0.644 ID x 0.087	1
40132-28	Filter fitting 0.750- 16 x 0.500	1
40132-29	Rate limiting orifice	1
40132-30	Preformed packing 0.755 ID x 0.097	1
40132-31	Connector assy 0.500 tube x 0.875- 14	1
40132-32	Washer - 0.250 lockwasher	29
40132-33	Screw - 0.250-28 x 1.000	27
40132-34	Seal retainer plug	1
40132-35	Preformed packing 0.676 ID x 0.070	3
40132-36	Step seal - 0.625 ID	3
40132-37	Laminated shim	2
40132-38	Laminated shim	2
40132-39	Bearing assembly	1
40132-40	Cover	1
40132-41	Preformed packing 4.489 ID x 0.750	1
40132-42	Screw - 0.250-28 x 0.750	2
40132-43	Retaining ring 0.225 dia.	1
40132-44	Washer	1
40132-45	Inner race	2
40132-46	Headed pin	1
40132-47	Servo cover	1
40132-48	Preformed packing	1
40132-49	Bowed retaining ring	1
40132-50	Piston rod guide tube	1
40132-51	Servo link assembly	1
40132-52	Preformed packing 0.989 ID x 0.070	1
40132-53	Pin - 0.375 OD x 1.062	1
40132-54	Piston - TM-55 servo	1
40132-55	Packing - preformed 1.051 ID x 0.070	1
40132-56	Seal - 1.250 OD glyd ring	1
40132-57	Sleeve - TM-55 servo	1
40132-58	Packing - preformed 1.362 ID x 0.103	1
40132-59	Seal - 1.688 OD glyd ring	1
40132-60	Nameplate	1
40132-61	Screw - #2 x 0.125 drive	4
40132-62	Body assembly - TM-55	1
40132-63	Servovalve assembly - torque motor	1
40132-64	Housing assembly - torque motor	1
40132-65	Cover - torque motor terminal	1
40132-66	Screw - 6-32 x 0.250 slotted fillister head	1
40132-67	Washer - #6 splitlock	1
	(Dual Coil Model	2)
40132-68	Clamp – wire	1
	(Dual Coil Model	2)
40132-69	Cover - Kearfott housing	1
40132-70	Packing - preformed 2.114 ID x 0.070	1
40132-71	Transmitter - linear syn	1
40132-72	Screw - #4-40 cleat	3
40132-73	Coupling - bellows	1
40132-74	Packing - preformed 0.424 ID x 0.103	1
40132-75	Seal - 0.312 ID	1
40132-76	Washer - 0.320 x 0.689 x 0.120 thick	1
40132-77	Housing assembly - Kearfott	1
40132-78	Anchor - nylon tie clamp - wire	1
	(Dual Coil Model	2)
40132-79	Washer - #6 splitlock	2
40132-80	Screw - #6-32 x 0.250 locking phillips pan head, stainless steel	1
	(Dual Coil Model	2)
40132-81	Plug - close up 1.000 - 11 1/2 NPT	1
40132-82	Cover - TM-55 conduit	1
40132-83	Lever assembly	1

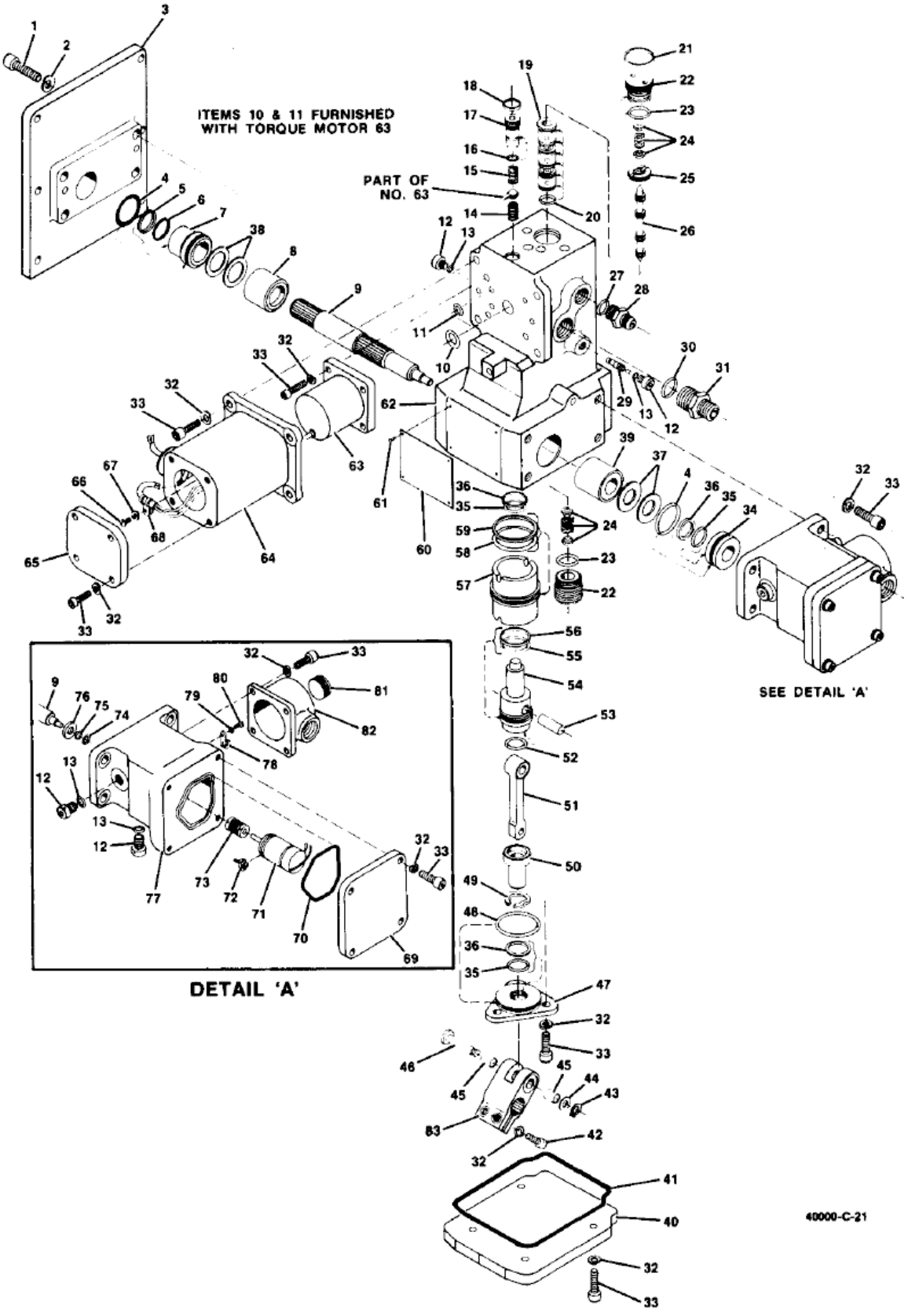

Figure 6-1. TM-55 Proportional Actuator Parts

Chapter 7.
Service Options

Product Service Options

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

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

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

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

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

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

www.woodward.com/directory

Woodward Factory Servicing Options

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

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

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

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

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

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

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

Returning Equipment for Repair

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

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

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

Packing a Control

Use the following materials when returning a complete control:

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

NOTICE

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

Replacement Parts

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

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

Engineering Services

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

- Technical Support
- Product Training
- Field Service

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

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

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

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

How to Contact Woodward

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

Electrical Power Systems

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

Engine Systems

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

Turbine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (129) 4097100
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

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

www.woodward.com/directory

Technical Assistance

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

Your Name	
Site Location	
Phone Number	
Fax Number	
Engine/Turbine Model Number	
Manufacturer	
Number of Cylinders (if applicable)	
Type of Fuel (gas, gaseous, steam, etc)	
Rating	
Application	
Control/Governor #1	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #2	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	
Control/Governor #3	
Woodward Part Number & Rev. Letter	
Control Description or Governor Type	
Serial Number	

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 40132D.

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

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

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