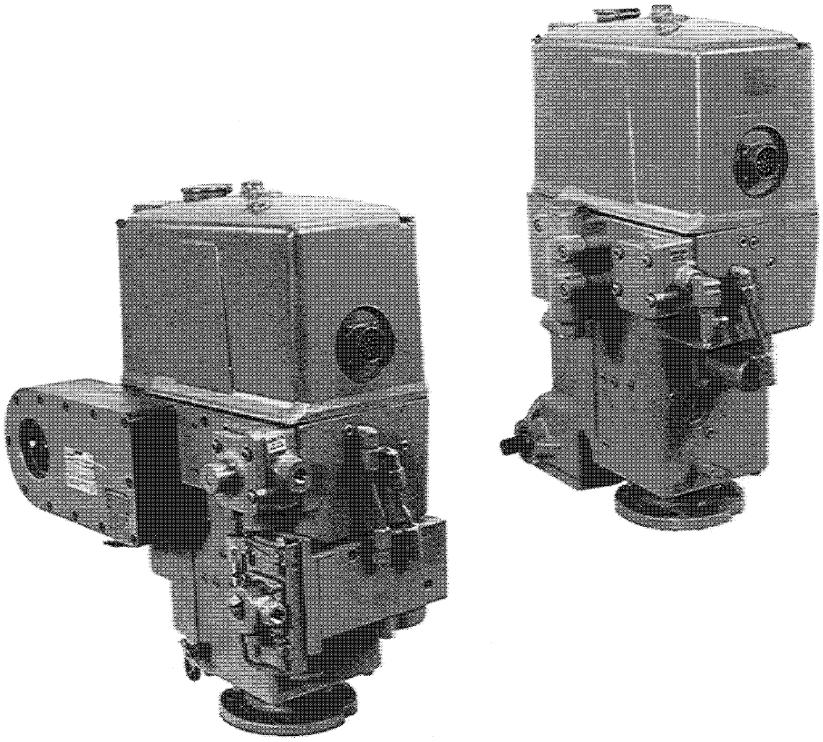
WOODWARD

Product Manual 54053
(Revision C)
Original Instructions



PGE and PGEV
Locomotive Governor Installation

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 Out-of-date translations are marked with ⚠.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

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.

PGE and PGEV Locomotive Governor Installation

Storage and Unpacking

Store governor as received in a cool, dry location in an upright position for up to six months. Refer to Woodward manual 25075 for extended storage.

Install a 5/16-20 x 1 inch eye bolt into the threads in the center of the governor cover to provide a lift point. Do not screw the eye bolt in tighter than hand snug as it can break through the inside of the cover. If the governor is a replacement governor save the carton, skid, and screws for use on the old governor being returned.

Use care while handling and installing the governor. Avoid striking the drive shaft or output shaft. Do not set the governor on its drive shaft. Abuse can damage seals, internal parts, and factory adjustment.

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 the following instructions before beginning the installation.

If the governor is factory set for one direction of rotation only, be sure the governor drive-shaft rotation is correct. Incorrect direction of rotation of the governor can cause seizure of rotating parts.

Make sure that the governor speed setting is correct for your application.

The prime mover to governor coupling must provide a close but free fit. This coupling must allow for thermal expansion without end loading the drive shaft. Make sure that no side loads are applied to the governor drive shaft. A misaligned drive shaft could break and cause an overspeed condition.

Be sure that the governor base and drive shaft and engine drive pad are clean and undamaged.

Governor Installation

Place a gasket between the base of the governor and the engine mounting pad. Install the governor squarely on its mounting pad and in line with the drive. Care must be taken to avoid rough gear teeth and incorrect backlash when installing the governor. Do not pound the drive coupling on to the governor drive shaft or force the governor into position. Refer to the engine manufacturer's specifications for the correct amount of backlash and for the adjustment procedure.

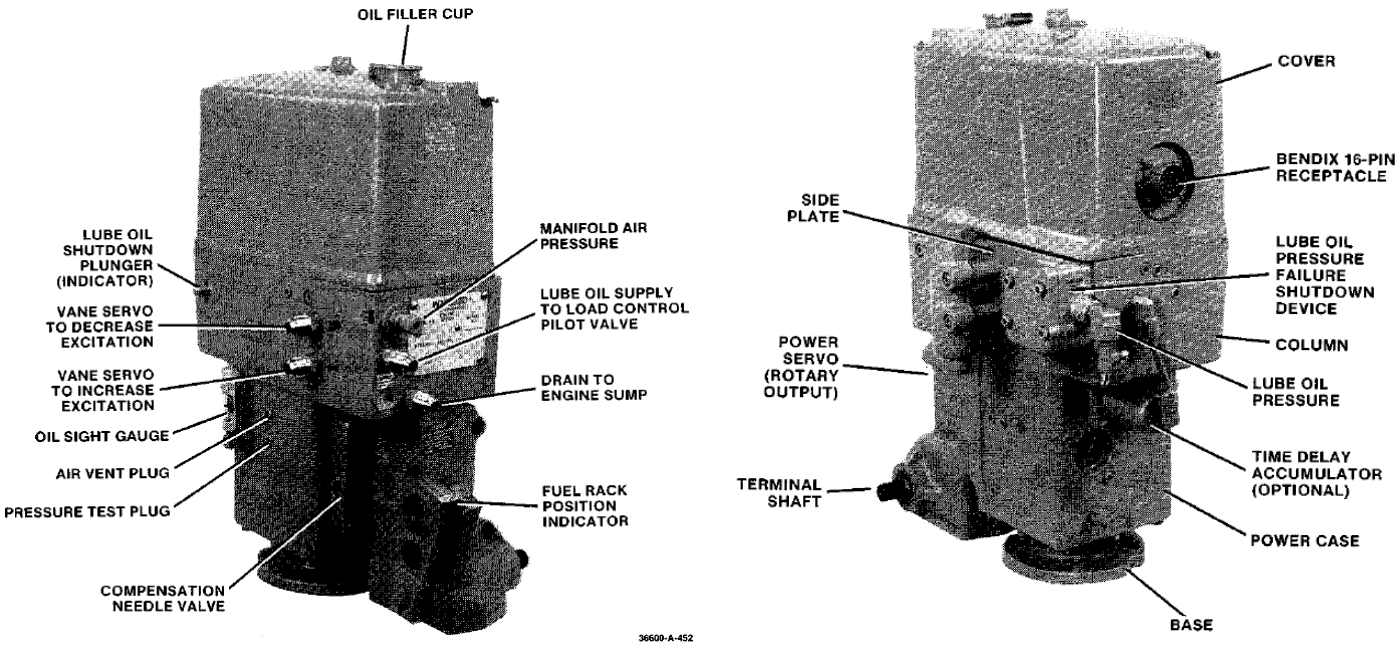

Figure 1a. PGE Governor Parts

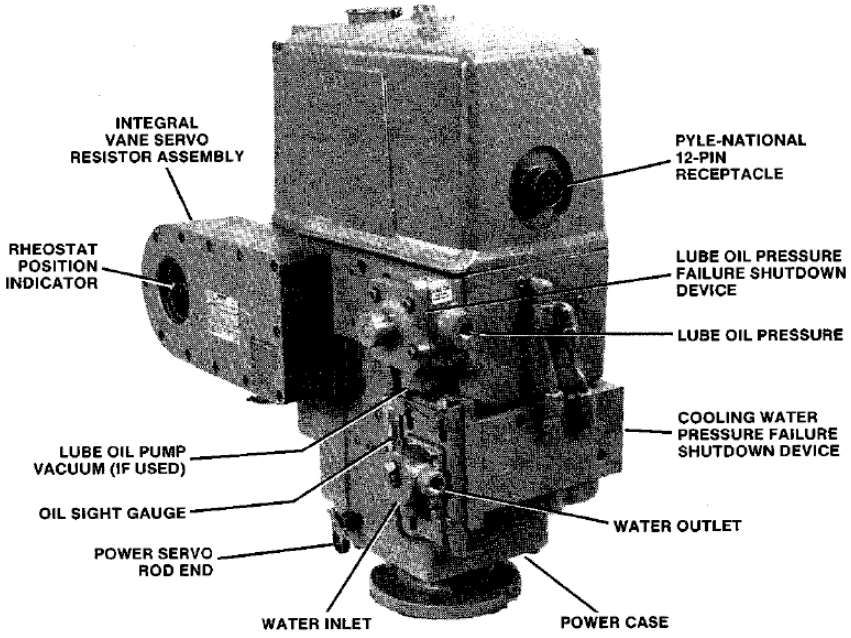

Figure 1b. PGEV Governor Parts

Torque the mounting bolts evenly to the engine manufacturer's specifications. There must be no movement or rocking of the governor on the engine mounting pad.

Install the load-control-resistor plumbing (if used for a remote load control application) in the correct location (see Figure 1). Connect the lube oil connection for shutdown, connect the air box manifold line, if required.

Connect the electrical plug, being careful not to bend pins as this can cause electrical damage.

Linkage Attachments

If replacing an existing governor make sure there is no wear in pivot points or lay-shaft bearings.

Carefully set injector racks according to the engine manual. Minimum and maximum fuel position must be accurately set if the governor is to provide the responsive control that will achieve maximum engine efficiency.

Be sure there is no lost motion or binding in the linkage.

Linear output governors require either a 3/8 or 1/2 inch diameter connecting pin. Rotary output governors provide either a 5/8-36 or 3/4-48 inch serration.

Use a linear linkage to attach the fuel rack to the governor output shaft. Linear servo travel is one inch maximum. Rotary servo travel is 30 degrees maximum.

Be sure to allow sufficient overtravel at each end of output shaft travel so the governor can shut down the prime mover and also give maximum fuel when required.

IMPORTANT

Most "governor troubles" occur because of linkage problems or because of inadequate oil selection and maintenance. Check the linkage between the governor and the fuel rack at the first sign of any problem. After installation of a new or replacement governor carefully check over the linkage to make sure that control will be according to engine specifications.

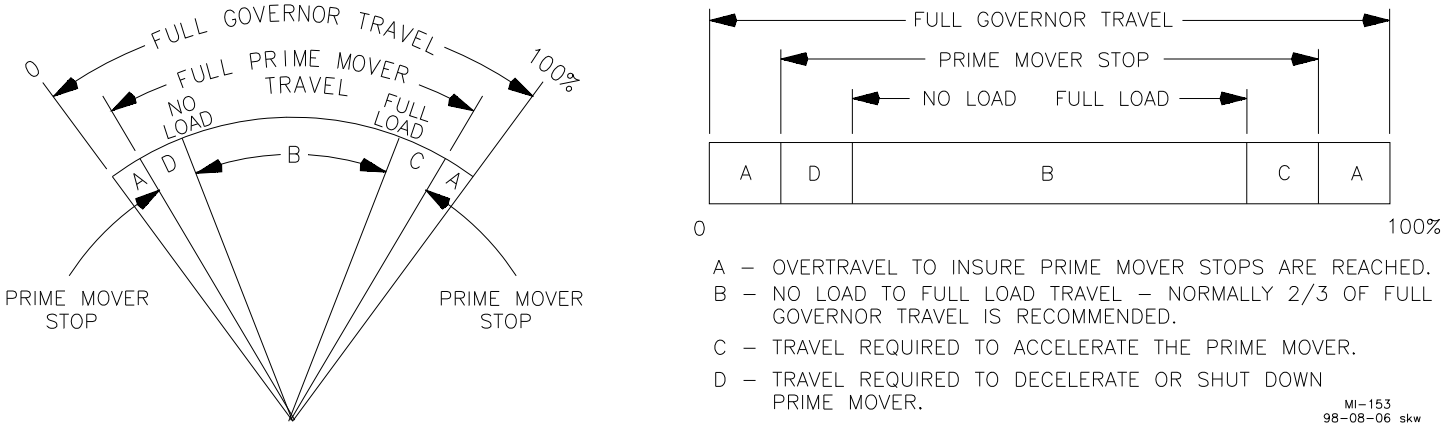

Figure 2. Recommended Governor Output Shaft Travel

Compensation Cutoff—Piston Gap

Due to the location of the compensation cutoff port in the power cylinder wall the minimum fuel position must be set in accordance with the engine manufacturer's specifications.

Rotary output governors provide an output position scale which must be properly set in regard to the rack position.

Linear output governors must be adjusted so that the power piston "gap" does not exceed 1-1/32 inches (26.2 mm) at idle speed no load. A one inch block inserted in the output as shown in Figure 3 will facilitate linkage setup.

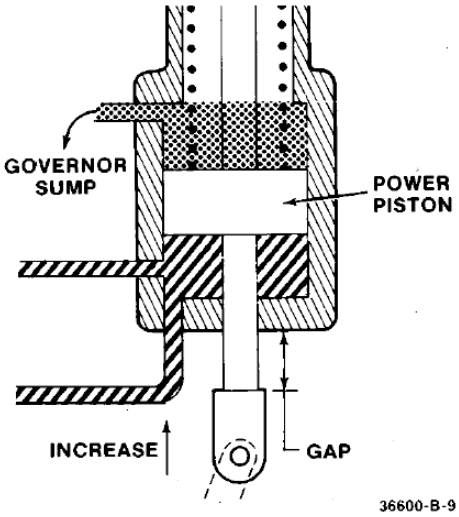

Figure 3. Power Piston "Gap" (Linear Servo)

The idle, no-load governor position must be correctly set if the governor is to provide accurate step power/speed positions through the speed schedule.

Oil Supply

Oil grade selection is based on the operating temperature range of the governor. Measure the temperature on the outside lower part of the governor case. The actual oil temperature will be about 10 °F (6 °C) higher. Use this information with the information given in Tables 1 and 2 to select the correct lubricating/hydraulic oil.

Use only new, clean oil in the governor. Dirty, contaminated, or oxidized oil cause fully half of the problems encountered with PG rail governors.

Governor oil viscosity at operating temperature must stay within the 50 to 3000 SUS (Saybolt Universal Seconds) range. Ideal oil viscosity at operating temperature is between 100 to 300 SUS.

⚠WARNING

A loss of stable governor control and possible engine overspeed with resulting personal injury and/or property damage may result if the viscosity is not within the 50 to 3000 SUS range.

Governor oil must be compatible with seal materials such at nitrile, polyacrylic, and fluorcarbon. If in doubt, contact Woodward Governor Company.

The selection of the proper oil for use in the governor is not related to the selection of oil used in the engine. Tables 1 and 2 are NOT intended to be used in the selection of engine oil. Systems which use a remote vane servo provide an engine oil supply to the vane servo and this oil is directed to the governor for control of load (excitation). The engine oil does not mix with governor oil during this control function. Governor oil must be provided separately from any engine oil connections to the governor.

Zinc dialkyldithiophosphates (ZDPs) are often used as anti-wear additives and are found in many common hydraulic and engine oils. Governors do not normally require anti-wear additives, but under certain marginal lubrication conditions may benefit from their use.

ZDP is corrosive to silver and tends to attack it. Oils with a ZDP anti-wear additive are not recommended for use in the PGEV governor with an oil-filled side plate. The PGEV governor contains a load-control resistor with silver contacts. Increased silver contamination of the oil and wear of the load-control resistor contacts may result from using an oil with a ZDP anti-wear additive. PGE governors and PGEV governors without an oil-filled side plate may continue to use oils with a ZDP anti-wear additive, as the oil does not come into contact with the silver contacts.

The oil capacity of the rail governor is about 1-5/8 to 2 quarts (1.5 to 1.9 liters). Units with oil-filled integral-vane servos will require more oil than those without vane servos or those with a dry ceramic resistor vane servo.

Oil Filled Servo—If the governor is equipped with an oil filled vane servo, it must be completely filled with oil before putting a load on the unit. The oil filled vane servo can be identified by its width of 2-15/16 inch (75 mm) and a drain cock on the underside. See Figure 4.

Dry Ceramic Resistor Vane Servo—The dry ceramic resistor vane servo is designed to operate dry and is never filled with oil. This type of vane servo can be identified by its width of 2-5/16 inch (75 mm). See Figure 4.

Remote Vane Servo—The remote vane servo operates with engine lube oil, controlled through the governor. The lube oil is kept separate from governor oil.

Before starting the engine, fill the governor with the selected oil to the mark on the oil sight glass. If the oil sight glass has two marks, fill the governor with oil to a level visible between the two marks. Oil must be visible in the glass at all times, under all operating conditions.

Check the oil level after the engine is started and add oil as necessary. Do not overfill. Use only new oil to fill the governor. Use clean containers to transfer oil to the governor.

NOTICE

If the PGE or PGEV Governor is equipped with an oil filled vane servo, the cavity around the resistor pack (rheostat) must be completely filled with oil before putting a load on the unit. Without oil for cooling, sufficient heat can be generated to overheat the resistor wiring and insulation.

To fill the cavity when the governor is on the test stand, energize or de-energize the overriding solenoid.

To fill the cavity when the governor is on the engine, move the throttle from the IDLE position to Number Two position to allow oil to enter the rheostat cavity. Make sure the cavity is full by changing load with the throttle a few times. The cavity is full when oil completely fills the area behind the indicator glass.

Add oil to the governor as necessary after filling the vane servo cavity.

Always check governor oil level during operation once the governor has reached normal operating temperature and speed. Add oil, if necessary, to the mark on the oil sight glass.

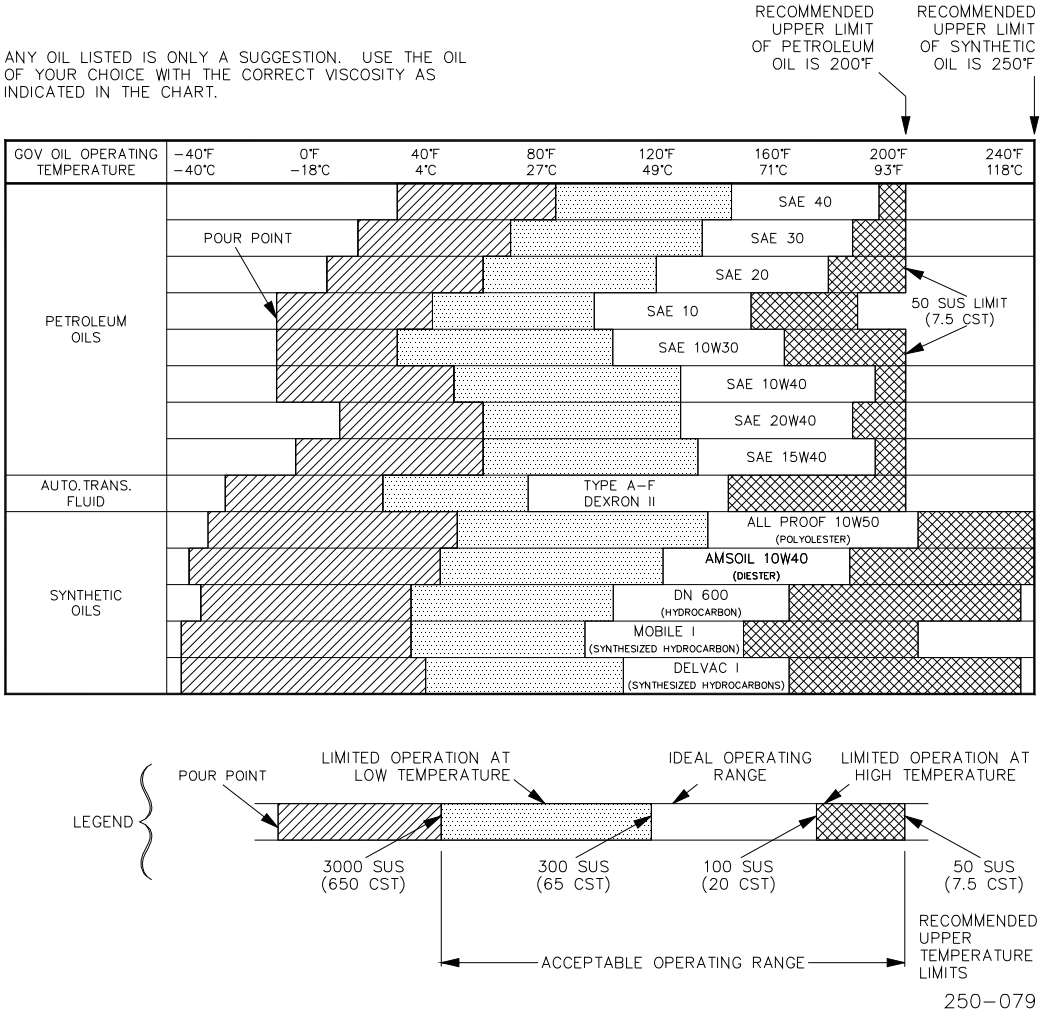

Table 1. Oil Selection Chart

VISCOSITY COMPARISONS				
CENTISTOKES (CST, CS, OR CTS)	SAYBOLT UNIVERSAL SECONDS (SUS) NOMINAL AT 100 DEGREES F	SAE MOTOR (APPROXIMATE)	SAE GEAR (APPROXIMATE)	ISO
15	80	5W		15
22	106	5W		22
32	151	10W	75	32
46	214	10	75	46
68	310	20	80	68
100	463	30	80	100
150	696	40	85	150
220	1020	50	90	220
320	1483	60	115	320
460	2133	70	140	460

250−087
97−11−04 skw

Table 2. Viscosity Comparisons

Initial Operation

Before initial operation of the PGE or PGEV equipped prime mover, be sure that all installation steps are accomplished.

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.

Normally, the only requirements for putting a new or rebuilt PGE or PGEV governor into service are:

1. Make the hydraulic and electrical connections required for the particular governor.
2. Fill the governor with oil.
3. Connect all auxiliary devices.
4. Select LOW SPEED on the engine speed control at initial startup.
5. Adjust the compensation needle valve to obtain maximum stability. (See Compensation Needle Valve Adjustment below.)

   Before Initial Startup be sure to select low speed.

   Start the engine as instructed by the engine manufacturer, and allow the governor to reach normal operating temperature. Make sure that the oil level remains visible on the sight glass

Compensation Needle Valve Adjustment

Make the following adjustments on the governor with the engine operating at IDLE.

1. Open the compensation needle valve several turns to cause the engine to hunt., If opening the needle valve does not cause the engine to hunt, manually disturb the governor output shaft position to induce the governor to hunt.

   Allow the governor to hunt for several minutes to remove air trapped in the governor oil passages.

2. Close the needle valve gradually until hunting is just eliminated. Do not close the needle valve more than necessary as this will cause sluggish governor response.
3. Check governor stability by manually disturbing the governor output.

   The needle valve adjustment is satisfactory when the engine returns to speed with only a slight overshoot or undershoot.

   It is not necessary to change the setting except for large permanent changes in operating temperature or changes in the viscosity of the oil used in the governor.

Troubleshooting Procedures

If improper speed, load, or horsepower variations appear the following procedure should be followed:

1. Check the load to be sure the changes are not the result of malfunctions in the vane servo, generator control circuit, switchgear, etc.

2. Check engine operation to be sure all cylinders are firing properly and that the fuel injectors are in good operating condition and properly calibrated.

3. Check the linkage between governor and fuel racks to be sure there is no binding or lost motion.

4. Check the setting of the governor compensation needle valve.

5. Check speed-setting circuits for voltage level and sequencing.

6. Make sure there are no fuel-pressure changes.

7. Check the governor operating oil pressure. Oil pressure must be 100 psi (690 kPa) minimum. A test port is provided in two sides of the governor power case for this purpose.

   With the engine shut down, remove a plug from the pressure port and install a pressure gauge rated above the governor operating oil pressure.

8. Check engine drive to governor for any evidence of misalignment, roughness, excessive backlash, etc.

9. Check oil level and oil condition. Oil level or oil condition is responsible for many governor problems. Oil in the governor must be at the proper level for proper operation. Oil type must provide the proper viscosity at operating temperatures. Oil must be clean.

10. For additional troubleshooting information, see manual 36703.

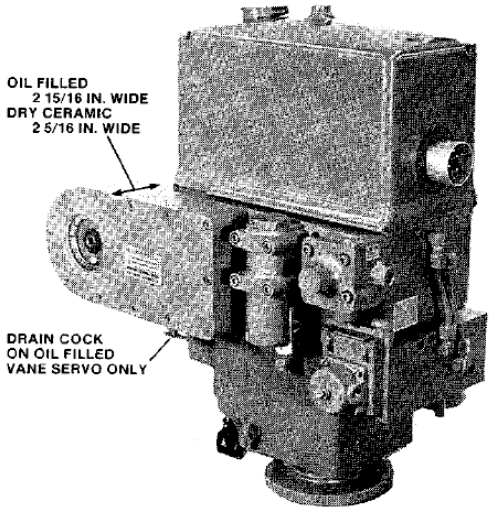

Figure 4. The Two Types of Vane Servos

Auxiliary Devices

Many auxiliary devices are available for use, either singly in combination for the PGE governor. Some auxiliary equipment may be supplied as original equipment only, and some may be installed in the field. Contact Woodward for information.

The following paragraphs give a brief description of some of the auxiliary equipment installed on PGE governors and lists the manuals where detailed information may be obtained.

Automatic Safety Shutdown and Alarm

(Manual 36652)

This devices protects the engine in the event of loss of normal lube oil operating pressure. It allows a relatively low minimum-oil-pressure level for safe engine operation at idle speed while requiring increasingly higher levels for safe operation at higher speeds.

A time-delay feature (adjustable within a range of 15 to 45 seconds or up to 60 seconds with an accumulator) allows the engine to be started without lubricating oil pressure, yet prevents prolonged operation if a safe pressure level is not reached within the preset time. At engine speeds above the first notch, the time delay is normally bypassed so that shutdown is immediate.

A Cooling Water Pressure Failure Shutdown device protects the engine from a drop in the normal operating pressure of the water cooling system. This unit's function is similar to that of the lube-oil-pressure-failure system.

Load Control Override

(Manual 36695)

This mechanism overrides the normal functioning of the load control system and reduces generator field excitation current during engine start up, wheel slip, or transition.

Manifold Air Pressure Bias Fuel Limiter

(Manuals 36601 and 36695)

The fuel limiter restricts engine fuel during acceleration as a function of manifold air pressure to ensure more complete combustion, reducing smoke to a minimum, and improving acceleration.

Load Control Device

(Manual 36630)

The load control device schedules load as a function of speed setting. If actual load is different, the load control device sends a signal to the locomotive excitation control system to increase or decrease excitation.

Altitude Compensator

(Manual 36695)

The altitude compensator linkage is used with the in-line model (single barrel) "Manifold Air Pressure Bias Fuel Limiter." This linkage compensates for altitude changes by biasing the load-control schedule.

If problems are encountered with the installation or operation of this governor, contact Woodward.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 54053C.

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