WOODWARD

Product Manual 03110
(Revision NEW)
Original Instructions

3161 Governor

Solid Piston Air Pressure Fuel Limiter

Operation Manual

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

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.

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.

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the *publications page* on the Woodward website:

www.woodward.com/publications

The current revision and distribution restriction of all publications are shown in manual *26311*.

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.

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.

NOTICE

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.

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*.

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Chapter 1.
General Information

Introduction

This manual describes the operation, repair, and calibration of the Solid Piston Air Pressure Fuel Limiter that is available for the 3161 governor. This device is installed and calibrated at the factory.

Description

The Solid Piston Air Pressure Fuel Limiter limits fuel in proportion to air pressure from the air manifold or air box. The device improves performance of a turbocharged engine.

In operation, the limiter uses the limit/shutdown pilot-valve plunger to allow the governor output (fuel setting) to increase only with a corresponding increase in turbocharger air pressure.

⚠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.

References

03101	3161 Governor
03102	3161 Governor product specification
03103	3161 Governor, Manual Shutdown Device
03104	3161 Governor, Pressure Shutdown Device
03105	3161 Governor, Electric Shutdown Device
03106	3161 Governor, Pneumatic Speed Setting Device
03107	3161 Governor, Speed Adjusting Motor with Manual Speed Adjust
03108	3161 Governor, Air Pressure Fuel Limiter
03109	3161 Governor, Load Limit Control
25075	Commercial Preservation Packaging for Storage of Mechanical-Hydraulic Controls

Chapter 2.
Principles of Operation

Operation

The Solid Piston Air Pressure Fuel Limiter is factory adjusted to provide an output shaft position limit while the turbocharger boost pressure is below a certain level, usually about 103 kPa (15 psi). As pressure in the air manifold builds, the limiter raises the output shaft position limit until it reaches a maximum position limit.

The limiter curve will resemble that shown in Figure 2-1. The slope and the lower and upper limits are set during factory testing of the governor. Field changes are nearly impossible to accomplish. The sealed covers to the adjustments should never be removed unless the governor will be adjusted on a test stand.

Notice in Figure 2-1 that the fuel position is limited at a constant position until the air pressure increases above 7 kPa (1 psi). This position is normally 19 or 20 degrees, depending upon the application. The position is adequate to provide starting fuel if the linkage and rack are correctly set up. The adjustment for this position is the Level Adjustment, located beneath the lock-wired plug on the cover.

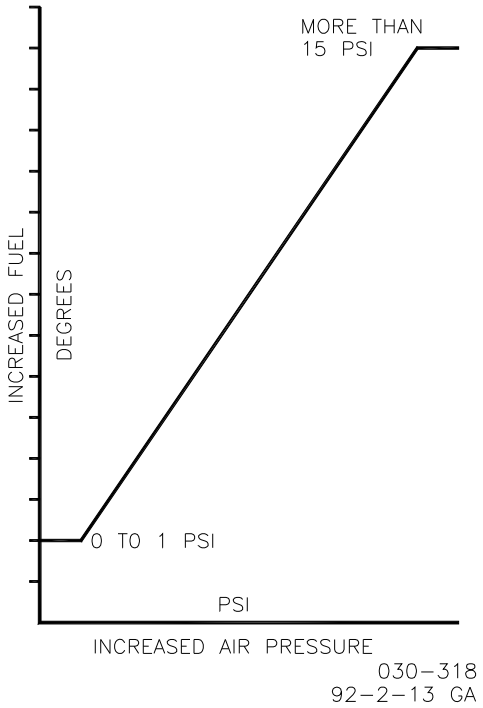

Figure 2-1. Limiter Slope

The position of the limiter is always a maximum allowable shaft position with respect to the air manifold pressure. Output errors at less than the limited position indicate possible problems in other parts of the governor, the linkage, or the engine.

As air pressure in the air manifold builds, the piston in the limiter cylinder rises, allowing the fuel-limit lever to rise and increase the maximum allowed position of the output shaft.

The limit slope is a linear function of air pressure. The slope of the limiter function is determined by a combination of the position of the range adjustment and the spring rate of the limiter spring. The range adjustment provides a fine adjustment of the slope.

The upper end of the limiter curve is horizontal, providing a maximum output position, usually about 31 degrees. This maximum position is usually reached with air pressure of more than 103 kPa (15 psi). The maximum position is set by adjusting the high pressure stop with a small Allen wrench (screw 4 in the exploded view). The adjustment is reached through a hole in the 0.250-inch Allen socket (6) of the preload adjustment. Both of the adjustments are located beneath a factory installed permanent seal which must be destroyed for access.

IMPORTANT

The proper slope and minimum and maximum limiter positions are included in test specifications specifically designed for the engine designation and application. These specifications are available from Woodward by supplying the governor designation and serial number.

Within the governor, the limit/shutdown pilot valve controls the availability of pressure oil to the speed-setting pilot valve which controls the position of the power piston. The limit floating lever links the output shaft to the limit/shutdown pilot-valve plunger with the pivot point determined by the limiter linkage rod.

This linkage allows the governor to function unimpeded, as long as the governor Is not attempting to call for more fuel than the limiter schedule allows.

Control Functions

Turbo air pressure is a function of exhaust flow. Since the limiter works on air pressure, allowing more fuel with increased pressure, the control provides a maximum fuel schedule in accordance with the availability of air to the combustion chamber. This helps to prevent smoke from the exhaust and improves fuel efficiency.

Pressure Sensor

The limiter assembly balances the turbo air pressure against a spring. The air pressure is applied against a rolling diaphragm at the bottom of the limiter assembly. This attempts to push up on the piston, compressing the limiter spring. The position of the piston sets the position of the limit lever, which determines the location of the pivot pin on the limit floating lever.

The floating lever connects between the output shaft and the limit pilot-valve plunger. Limiting occurs if the output shaft rotates enough to make contact with the limit floating lever. At this point, any additional increase in output-shaft rotation causes the limit floating lever to pivot and press down on the limit/shutdown pilot-valve plunger. In turn, this limits the pressure oil to the power piston, which rotates the output shaft. Because the floating lever is connected to both the limit/shutdown rod and the output shaft, the movement of the pivot point provides a constant ratio between turbo air pressure and the fuel setting.

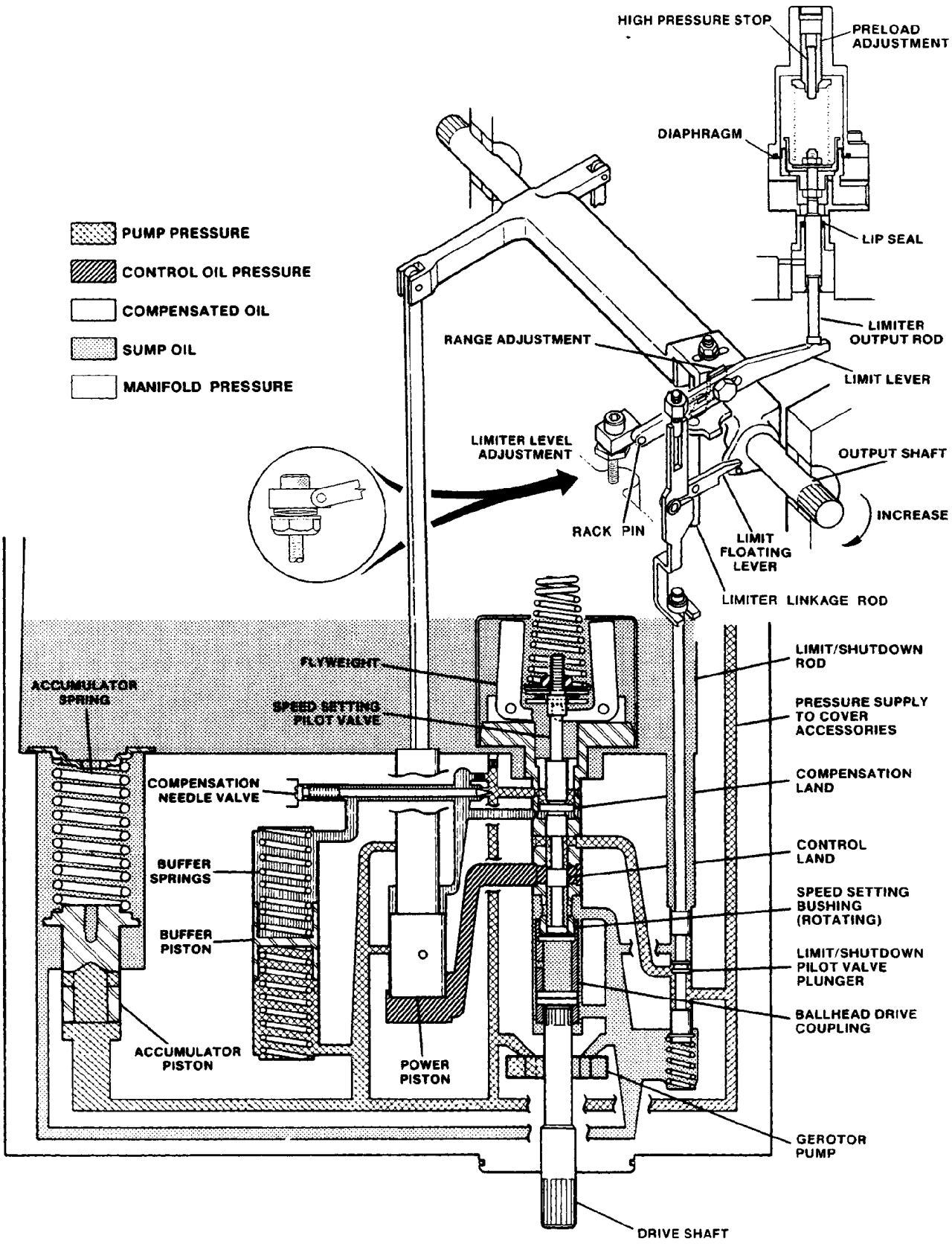

Figure 2-2. Schematic of Solid Piston Fuel Limiter Operation

Chapter 3. Troubleshooting

Use the following Troubleshooting guide to troubleshoot the Solid Piston Air Pressure Fuel Limiter.

IMPORTANT **If the fuel limiter is disassembled and repaired, it will require calibration on a test stand before being returned to service on the prime mover. Do not attempt adjustment or repair unless test stand calibration is available.**

Symptom	Possible Cause	Corrective Action
Engine will not start, Rack does not open far enough to provide starting fuel.	Cranking speed too low to provide governor output. Governor oil pressure insufficient to move governor output.	Increase cranking speed. Check that governor pump direction is correct. Cheek governor oil level. Check that governor drive is correctly installed. Check that linkage is not bound or frozen.
	Fuel limiter Level Adjustment incorrectly set.	Level adjustment should allow starting fuel with 0 air pressure. Do not attempt to change the adjustment unless test stand calibration is available.
	Shutdown devices activated or incorrectly adjusted.	Correct setting of any shutdown devices.
Excessive smoke on start or excessive speed immediately after start.	Governor allows too much fuel during cranking.	Fuel limiter level set too high. Adjustment should only be changed when a test stand is available for calibration.
Engine is slow to accelerate.	Inadequate manifold pressure, restricted air lines from air box to governor, or leaky air lines to governor.	Correct deficiency in turbocharger system, Check that the same air pressure is at the governor and at the air box.
	Fuel limiter preload or level setting is set too high.	Adjust level to factory specification. (Adjustment should only be made on a test stand.)
	Fuel limiter diaphragm is damaged.	Remove turbo-boost line from fuel limiter and perform a leak-down test on the fuel limiter. Maximum rate is 14 kPa (2 psi)/minute.

Chapter 4.
Replacement Parts

When ordering replacement parts, include the following information:
1. Manual number (this is manual 03110).
2. Governor serial number and part number shown on the nameplate.
3. Part reference number and part name from parts list.

Ref. No.	Part Name	Quantity
03110-1	Screw, .250-20 x 1.250 inch	3
03110-2	Washer, .250 ID	3
03110-3	Tapered Plug	1
03110-4	Screw, 10-32 x 1.250 inch, socket hd set	1
03110-5	Cover Assembly, 3161 Fuel Limiter	1
03110-6	Screw Assembly, Fuel Limiter	1
03110-7	Upper Spring Seas	1
03110-8	Spring	1
03110-9	Nut, .250-28 Special	1
03110-10	Washer, .250 ID	1
03110-11	Nitrile Thread Seal	1
03110-12	Fuel Limiter Piston	1
03110-13	Fuel Limiter Diaphragm	1
03110-14	Spacer, 3161 Fuel Limiter, Inner	1
03110-14a	Nut, .250-28 Hex, thin	1
03110-15	End, Bellofram Clamp Screw	1
03110-16	Diaphragm Clamp Screw Assembly	1
03110-17	Limiter Rod Contact Assembly	1
03110-18	Retainer Seal	1
03110-19	O-Ring, .864 ID	1
03110-20	U-Type Seal	1
03110-21	Seal Retaining Bushing	1
03110-22	Governor Cover	1
03110-23	Gasket	2
03110-24	Orifice Plate	1
03110-25	Cover	1
03110-26	Gasket	1
03110-27	Spacer, Limiter Bellofram	1
03110-28	.250-20 x 1.0	1
03110-29	.250-20 x 1.0	6
03110-30	Limiter Assembly (Includes parts 9 through 17)	1

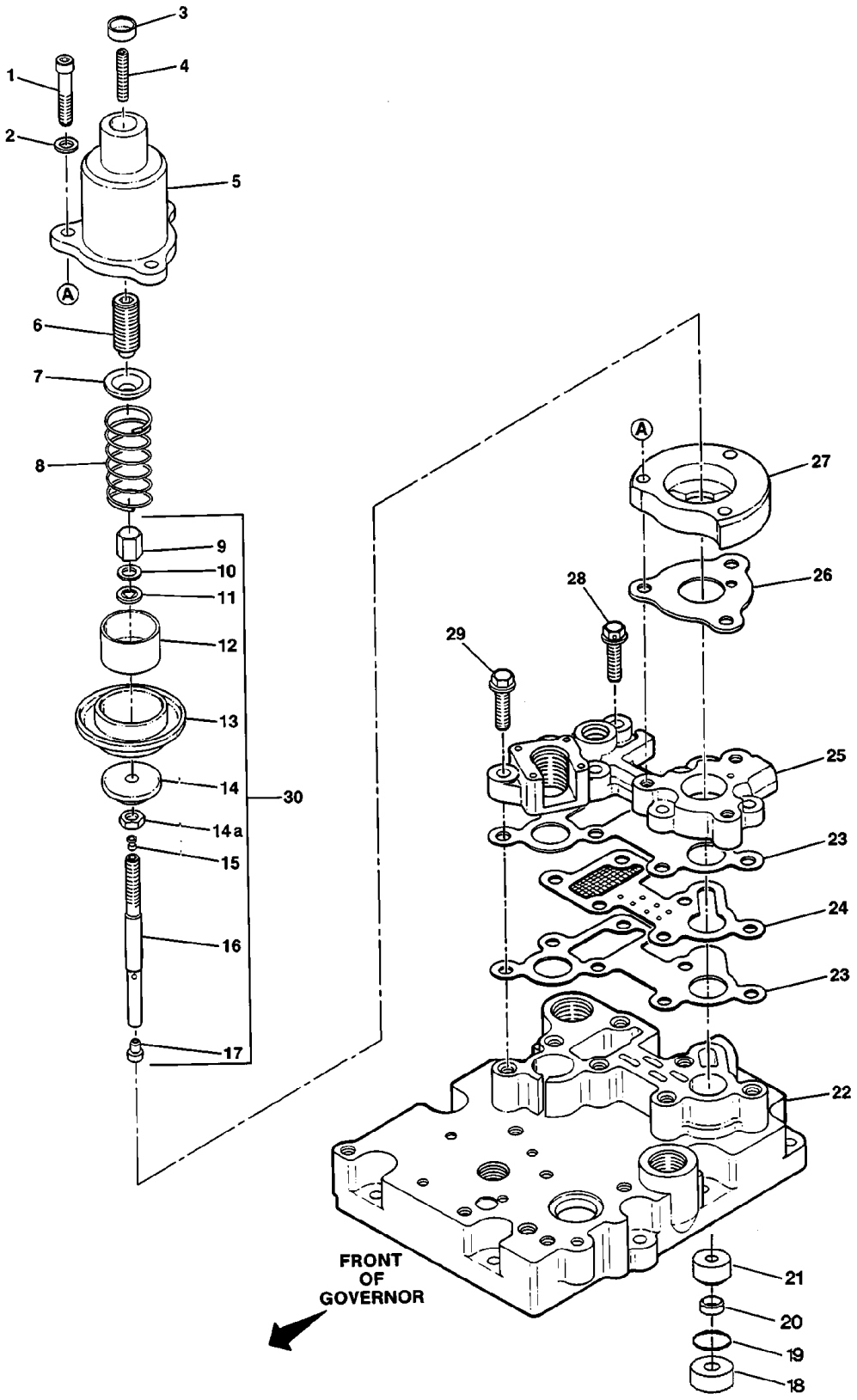

Figure 4-1. Exploded View of 3161 Solid Piston Air Pressure Fuel Limiter

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:

1. Consult the troubleshooting guide in the manual.
2. Contact the **OE Manufacturer or Packager** of your system.
3. Contact the **Woodward Business Partner** serving your area.
4. Contact Woodward technical assistance via email (**EngineHelpDesk@Woodward.com**) with detailed information on the product, application, and symptoms. Your email will be forwarded to an appropriate expert on the product and application to respond by telephone or return email.
5. If the issue cannot be resolved, you can select a further 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 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 current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

Depending on the type of product, the following options for servicing Woodward products may be available through your local Full-Service Distributor or the OEM or Packager of the equipment system.

- 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 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.

Flat Rate Repair: Flat Rate Repair is available for many of the standard mechanical products and some of the electronic 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.

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. 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 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's Full-Service Distributors offer various Engineering Services for our products. For these services, you can contact the Distributor by telephone or by email.

- 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.

Product Training is available as standard classes at many Distributor locations. Customized classes are also available, which can be tailored to your needs and held at one of our Distributor 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 one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact one of the Full-Service Distributors listed at **www.woodward.com/directory**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory published at **www.woodward.com/directory**.

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

For the most current product support and contact information, please visit our website directory at **www.woodward.com/directory**.

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 _____

Engine Model Number _____

Number of Cylinders _____

Type of Fuel (gas, gaseous, diesel, dual-fuel, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.) _____

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number _____

Symptoms

Description _____

_____

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

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 03110.

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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.

2012/9/Colorado