

Operator's Manual

RDJC GENERATOR SET



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Table of Contents

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SECTION	TITLE	PAGE
	SAFETY PRECAUTIONS	iii, iv
1		1-1
	About This Manual	1-1 1-1
	How To Obtain Service	1-1
2	SPECIFICATIONS	
3		3-1
	General	3-1
	Location	3-1
	Mounting	
	Ventilation	3-3
	Radiator Cooling	3-3
	City Water Cooling (Opitional)	3-3
	Exhaust	3-4
	Fuel Tank And Lines	3-5
	Oil Drain	3-6
4		4-1
	General	4-1
	Transfer Switch	4-2
	Generator Voltage Connections	4-3
	DC Wiring	4-6
	Battery Connections	4-6
5	CONTROL DESCRIPTION	5-1
	General	5-1
	DC Controls	5-2
· ·	AC Controls	5-4

i

SECTION	TITLE PA	\GE
6	OPERATION	6-1
	General	. 6-1
	Prestart Checks	. 6-2
	Starting	. 6-3
	Running	. 6-5
	Stopping	. 6-6 6 7
	Break-In	. 0-7 6.7
	No-Load Operation	. 0-7 6-7
		-6-8
		6-8
	Low temperatures	6-8
	High Altitude	. 6-8
· · · ,	Power Rating Factors	. 6-8
7	ADJUSTMENTS	. 7-1
-	Generator Voltage Check and Adjustment	. 7-1
	Governor	. 7-2
	Valve Clearance Adjustments	. 7-3
	Centrifugal Switch	. 7-4
	Charge Rate Adjustment	. 7-4
8	TROUBLESHOOTING	. 8-1
	Safety Considerations	. :8-1
9	MAINTENANCE	. 9-1
	General	. 9-1
	Generator Set Inspection	. 9-3
	Lubrication System	. 9-3
	Fuel System	. 9-6
	Air Cleaners	. 9-9
	Contractor Model Air Cleaner	. 9-9
	Governor Linkage	9-10
	Batteries	9-11
	Crankcase Breather	9-12
		9-12
	lorsional Washers	0.14
		9-14
10		10-1
ΊU		10-1
11	WIRING DIAGRAMS	11-1
	General	11-1

1

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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and the equipment. Safe and efficient operation can be achieved only if the equipment is properly operated and maintained. Many accidents are caused by failure to follow fundamental rules and precautions.

The following symbols, found throughout this manual, alert you to potentially dangerous conditions to the operator, service personnel, or the equipment.

A DANGER This symbol warns of immediate hazards which will result in severe personal injury or death.

<u>AWARNING</u> This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.

A CAUTION This symbol refers to a hazard or unsafe practice which can result in personal injury or product or property damage.

FUEL AND FUMES ARE FLAMMABLE

Fire, explosion, and personal injury or death can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, arcing equipment, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.

- Be sure all fuel supplies have a positive shutoff valve.
- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc..

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect battery charger from its AC source, then disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Remove electric power before removing protective shields or touching electrical equipment. Use rubber insulative mats placed on dry wood platforms over floors that are metal or concrete when around electrical equipment. Do not wear damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages can cause injury or death. DO NOT tamper with interlocks.
- Follow all applicable state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches to avoid accidental closure.
- DO NOT CONNECT GENERATOR SET DI-RECTLY TO ANY BUILDING ELECTRICAL SYSTEM. Hazardous voltages can flow from the generator set into the utility line. This creates a potential for electrocution or property damage. Connect only through an approved isolation switch or an approved paralleling device.

GENERAL SAFETY PRECAUTIONS

• Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.

- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.

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- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breath or ingest or come into contact with exhaust gases.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

ABOUT THIS MANUAL

This manual provides installation instructions, and information on operating, maintaining and adjusting the Onan® RDJC generator set (genset). Study this manual carefully and comply with each of its warnings and cautions. Using the generator set properly and performing regular maintenance can result in longer unit life, better performance, and safer operation.

SAFETY CONSIDERATIONS

The generator set has been carefully designed to provide safe and efficient service when properly installed and operated. However, the overall safety and reliability of the complete system is dependent on many factors outside the control of the generator set manufacturer. To avoid possible safety hazards, make all mechanical and electrical connections to the generator set exactly as specified in this manual. All systems external to the generator (fuel, exhaust, electrical, etc.) must comply with all applicable codes. Make certain all required inspections and tests have been completed and all code requirements have been satisfied before certifying the installation is complete and ready for service.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your nearestl Cummins[®]/Onan[®] dealer or distributor. Factory-trained Parts and Service representatives are ready to handle all your service needs.

If you are unable to locate a dealer or distributor, consult the Yellow Pages. Typically, our distributors are listed under:

GENERATORS-ELECTRIC or ELECTRICAL PRODUCTS

For the name of your local Cummins/Onan or Onanonly distributor in the United States or Canada, call 1-800-888-ONAN (this automated service utilizes touch-tone phones only). By entering your area code and the first three digits of your local telephone number, you will receive the name and telephone number of the distributor nearest you.

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For outside North America, call Onan Corporation, 1-612-574-5000, 7:30 AM to 4:00 PM, Central Standard Time, Monday through Friday. Or, send a fax to Onan using the fax number 1-612-574-8087.

When contacting your distributor, always supply the complete Model Number and Serial Number as shown on the generator set nameplate.

A WARNING

INCORRECT SERVICE OR PARTS REPLACEMENT CAN RESULT IN SEVERE PERSONAL IN-JURY, DEATH, AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

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Cummins is a registered trademark of Cummins Engine Company, Inc.

2. Specifications

DIMENSIONS

Height	40.12 inches (1019 mm)
Width	27.00 inches (686 mm)
Length	56.62 inches (1438 mm)
Weight	940 lbs (426 kg)

ENGINE

Number of Cylinders	
Engine Speed (50/60 Hz)	1500/1800 rpm
Recommended Fuel	#1 or #2 diesel
Exhaust Connection (pipe tapped)	1.5 in. (38.1 mm)
Fuel Pump Maximum Lift	6 feet (1.8 mm)
Oil Filter	Full flow type
Fuel Consumption (full load)	1.6 gallons/h (6 liters/h) (60 Hz)
	1.4 gallons/h (5 liters/h) (50 Hz)

ELECTRICAL SYSTEM

Starting Voltage	12 Volts DC
Cranking Current	225 amps at ambient temp. of 32° F (0° C)
Battery	12 Volt, negative ground
Battery Size	
•	800 amps (cold cranking) at 0° F (-18° C)
Battery Charge Rate	2 to 5 amps (adjustable)

GENERATOR

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15.0 RDJC	15 kW (60 Hz)
12.5 RDJC	12.5 kW (50 Hz)
Output Rating	1.0 power factor (single-phase)
•	0.8 power factor (three-phase)

CAPACITIES

Coolant System (Includes Radiator)	13 U.S. quarts (12 I)
Oil Capacity	6.5 U.S. quarts (6.0 I)

TUNE-UP SPECIFICATIONS

Start-Disconnect Centrifugal Switch Point Gap	0.020 in. (0.51 mm)
Cylinder Head Bolt Torque	44 - 46 ft-lb (60 - 62 N∙m)
Glow Plug Torque	10 - 15 ft-lb (14 - 20 N•m)
Valve Clearances	
Intake	0.011 in. (0.28 mm)
Exhaust	0.016 in. (0.41 mm)
Injector Firing Order	1, 2, 4, 3

3. Installation

GENERAL

Most generator set installations must be designed so that the generator set will function properly under all anticipated operating conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components.

Generator set installations must conform to local building codes, fire ordinances, and other local, state and federal regulation. For more detailed installation instructions, consult Onan Application Manual T-030, or contact an authorized Onan service representative.

Requirements to be considered prior to installation:

- Level mounting surface
- Adequate cooling air
- Adequate fresh induction air
- Discharge of circulated air
- Discharge of exhaust gases

- Electrical connections
- Fuel connections
- Accessibility for operation and servicing
- Noise levels
- Vibration isolation
- Electrical connections

LOCATION

Provide a location for the genset that is dry, clean, dust-free, well-ventilated, and protected from the weather (see Figure 3-1). Generator set location is decided mainly by related systems such as ventilation, wiring, fuel, and exhaust. The set should be located as near as possible to the main power fuse box.

Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions. An optional housing is available for outside operation.



FIGURE 3-1. TYPICAL INSTALLATION

MOUNTING

Generator sets are mounted on a steel skid that provides proper support. The engine-generator assembly is isolated from the skid frame by rubber mounts that provide adequate vibration isolation for normal installations. For critical installations, install vibration isolators between the skid base and foundation.

Mount the genset on a substantial and level base such as a concrete pad.

Use 3/4-inch diameter, anchored mounting bolts to secure the generator set skid to the floor to prevent movement. Secure the skid using a flat washer and hex nut for each bolt (Figure 3-2).



FIGURE 3-2. BOLT DIAGRAM

VENTILATION

Generator sets create a large amount of heat, which must be removed by ventilation. An outdoor installation can rely on natural air circulation, but indoor installations need enough properly sized vents in the correct positions to maintain the necessary air flow.

The presence or absence of a fan and radiator determines ventilation system design. With a radiator, engine-pusher fan size is large enough to remove heat from the engine, generator, and a few feet (roughly a metre) of uninsulated exhaust pipe. Restrictive ducting or heat sources other than the generator set require extra fans to increase airflow.

With other cooling options, ventilation fans are needed. Fan size must be large enough to remove the heat in the room given off by the generator set, uninsulated exhaust pipes and any other heat-producing equipment. A temperature differential of 20° to 30° F (11° to 17° C) is usually satisfactory. **<u>A CAUTION</u>** Operating the generator set with any of the cooling system components removed can cause equipment damage. Do not operate the generator set with any of the cooling system components removed.

RADIATOR COOLING

Cooling air travels from the rear to the front of the set. Locate the room/compartment air inlet where it is most convenient, preferably to the rear of the set. The minimum inlet opening should be at least 1-1/2 times the size of the radiator area. Increase the size of the opening if it will be restricted with louvers or filters (see Figure 3-1).

Engine heat is removed by a pusher fan which blows cooling air through the front of the radiator. The cooling air outlet should be directly in front of the radiator, and as close to it as is practical. The unrestricted outlet opening must be at least as large as the radiator opening. A flexible section must connect the radiator and the air outlet opening, to prevent recirculation of heated air.

Generator cooling air is discharged through the engine-to-generator adapter on the left side of the engine.

EXHAUST

Pipe exhaust gases outside the enclosure. The exhaust outlet is 1-1/2-inch pipe size. Locate the exhaust outlet far from the air inlet to avoid gases reentering the enclosure. Use flexible seamless tubing to connect between the engine exhaust and any rigid pipe extension to prevent transmission of vibration.

AWARNING Exhaust gas is polsonous. Inhalation can result in severe personal injury or death. Modifying the exhaust system can allow polsonous exhaust gases to escape. Use only original equipment replacement parts when servicing the exhaust system. Unauthorized modifications will also void the warranty and cancel the UL Listing/CSA Certification. Liability for injury or damages due to unauthorized modifications becomes the responsibility of the person making the change.

Because an exhaust system is subjected to detrimental conditions such as extreme heat, infrequent operation, and light operating load, inspect the exhaust system frequently to be sure that it remains fume-tight.

AWARNING Inhalation of exhaust gases can result in severe personal injury or death. Do not use exhaust heat to warm a room, compartment or storage area.

An approved thimble must be used (Figure 3-3) to pass exhaust pipes through walls or partitions. Build this thimble according to code (see National Fire Protection Association bulletin, Volume 4, section 211 on "Standards for Chimneys, Fireplaces, and Vents").

As the exhaust pipe length and number of bends increases, a larger pipe is required to reduce excessive exhaust restriction and back pressure. Excessive exhaust back pressure will reduce the air-fuel ratio, resulting in reduced output, smoke, wasted power, high exhaust temperatures and reduced engine life.

Total back pressure of all system components must not exceed maximum back pressure limits. Note that any exhaust restriction, even if less than maximum, will affect performance.



FIGURE 3-3. EXHAUST PIPING

FUEL TANK AND LINES

AWARNING Fuel tanks present the risk of explosion and fire, which can cause severe personal injury or death. Because fuel leaks create fire hazards, always use flexible tubing between the engine and the fuel supply, to avoid leaks due to vibration and/or fuel line failure. Do not allow the fuel line to contact rough, sharp or hot surfaces.

The top of the fuel tank must be lower than the fuel pump to prevent siphoning if a system leak occurs. Install a shutoff valve at the fuel tank, to enable servicing. If the fuel tank is shared, do not connect it to an existing line at a point above the fuel supply level, to avoid starving either engine.

Use an approved flexible fuel line next to the engine. Diesel engines require a fuel supply line and a separate fuel return line. Install the fuel supply line from the supply tank to the inverted flare male elbow mounted in the inlet of the fuel pump. The pump is threaded 7/16-24 NPTF (American Standard Internal Tapered Pipe Thread).

Install fuel return line from the 7/16-24 size opening in the overflow fitting located on injection pump (where nozzle fuel return line is also connected) to the top of the fuel supply tank. Shield the line with fire-retardant material if it passes through a combustible wall or partition.

<u>AWARNING</u> Always use flexible tubing between engine and fule supply to avoid line failure and leaks due to vibration.

A CAUTION Never use galvanized or copper fuel lines, fittings or fuel tanks. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The molecular structure of the copper or galvanized lines or tanks reacts with the acid and contaminates the fuel.

Carefully clean all fuel system components before putting the set into operation. Any dirt or contamination may cause major damage to the fuel injection system.

ACAUTION Dirt in the system can severely damage both the injection pump and the injection nozzles. Dirty fuel is one of the major causes of engine failure. Even a tiny particle of dirt in the injection system may stop the engine. Because diesel injection systems have extremely precise tolerances, make certain that fuel is kept clean.

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FIGURE 3-4. FUEL LINE CONNECTIONS

Separate Fuel Tanks

The fuel tank top must be lower than the fuel pump level to prevent putting a static head on the fuel pump inlet. If the fuel tank is shared with another engine, use separate fuel lines for both engines to avoid starving either one.

The following restrictions apply to separate fuel tank installation:

1. The bottom of the fuel tank must not be more than 6 feet (1.8 m) below the fuel transfer pump inlet, unless an auxiliary electric fuel pump is added. The maximum lift capacity of the transfer pump is six feet. See the Wiring Diagram for the connection.

2. If the tank is installed above the fuel pump inlet level without a supply line shutoff valve, a ruptured pump diaphragm could cause oil dilution, fuel loss, and fuel leakage to the crankcase.

- 3. If the maximum fuel lift must be exceeded on any installation, consult Onan Application Manual T-030 for information on installing a day tank and an electric solenoid shutoff valve.
- 4. Use an electric or manual shutoff valve if the minimum fuel level in the tank is higher than the pump inlet, to provide positive fuel shutoff

when the engine is stopped. This valve also prevents loss of fuel from possible leaks between the tank and the fuel pump.

AWARNING Fuel leaks create fire and explosion hazards which can result in severe personal injury or death. Always use flexible tubing between engine and fuel supply to avoid line failure and leaks due to vibration. The fuel system must meet applicable codes.

OIL DRAIN

Extend the drain to suit the installation. The oil base has a 1/2-inch pipe size tapped hole.

AWARNING Do not position the oil drain so that oil might drip onto the muffler, any exhaust components, or any other hot parts, causing a fire hazard. Fire presents the hazard of severe personal injury or death.

AWARNING Fuel and oil must be contained and disposed of properly to avoid environmental damage and clean-up liability. Check all federal, state and local regulations regarding storage tanks and secondary containment and disposal requirements.

4. Electrical Preparation

GENERAL

The genset electrical system includes connecting the load, installing the control wiring and connecting the batteries. Connect the batteries last to avoid accidental starting of the unit during installation.

A CAUTION Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.

AWARNING Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [-] first).

Arcing can ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (--) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (--) cable first, and reconnect it last.

The following paragraphs contain the procedures that are used to connect the electrical system of the genset.

AWARNING Each of the operations described in this section should be done only by persons trained and experienced in electrical maintenance. Improper procedures may result in property damage, bodily injury or death. Connecting the genset electrical system involves:

- Installation of transfer switch (standby service only)
- Generator voltage connections
- Load connection
- Control wiring
- Battery connection

Local regulations often require that wining connections be made by a licensed electrician, and that the installation be inspected and approved before operation. All connections, wire sizes, materials used, etc. must conform to the requirements of electrical codes in effect at the installation site.

<u>AWARNING</u> Improper wiring can cause a fire or electrocution, resulting in severe personal injury or death and/or property and equipment damage.

Before starting the genset, verify that all electrical connections are secure, and that all wiring is complete. Replace and secure any access panels that have been removed during installation. Check that the load cables from the genset are properly connected.

AWARNING Backfeed to utility system can cause electrocution or property damage. Do not connect to any building electrical system except through an approved device and after building main switch is opened.

TRANSFER SWITCH

If the installation is for standby service, a transfer switch must be used for switching the load from the normal power source to the genset (see Figure 4-1). Either a manual or automatic transfer switch may be used. Follow the installation instructions provided with the transfer switch when connecting the load and control wiring. Refer to heading *"Preheat/Time-Delay Module"* in this section, for generator set remote start connections.

EIGURE 4-1. TYPICALLOAD TRANSFER

4-2

GENERATOR VOLTAGE CONNECTIONS

A CAUTION Reconnecting factory connected generator sets to lower voltages may reduce set ratings, and also render line circuit breakers too small. Consult with your distributor before performing reconnection for different voltage.

The generator output voltages and maximum current rating are specified on the generator nameplate. Line-to-neutral voltage is always the lower voltage shown on the nameplate. Line-to-line voltage is the higher rating.

The factory ships special-order sets with control panels especially wired for the voltage specified by the customer. Standard sets without instruments are shipped with the T1-T4 or T1-T12 output leads separated in the output box. These single-phase and broad-range generators may be connected to provide any of the output voltages shown in the Reconnection Diagram. The Installer must always check the stator lead connections and perform any necessary reconnections to obtain the desired voltage.

Refer to the Reconnection Diagram when reviewing the voltage connection information, and use the electrical schematic supplied with your genset when actually performing load connections. (A reconnection diagram is located on the inside of the power output box cover.)

EXAMPLE: HAZARDOUS VOLTAGE! Touching uninsulated live parts inside the control and power output boxes can result in severe personal injury or death. Measurements and adjustments must be done with care to avoid touching uninsulated live parts.

For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands and use tools with insulated handles.

The genset control panel box contains the automatic voltage regulator (AVR) printed circuit board. The AVR controls the output of the generator so that a constant voltage is maintained under varying load conditions. There are two types of AVR's available; one requiring jumper adjustments when connecting or changing load connections. If the genset contains the AVR shown in Figure 4-2, be sure to connect jumper W10 between terminal V4 (common) and V1, V2, or V3 as listed on the reconnection diagram.

FIGURE 4-2. AVR SELECTION JUMPERS (P/N 300-1540)

LOAD CONNECTION

AWARNING HAZARDOUS VOLTAGE! Touching uninsulated live parts inside the AC power output box can result in severe personal injury or death. Shut down the set and disconnect ALL power sources to the generator set before removing the cover of the AC power output box. See Figure 4-3.

Load wires can be brought into the power output box through the holes that are shown in Figure 4-3. Use flexible conduit and stranded load wires near the set to isolate vibration and permit movement. Use suitable size insulated wires for the load rating applied.

When installing sets with AC meters, the generator output leads must be routed through current transformers for proper meter operation. The transformers are labeled CT21, CT22 and CT23. Refer to Figure 4-3 and the reconnection diagram to identify the output leads that must be routed through each current transformer, and also appropriate transformer post selection for meter sensing leads.

Without optional main circuit breaker: Connect each load wire to the proper generator output lead inside the output box. Insulate bare ends of ungrounded wires. Use bolt provided on the output box to connect the generator ground lead or earth wire. Install a fused main switch (or circuit breaker) between the generator and load. If a test-run indicates wrong rotation of 3 phase motors in the load circuit, switch the connections at any two of the generator terminals.

With optional main circuit breaker: To attach the load wires to the optional circuit breaker, remove the access plate that is located directly below the circuit breaker. Attach the load cables to the base of the circuit breaker and install the access panel. If a test-run indicates wrong rotation of 3 phase motors in the load circuit, switch the connections at any two of the generator terminals. **AWARNING** Backfeed to utility system can cause electrocution or property damage. Do not connect to any building electrical system except through an approved device and after building main switch is opened.

A<u>CAUTION</u> Phase rotation of the genset and utility must be the same. Equipment damage can occur. Check and reconnect as necessary.

Check the rotation of 3-phase motors before loading and reconnect if necessary.

Balancing Loads

When connecting loads to the genset, balance the loads so that the current flow from each line terminal (L1, L2 and L3) is about the same. This is especially important if both single phase and three phase loads are connected. Any combination of single phase and three phase loading may be used as long as all line currents are roughly the same (within 10 percent of median value) and no line current exceeds the nameplate rating of the generator. Check the current flow from each load cable after connections are made, by observing the control panel ammeter.

Grounding

Grounding involves making a conducting connection between the metal parts of the generator set or one of its electrical circuits and the earth. The design and installation of a grounding system is affected by many factors such as the use of multiple transformers, ground fault protection requirements, and physical location of the generator. Follow the recommendations of the consulting engineer when installing the grounding system.

AWARNING Contact with electrical equipment can result in severe personal injury or death. It is extremely important that bonding and equipment grounding be properly done. All metallic parts that could become energized under abnormal conditions must be properly grounded.

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FIGURE 4-3. POWER OUTPUT BOX

CONTROL WIRING

The generator set control panel box contains connection points for remote control and monitor options. These connection points are located on the engine control monitor board (ECM), the preheat/ time-delay module and the optional auxiliary relay board (ARB). (Note that if the optional ARB is installed, no remote monitor connections are attached to the ECM. The ARB provides all remote monitor connection points.)

If the distance between the genset and the remote station is less than 1000 feet (305 m), use 18 gauge stranded copper wire. If the distance is 1000 to 2000 feet (305 to 610 m), use 16 gauge stranded copper wire. Always run control circuit wiring in a separate metal conduit from AC power cables to avoid inducing currents that could cause problems within the control.

AWARNING HAZARDOUS VOLTAGE Touching uninsulated live parts inside the control panel box can result in severe personal injury or death. Control wire installation must be done with care to avoid touching uninsulated live parts. For your protection, stand on a dry wooden platform or rubber insulating mat, make sure your clothing and shoes are dry, remove jewelry from your hands and use tools with insulated handles.

ENGINE MONITOR BOARD (ECM-A11)

The heart of the engine control system is the engine monitor (A11). It is a printed circuit board assembly mounted on the back wall of the control box (Figure 4-4). It starts and stops the engine in response to the control panel switches, engine sensors and remote control signals.

Remote Monitor Connections

The optional Detector 12 Control (12 light panel) provides the capability of attaching a remote monitor panel. Connections are made on the terminal block (TB2) located on the ECM board. See Page 11-3 for typical connections at TB2 of the ECM board. (If the optional ARB is installed, remote monitor connections attach to the ARB, not the ECM.)

FIGURE 4-4. ENGINE MONITOR BOARD (ECM)

AUXILIARY RELAY BOARD (OPTIONAL)

The following describes the design/functional criteria for the auxiliary relay board (ARB) with a Detector-7 or -12 Genset control. When provided, the board is mounted on the right wall of the control box. See Figure 4-5. There are two versions of the ARB; with and without the set of 12 Fault relays. Page 11-4 is a detailed connection diagram for the ARB.

Terminal Blocks:

- TB1 ARB TB1 and engine monitor TB1 are
- identically numbered and provide the same remote control connection points. Note that additional terminals are provided for terminals 5, 7, and 10 of ARB TB1.
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- TB2 through TB5 Connection points for re-
- lays K1 through K3. TB2 provides the N/O and N/C connections (three form 'C' contacts for each relay). TB3 through TB5 provide the common connection points (TB3 for K1, TB4 for K2 and TB5 for K3).
- TB6 and TB7 Connection points for fault relays K4 through K15. Three terminals are provided for each relay, which are labeled COM, N/C, N/O.

Plug-In Relays (K1, K2, K3): The ARB can be equipped with one to three 3-pole, double-throw relays. These relays (K1, K2, K3) are field changeable plug-in relays for easy field addition and replacement.

Each relay can be operated as a RUN, COMMON ALARM, or ISOLATED COIL with the changing of a jumper.

The relay contact ratings are:

- 10 amps at 28 VDC or 120 VAC, 80% PF
- 6 amps at 240 VAC, 80% PF
- 3 amps at 480 VAC, 80% PF

Jumper Positions for Plug-In Relays: Jumpers W1, W2 and W3 perform the same functions for their respective relays, W1 for relay K1, W2 for relay K2, and W3 for relay K3. They can be located in any of 3 positions (A, B, C) independently of each other.

- Jumper Position A (Run) The relay operates as a Run relay, energizing when SW B+ is applied from the engine monitor.
- Jumper Position B (Common Alarm) The relay operates as a Common Alarm relay. The relay energizes any time there is an engine shutdown. This signal is provided from the engine.
- Jumper Position C (Isolated) The relay operates as an Isolated relay. The relay coil is energized by a customer applied B+ signal through the terminal block; TB3-1 for relay K1, TB4-1 for relay K2, and TB5-1 for relay K3.

Jumpers W11, W12, and W13 perform the same functions for their respective relays; W11 for relay K1, W12 for relay K2, and W13 for relay K3. They can be located in two different positions (A, B) independently of one another.

- Jumper Position A The relay operates isolated from the board. The customer provides the circuit completion through terminal block; TB3 for relay K1, TB4-5 for relay K2, and TB5-5 for relay K3. The customer can operate the relay with switched ground logic or use this relay in the middle of more complex logic circuits if needed.
- Jumper Position B The relays operate with the coils connected to ground through the board connections. The coil will require a B+ signal to energize with the jumper in this position.

Fault Relays (K4 through K15): These optional relay modules are used to operate a remote alarm annunciator that has an independent power source. This allows the use of either AC or DC for alarm drives. The relays are energized through the latching relays on the engine monitor and provided N/O and N/C contacts for each external alarm connection.

The 12 relays with form 'C' contacts are rated:

- 10 Amp, 120 VAC
- 10 Amp. 30 VDC

FIGURE 4-5. AUXILIARY RELAY BOARD (ARB)

PREHEAT/TIME-DELAY MODULE (A15)

The start delay/preheat is adjustable from 1/2 to 15 seconds and the stop delay from 1 to 30 minutes. Turn the delay adjusting potentiometers clockwise to increase delay and counterclockwise to decrease delay. Pre-heat occurs during the delayed start period and continues through cranking.

Remote Control Connections

Remote control connections are made at the terminal block (TB1) that is located on the preheat/timedelay module (Figure 4-6). Connect one or more remote switches across the remote terminal (TB1-5) of the preheat/time-delay module and the B+ terminal of the ECM (A11).

FIGURE 4-6. PREHEAT/TIME-DELAY MODULE

BATTERY CONNECTIONS

Starting the unit requires a 12 volt battery current. Use one 12 volt battery for a normal installation (Figure 4-7). (Refer to Section 2, *Specifications* for battery type.)

Necessary battery cables and rack are on the unit. Service battery as necessary. Infrequent use (as in emergency standby service), may allow battery to self-discharge to the point where it cannot start the unit. If installing an automatic transfer switch that has no built-in charge circuit, connect a separate trickle charger. Onan automatic transfer switches can include an optional battery charging circuit.

AWARNING Ignition of explosive battery gases can cause severe personal injury. Always connect battery negative (-) last to prevent arcing.

AWARNING Do not smoke while servicing the batteries. Explosive gases are emitted from batteries in operation. Ignition of these gases can cause severe personal injury.

FIGURE 4-7. BATTERY CONNECTIONS

5. Control Description

GENERAL

The following describes the function and operation of the standard Detector 7 and optional Detector 12 generator set control. All instruments and control switches are located on the face of the control panel as illustrated in Figures 5-1 through 5-3. The control panel description is separated into a DC portion for monitoring the engine and an AC portion for monitoring the generator.

FIGURE 5-1. DC CONTROLS (DETECTOR 12 SHOWN)

DC CONTROLS

Panel Lamp: Illuminates control panel.

Oll Pressure Gauge: Indicates pressure of lubricating oil in engine (wired to a sensor located on the engine).

Coolant Temperature Gauge: Indicates temperature of circulating coolant in engine (wired to a sensor located on engine).

DC Voltmeter: Indicates the battery charging system voltage.

Run/Stop/Remote Switch:

- Push the switch to the **Run** position to start and run the generator set.
- Push the switch to the **Stop** position to stop the set (The switch must be in the **Stop** position when the reset switch is used to restore generator set operation following a fault shutdown.)
- Push the switch to the Remote position to allow a remote controller to automatically run the set.

Running Time Meter: Registers the total number of hours the unit has run. Use it to keep a record of periodic servicing. Time is cumulative; meter cannot be reset.

Preheat/Reset/Lamp Test/Panel Lamp Switch:

- Push the switch to the **Preheat** position (momentary contact) to manually preheat the engine combustion chambers before starting. (This is normally accomplished automatically by the preheat module inside the control box.)
- Push the switch to the Reset, Lamp Test position (momentary contact) to reset the engine control to restore operation following a fault shutdown (the Run Stop Remote switch must be in the Stop position for reset to occur) and to test the indicator lamps. Also, this switch has a light which lights following a fault or emergency shutdown. The light remains lit until the engine control has been reset.
- Push the switch to the Panel Lamp position to light the panel illumination lamp.

Emergency Stop Button (Optional): Push-in switch for emergency shutdown of the engine. The button lights up when it is pushed in. To reset, pull switch out and move Run/Stop/Remote switch to Stop position. Then push Preheat/Reset/Lamp Test/ Panel Lamp switch to Reset/Lamp Test position. **Detector 7 Indicator Lamps:** The standard control panel has seven indicator lamps which are described as follows:

- RUN (green) lamp comes on when starter circuit opens after set starting.
- PRE LO OIL PRES (yellow) indicates engine oil pressure is marginally low.
- PRE HI ENG TEMP (yellow) indicates engine temperature is marginally high (or coolant level is low on optionally wired sets).
- LO OIL PRES (red) indicates engine has shut down because of critically low oil pressure.
- HI ENG TEMP (red) indicates engine has shut down because of critically high engine temperature or low coolant level.
- OVERSPEED (red) indicates engine has shut down because of excessive speed.
- OVERCRANK (red) indicates engine has failed to start during the cranking period.

Detector 12 Indicator Lamps: The optional twelve lamp control includes all the features of the seven lamp control plus the following:

- FAULT 1 (red) lamp indicates an undedicated fault. May be field programmed as a shutdown or non-shutdown, and as a timed or non-timed fault. (Normally set for timed shutdown).
- FAULT 2 (red) lamp indicates same features as Fault 1 (normally set for timed shutdown).
- LOW ENG TEMP (yellow) lamp lights if engine temperature is marginally low for starting. It may indicate an inoperative coolant heater.
- LO FUEL (yellow) indicates fuel supply is marginally low.
- SWITCH OFF (flashing red) indicates generator set is not in automatic start mode.

FIGURE 5-2. INDICATOR LAMPS

FIGURE 5-3: AC CONTROLS

AC CONTROLS

AC Voltmeter (Optional): Dual range instrument indicating AC voltage. Measurement range in use shown on indicator lamp.

AC Ammeter (Optional): Dual range instrument indicates AC generator line current.

Frequency Meter (Optional): Indicates generator output frequency in hertz.

Voltage Adjusting Rheostat: Provides approximately plus or minus five percent adjustment of the rated output voltage.

Upper and Lower Scale Indicator Lamps (Optional): Indicates which scale to use on the AC voltmeter and ammeter.

Phase Selector Switch: Selects phases of generator output to be measured by AC voltmeter and ammeter.

Excitation Field Breaker: Provides generator exciter and regulator protection from overheating in the event of certain failure modes of generator, exciter and voltage regulator.

6. Operation

AWARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is polsonous and can cause unconsciousness and death. Symptoms of carbon monoxide polsoning can include:

- Dizziness
- Nausea
- Headache
- Weakness and Sleepiness
- Throbbing in Temples
- Muscular Twitching
- Vomiting
- Inability to Think Coherently

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Protection against carbon monoxide inhalation also includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.

GENERAL

This section describes generator set operation, including pre-start checks, starting, running, and stopping the set. Study this entire section carefully before starting the set. Be completely familiar with the set for safe operation.

ACAUTION Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.

AWARNING Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [--] first).

Arcing can ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (--) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (--) cable first, and reconnect it last.

PRESTART CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation. Refer to the *Maintenance* section for the recommended procedures.

Ventilation

Verify all air vents and ducts are open and free from any obstructions. Verify dampers, if used, operate properly.

Mechanical Checks

Check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately.

Coolant

Check the coolant level. Fill the cooling system with the recommended coolant if low.

Lubrication

Check the engine oil level. Keep the oil level near as possible to the dipstick high mark without overfilling.

Fuel

Make sure the fuel tank has sufficient fuel and that the fuel system is primed.

DC Electrical System

Check the terminals on the batteries for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always disconnect both ends of the negative battery cable. Reconnect one end of the cable to the negative battery terminal and the other end to ground. This will make sure that any arcing will be away from the battery and least likely to ignite explosive battery gases.

Fault Lamps: Push the Reset/Lamp switch on the control panel. All indicator lamps should light. Verify that all the bulbs are on and then release the switch. Replace any bulbs that are burned out.

STARTING

The following sections cover the three methods used to start the generator set.

\triangle CAUTION Phase rotation of the genset and utility must be the same. Equipment damage can occur. Check and reconnect as necessary.

Check the rotation of 3-phase motors before loading and reconnect if necessary.

A CAUTION Preheating the engine longer than one minute before cranking the engine can destroy the manifold heater and glow plugs, because there is no incoming air flow to cool them. For this reason, do not exceed the one minute preheat periods, to prevent heater burnout and conserve the battery.

Preheat

The preheat circuit provides a signal during time delayed start and during cranking to activate the engine glow plugs and the manifold heater.

Delayed Starting

The time delay start function precludes automatic start-up of the genset for a determined amount of time (1/2 to 15 seconds). It is used for installations that might experience power interuptions of short duration, and not want the genset to start and also for the preheat function noted above.

Starting at Control Panel

- 1. Press the Preheat switch (Figure 6-1) to preheat and hold it there for:
 - One minute if the outdoor temperature is below 55° F (13° C)
 - Thirty seconds if the outdoor temperature is above 55° F (13° C)

In extreme cold (below 32° F [0° C]) it may be necessary to maintain preheating for two minutes after the engine starts, to obtain firing or smooth out cylinders, especially at no load or light loads. 2. Release the Preheat switch and move the Run/ Stop/Remote switch to the RUN position. This activates the engine control system and the starting system. The starter will begin cranking, and after a few seconds, the engine should start. The starter will disconnect when the engine speed reaches 450 to 570 r/min.

If the engine does not start, the starter will disengage after a specified period of time and the control will indicate an overcrank fault. Generator sets with the standard overcrank control will crank continuously for up to 75 seconds before disengaging the starter. Generator sets with the cycle cranking option will crank for 15 seconds in each cycle until 3 cycles have been completed.

To clear an overcrank fault, place the Run/ Stop/Remote switch in the STOP position and momentarily depress the Reset switch. Wait two minutes for the starter motor to cool, then repeat the starting procedure. If the engine does not run after a **second attempt** at starting, refer to the *Troubleshooting* section.

A CAUTION Overvoltage will destroy the glow plugs and air heater in 2 to 3 seconds. If extra power is needed to start the set, connect an additional 12 volt battery in parallel to the starting battery. Do not apply overvoltage to the starting circuit at any time.

Starting From Remote Location

Move the Run/Stop/Remote switch on the genset control panel to the REMOTE position. This allows the generator set to be started from a remote switch. Closing the remote switch initiates the starting sequence described in the previous section.

Automatic Starting and Stopping

Place the Run/Stop/Remote switch on the generator set DC panel in the REMOTE position if an automatic transfer switch is used. This allows the transfer switch to start the generator set if a power outage occurs and stop it when the power returns.

27

Cold Starting With Loads

In addition to the following recommendations, the RDJC generator set will require the installation of the constant glow plug kit. This will enable the set to start and accept a load within 10 seconds when ambient temperatures are above $40^{\circ}F$ ($4^{\circ}C$).

In accordance with NFPA 110, Onan recommends installing diesel standby generator sets (life safety systems) equipped with coolant heaters in locations where the minimum ambient temperature is above $40^{\circ}F$ (4°C). NFPA also requires that the engine coolant be maintained at a minimum of 90°F (32°C) and for most applications, accept the emergency load in 10 seconds or less. Although most Onan generator sets will start in temperatures down to -25°F (-32°C) when equipped with coolant heaters,

1

it might take some running time to warm the engine up before a load can be applied when ambient temperatures are below 40°F (4°C).

The Low Engine Temperature (LET) lamp on the Onan Detector 12 control is provided to meet the requirements of NFPA 110. The LET sensor alarms when the engine coolant temperature falls below $70^{\circ}F$ (21°C). In applications where the ambient temperature falls below $40^{\circ}F$ (4°C), the LET may be lit even though the coolant heaters are connected. Under these conditions, although the generator set may start, it may not be able to accept load within 10 seconds. When this condition occurs, check the coolant heaters for proper operation. If the coolant heaters are operating properly, other precautions might be necessary to warm the engine before applying a load.

FIGURE 6-1. CONTROL PANEL (DETECTOR 12 SHOWN)

RUNNING

With the genset running, listen for any unusual noises that may indicate mechanical problems and check the oil pressure frequently. Investigate any-thing that indicates possible mechanical problems.

Before operating the genset under load, make certain the genset will perform correctly by checking the following areas.

Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler and exhaust pipe and rain cap (if equipped). Check for leaks at all connections, welds, gaskets and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the genset and have leaks corrected immediately.

<u>AWARNING</u> Inhalation of exhaust gases can result in severe personal Injury or death. Be sure deadly exhaust gas is piped outside and away from any windows, doors or other inlets to building.

Fuel System

With the generator set operating, inspect the fuel supply lines, return lines, filters and fittings for cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, have them corrected immediately.

AWARNING Ignition of fuel can cause severe personal injury or death by fire or explosion. Do not permit any flame, cigarette, spark, pilot light, arcing equipment, switch or other igniter near the fuel system.

Engine Gauges

Check the following while the genset is operating. Refer to Figure 6-1 for location of engine gauges. **Oll Pressure Gauge:** The oil pressure should be 35 to 55 psi (241 to 379 kPa) when the engine is at operating temperature.

Coolant Temperature Gauge: The coolant temperature should be 170° to 216° F (77° to 102° C) depending on the load and ambient temperature.

DC Voltmeter: This is a voltage reference gauge, indicating condition of the batteries and also of battery charging circuit. Gauge should read approximately 12 to 14 volts while genset is running. If reading is high or low, check batteries and the battery charging circuit.

Generator AC Meters (Optional)

Check the following meters while the genset is operating. Refer to Figure 6-1 for location of the generator AC meters.

Frequency Meter: The generator frequency should be stable and the reading should be the same as the nameplate rating (50 or 60 hz).

The generator frequency is a result of engine speed, which is automatically controlled. If the generator frequency is below specification, contact an authorized service center.

AC Voltmeter: Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2 on single phase gensets: L1-L2, L2-L3, and L3-L1 on three phase gensets). Read the AC voltmeter using the upper or lower scale as indicated by the scale indicator light. At no load, the line-to-line voltage should be the same as the genset nameplate rating. If the reading is incorrect, refer to the Generator Voltage Adjustment procedure at the end of this section.

AC Ammeter: Turn the phase selector switch to each phase selection shown on the amperes scale (L1 and L2 on single phase gensets; L1, L2 and L3 on three phase gensets). Read the ammeter using the upper or lower scale as indicated by the scale indicator light. At no load, the current readings should be zero. With a load applied, each line current should be approximately the same, and no line current should exceed the genset nameplate rating.

STOPPING

Before Stopping

Run the genset at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

Normal Stop

If the genset was started at the genset control panel or at a remote control panel, move the Run/Stop/ Remote switch or remote starting switch to the STOP position. If the stop circuit fails, push the governor arm down to shut off fuel injection pump.

If the set was started by an automatic transfer switch, the genset will automatically stop about 15 minutes after the normal power source returns.

Time Delayed Stopping

The time delay stop function (adjustable from 0.5 to 15 minutes) provides for automatic cool-down running of the genset for a preset amount of time (approximately 3 to 5 minutes is recommended).

Emergency Stop (Optional)

An optional emergency stop button is located on the right side of control panel. Push the button in for emergency stop. Note that no fault indicators will light when the emergency button is used. To reset the fault circuitry, pull the emergency stop button out and move the Run/Stop/Remote switch to the Stop position. Then move the test switch to Reset/ Lamp Test position.

Engine Monitor Indicator Lamps

With the genset stopped, hold the Reset/Lamp Test switch in the Test position (see Figure 6-1). All indicator lamps should light. Verify all of the lamps are on and then release the switch. Contact an Onan distributor if any lamps require replacement.

Mechanical Checks

With the genset stopped, check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage. If any problems are found, have them corrected immediately.

BREAK-IN .

Observe the following schedule for genset break-in:

- 1. One half hour at 1/2 load.
- 1. One half hour at 3/4 load.
- 3. Full load.

During the first few hundred hours of operation, the genset load should be at least 1/2 to full load. Continuous operation below this load recommendation, can result in poor piston ring seating, causing higher-than-normal oil consumption and blowby.

Drain and replace the crankcase oil after the first 50 hours of operation on new generator sets. Refer to the Maintenance section of this manual for the recommended procedures.

NO-LOAD OPERATION

Periods of no-load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a "dummy" electrical load. Such a load could consist of a heater element, etc.

EXERCISE PERIOD

A<u>CAUTION</u> Improper exercising of the generator set may cause more damage than no exercising at all. Significant amounts of water and raw fuel will remain in the lubrication oil if the unit is run at a low operating temperature. Also, operating the engine at no load or at low temperatures causes carbon buildup and exhaust system fouling. Continued operation in this manner may cause starting failure and/or engine damage. Exercising a generator set without exercising its associated controls and switchgear does not test the operation of the controls and switchgear. If the control systems are not fully functional, the system may fail to provide power when required.

Infrequent use of the generator set can cause it to deteriorate. The following can occur:

- Condensation in the fuel and lubrication system, causing contamination and/or corrosion
- Loss of protective oil film on moving engine parts
- Loss of engine fuel prime due to drain-back and/or evaporation
- Battery discharge due to internal and external current leakage
- Breakdown of generator insulation due to water absorption

Proper exercising does the following:

- Elevates engine oil temperature to at least 180°
 F (82.2° C)
- Evaporates water from engine lubrication system
- Re-establishes a protective oil film on engine parts
- Recharges battery to full normal potential
- Brings generator to normal operating temperature through load application

The generator set should be exercised at least once each week; the engine oil temperature should be held at 180° F (82.2° C) for at least 30 minutes during this exercise.

To exercise the generator set, do the following;

- 1. Perform all required maintenance checks, start the unit, and apply a load (50 percent or more) by creating a simulated power failure*. This exercises the control and switchgear systems.
- 2. After the genset has reached its normal operating temperature, allow the genset to run an additional 30 minutes.
- Shut the unit down by simulating the return of normal power*. Run the set for approximately three to five minutes with no load to allow the engine to cool down.
- This applies to a standby genset only. Other units should be started and loaded by control and load application systems normally associated with operation of the unit.

After each exercise period, refill the fuel tank and check the engine for leaks and overall condition. Locate the cause of any leaks and correct.

HIGH TEMPERATURES

- 1. Make certain that nothing obstructs air flow to and from the set.
- 2. Be sure that the set location is properly ventilated.
- 3. Check the level of battery electrolyte frequently, and add approved water when necessary to maintain the proper level.
- 4. Keep the cooling system clean and the radiator filled, and see that the fan belt tension is properly adjusted.

LOW TEMPERATURES

- 1. Use the correct viscosity oil for the prevailing temperature. Change oil only when the engine is warm. If an unexpected temperature drop causes an emergency, move the set to a warm location or apply externally heated air until the oil flows freely (never use an open flame).
- 2. Use fresh fuel, and protect against moisture condensation.
- 3. Keep the fuel system clean, and maintain the batteries in a well-charged condition.
- 4. Use additional preheating for cold starts.

DUST AND DIRT

- 1. Keep the generator set and the cooling system clean.
- 2. Service the air cleaner as frequently as necessary
- 3. Change the crankcase oil every 100 operating hours. Keep the governor linkage clean.

HIGH ALTITUDE

Maximum power is reduced approximately 4 percent for each 1000 feet (305 m) altitude.

POWER RATING FACTORS.

The generator set power rating applies to sets used in standby applications. The set will operate at the stated rating for the duration of normal utility power interruptions. The rating was established for a standard radiator cooled set running on diesel fuel and operating at an altitude of 300 feet (92 m) with an ambient temperature of 81° F (27° C). For a rating relative to other applications, altitudes, cooling systems, or ambient temperatures, contact an authorized service center.

7. Adjustments

GENERATOR VOLTAGE CHECK AND ADJUSTMENT

If the optional AC meters are installed, an external control panel-mounted potentiometer is provided for adjusting the AC output (see Figure 7-1). Output voltage can be adjusted plus or minus five percent of nominal voltage by turning this potentiometer. Call your distributor if the required voltage cannot be obtained by this adjustment.

Move the Run/Stop/Remote switch on the engine control panel to the Run position. Check the following conditions while the genset is operating.

AWARNING Use extreme caution when working on electrical components. High voltages can cause injury or death. Do not wear jewelry or damp clothing (particularly wet shoes) or allow skin surface to be damp when handling electrical equipment.

- 1. Move the Phase Selector switch to read generator output current and voltage, and perform the following steps:
 - A. Insert a screwdriver into the Voltage Adjust potentiometer located on the front of the genset control panel and using a wrench carefully loosen the locking nut.
 - B. While observing the voltmeter, slowly turn the screwdriver clockwise to increase voltage or counterclockwise to decrease voltage, and adjust to the rated nameplate voltage.

If correct voltage cannot be attained through this adjustment, contact an authorized service center for assistance.

- C. After setting the correct voltage, tighten the locking nut, being careful not to change the adjustment.
- 2. Move the Phase Selector switch to the Off position.

FIGURE 7-1. CONTROL PANEL (DETECTOR 12 SHOWN)

GOVERNOR

The governor controls engine speed. On a 4 pole generator, engine speed equals frequency multiplied by 30. Thus 1800 rpm generates 60 hertz. Preferred engine speed does not vary more than 3 hertz from no-load to full-load operation. Be sure that the throttle, linkage, and governor mechanism operate smoothly.

Speed Adjustment

To change the governor speed, change the spring tension by turning the governor speed adjusting nut (Figure 7-2). Turn the nut clockwise (more spring tension) to increase rpm, or counterclockwise to reduce governed speed. Use a stroboscope or a frequency meter to make this adjustment.

Sensitivity Adjustment

If the governor is too sensitive, a rapid hunting condition occurs (alternate increasing and decreasing speed). Adjust the governor for maximum sensitivity without hunting. After making the sensitivity adjustment, readjust the speed.

To adjust governor sensitivity (no-load to full-load speed droop), turn the sensitivity adjusting ratchet as follows.

Radiator cooled Sets: Turning the ratchet clockwise provides more sensitivity (less speed drop when full load is applied), and turning it counterclockwise provides less sensitivity (more speed drop).

City Water Cooled Sets: Turning the ratchet counterclockwise provides more sensitivity (less speed drop when full load is applied), and turning it clockwise provides less sensitivity (more speed drop).

FIGURE 7-2. ADJUSTING GOVERNOR

VALVE CLEARANCE ADJUSTMENTS

Check the valve clearance when the engine is at room temperature, about 70° F (21° C).

A CAUTION Incorrect valve clearance adjustment can lead to irrevocable damage to the generator set. Make certain that only qualified personnel perform this adjustment.

1. Turn the flywheel until the cylinder which is to have its valve adjusted is on its compression stroke. On engines without a hand crank, use a socket wrench on the flywheel hex head screw.

To determine if the cylinder is in its compression stroke, observe the push rods as the engine is rotated in a clockwise direction. The exhaust valve push rod will be in its lowest position, and the intake valve push rod will be moving downward. As the piston reaches top dead center, the flywheel timing mark should be aligned with the timing pointer, and the valve push rods should be stationary.

- 2. Turn the flywheel an additional 10 to 45 degrees clockwise (estimated). When the piston is in this position, it is in its power stroke, with both valves completely closed.
- 3. Check cylinder head-bolt torque prior to valve clearance adjustment. Torque values are listed in the *Specifications* section. Adjust valve clearance with the locknut which secures the rocker arm to the cylinder head (Figure 7-3). Loosen this locknut to increase clearance, tighten it to reduce clearance.
- 4. Using a feeler gauge, check the clearance between the rocker arm and the valve (Figure 7-4). Increase or decrease the clearance until the proper gap is established. Valve clearances are listed in the *Specifications* section.

FIGURE 7-3. VALVE CLEARANCE ADJUSTMENTS

FIGURE 7-4. CHECK VALVE CLEARANCE

CENTRIFUGAL SWITCH

The start-disconnect centrifugal switch (Figure 7-5) is located on the side of the engine, above the oil filter. The switch opens when the engine stops, and closes when engine speed reaches 900 rpm. If necessary, loosen the stationary contact and adjust the point gap to 0.020 inch (51 mm). Replace burned or faulty points.

AWARNING High voltage, which can cause severe personal injury or death, is present at the breaker point gap. Disconnect the battery cable, negative (--) terminal first, before setting the breaker point gap.

FIGURE 7-5. CENTRIFUGAL SWITCH ADJUSTMENT

CHARGE RATE ADJUSTMENT

The adjustable resistor slide tap (Figure 7-6) in the charging circuit is set to produce a 2 ampere charging rate. This resistor is found in the generator air outlet. For applications requiring frequent starts, check the battery specific gravity periodically. If necessary, increase the charging rate slightly (move the slide tap up). Adjust this slide tap only when the engine is stopped.

AWARNING Batteries present the hazard of explosion, which can result in severe personal injury. Because batteries produce explosive gas, do not smoke or allow any flame, sparks, or arc-producing devices in the battery area.

Avoid overcharging the battery. Make small increments of change until the proper rate has been determined to keep the battery charged.

FIGURE 7-6. CHARGING RESISTOR

8. Troubleshooting

The generator set has sensors that continuously monitor the engine for abnormal conditions, such as low oil pressure or high coolant temperature. If these conditions occur, the engine monitor activates a fault lamp, and may also stop the engine (depending on the condition). If the generator set is stopped for this reason, the operator may be able to restart the set after making adjustments or corrections. This section describes the fault condition system, and suggests troubleshooting procedures.

The standard seven light control has a single green light to indicate RUN, two amber lights and four red fault lights. The optional twelve-light control has a single green light to indicate RUN, four amber lights and seven red fault lights. Both controls also have a terminal connection for a customer supplied audible alarm, which sounds when a fault occurs.

SAFETY CONSIDERATIONS

High voltages are present inside the control box and generator output box when the set is running. Do not open the control box or generator output box while the set is running.

<u>AWARNING</u> Contacting high voltage components can cause electrocution, resulting in severe personal injury or death. Keep control and output box covers in place during troubleshooting.

Generator set installations are normally designed for automatic starting or remote starting. When troubleshooting a set that is shut down, make certain the generator set cannot be accidentally restarted. Place the Run/Stop/Remote switch in the STOP position and remove the negative battery cable from the set starting battery.

AWARNING Accidental starting of the generator set during troubleshooting can cause severe personal injury or death. Disable the generator set before troubleshooting.

When a fault lamp turns on during operation, follow the procedures listed below to locate and correct the problem. For any symptom not listed, contact an authorized service center for assistance.

Resetting the Control

The external alarm and fault lamp may be deactivated by moving the Run/Stop/Remote switch to the Stop position and pressing the Reset/Lamp Test/Preheat switch. Locate the problem and correct it before restarting the set. While pressing the Reset/Lamp Test/Preheat switch, make certain that all lamps light.

Line Circuit Breaker (Optional)

The line circuit breaker mounts on the generator output box. If the load exceeds the circuit breaker current rating, the line circuit breaker will open, preventing the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as necessary. Manually reset the breaker to reconnect the load to the generator.

TABLE 8-1. TROUBLESHOOTING

AWARNING Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages III and IV.

SYMPTOM	CORRECTIVE ACTION
1. Green RUN lamp lights following engine startup.	1. Indicates all engine systems are normal. No correc- tive action required.
2. PRE HI ENGINE TEMP lamp lights. En- gine continues to operate.	 Indicates engine is operating near its capacity and temperature has risen to approximately 220°F (104° C) or coolant level is low on optionally wired sets. If generator is powering non-critical and critical loads and cannot be shut down, use the following:
	a. Reduce load if possible by turning off non-critical loads.
•	b. Check air inlets and outlets and remove any ob- structions to airflow.
	if engine can be stopped, follow procedure in step 3.
3. HI ENG TEMP lamp lights. Engine shuts down.	 Indicates engine has overheated (engine tempera- ture has risen above 230°F/110°C) or coolant level is low. Allow engine to cool down completely before proceeding with the following checks:
- -	a. Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary.
	b. Check for obstructions to cooling airflow and correct as necessary.
	c. Check for a slipping fan belt and tighten if loose.
	d. Reset control and restart after locating and cor- recting problem. Contact an authorized service center if none of the above.
4. PRE LO OIL PRES lamp lights. Engine continues to operate.	4. Indicates engine oil pressure has dropped to 20 psi (138 kPa). If generator is powering critical loads and cannot be shut down, wait until next shutdown period and then follow step 5 procedure. If engine can be stopped, follow procedures in step 5.
5. LO OIL PRES lamp lights. Engine shuts down. NOTE: See also step 6.	 Indicates engine oil pressure has dropped to 14 psi (97 kPa). Check oil level, lines and filters. If oil system is OK but oil level is low, replenish. Reset control and restart. Contact an authorized service center if oil pressure is 20 psi (138 kPa) or lower.

TABLE 8-1. TROUBLESHOOTING (continued)

<u>AWARNING</u> Many troubleshooting procedures present hazards which can result in severe personal Injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages iii and iv.

SYMPTOM	CORRECTIVE ACTION
6. OVERCRANK lamp lights and engine	6. Indicates possible fuel system problem.
stops cranking. or	 a. Check for loss of engine prime, empty fuel tank, fuel leaks, or plugged fuel lines and correct as required.
Engine runs, shuts down, and LO OIL PRES lamp lights	b. Check for dirty fuel filter and replace if necessary (see <i>Maintenance</i> section).
	c. Check for dirty or plugged air filter and replace if necessary (see <i>Maintenance</i> section).
	d. Reset the control and restart after correcting the problem. Contact an authorized service center for service if none of the above.
7. Engine runs and then shuts down, OVERSPEED lamp lights.	 Indicates engine has exceeded normal operating speed. Contact an authorized service center for service.
*8. SWITCH OFF lamp flashes.	8. Indicates Run/Stop/Remote switch is in the Stop po- sition which will prevent automatic starting if an auto- matic transfer switch is used. Move the Run/Stop/ Remote switch to the Remote position for automatic starting.
*9. LO FUEL lamp lights. Engine continues to run.	9. Indicates diesel fuel supply is running low. Check fuel supply and replenish as required.
*10. LO FUEL LAMP lights. Engine shuts down and LO OIL PRES lamp lights.	10. Indicates engine has run out of fuel. Check fuel level and replenish as required.
 *11. LO ENG TEMP lamp lights. Set is in standby mode but is not operating. (Lamp lights when engine coolant temperature is 70° F (21° C) or lower. Since the lamp goes out after the engine warms up, there should be no cause for alarm even during initial generator set 	11. Indicates engine coolant heater is not operating, is not circulating coolant, or ambient temperature has exceeded capability of heater. Check for the follow- ing conditions:
	a. Coolant heater not connected to power supply. Check for blown fuse or disconnected heater cord and correct as required.
operation.)	 b. Check for low coolant level and replenish if re- quired. Look for possible coolant leakage points and repair as required.
	c. Contact an authorized service center if none of the above.

* 12-Light Control Only.

TABLE 8-1. TROUBLESHOOTING (continued)

AWARNING Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages ill and iv.

SYMPTOM	CORRECTIVE ACTION
*12. The FAULT 1 or FAULT 2 fault lamp lights. Engine shuts down immediately, engine runs for several seconds and then shuts down, or engine continues to run.	12. The standard undesignated fault functions are pro- grammed to shut down the set when a fault is sensed. Fault 1 is time delayed while Fault 2 is immediate. The nature of the fault is an optional selection that is determined when the set installation is designed. The undesignated fault functions may also be pro- grammed for non-shutdown or non-time delay.
13. Fault lamp lights but no fault exists. En- gine gauges show oil pressure, engine temperature, and frequency (speed) are within normal limits.	13. The monitor board or a sensor may be at fault. Con- tact an authorized service center for service.
14. Engine starts from generator control panel but will not start automatically or from a remote panel. (Note: The Run/ Stop/Remote switch must be in the Re- mote position for automatic or remote starting).	14. Remote circuit breaker is tripped. Reset breaker and restart. Contact an authorized service center if breaker trips after resetting.
15. Engine will not crank.	15. Indicates possible fault with control or starting sys-
	a. Fault lamp on. Correct fault and reset control.
	b. Poor battery cable connections. Clean the bat- tery cable terminals and tighten all connections.
	c. Discharged or defective battery. Recharge or replace the battery.
	d. Emergency stop button (if equipped) pushed in. To reset, pull switch out and move Run/Stop/Re- mote switch to Stop position. Then push test switch to Reset/ Lamp position.
	e. Contact an authorized service center if none of the above.
16. No AC output voltage.	16. Field breaker is tripped. Reset breaker. Contact an authorized service center if voltage buildup causes breaker to trip.
17. Green RUN lamp does not light follow- ing engine startup.	17. Indicates possible Start/Disconnect relay failure. Contact an authorized service center for assistance.

* 12-Light Panel Only.

9. Maintenance

GENERAL

Establish a maintenance/service schedule based on the type of application, and on the severity of the environment. The Table 9-1 lists the recommended service intervals. In extreme operating conditions, reduce the service intervals accordingly. Factors that affect the maintenance schedule include the following:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

Consult with an authorized service center if the set is subject to extreme operating conditions, and determine a suitable maintenance schedule. Perform all service at the time period indicated, or after the number of operating hours indicated, whichever comes first. Use Table 9-1 to determine the required maintenance. Refer to this section for maintenance procedures. **A CAUTION** Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.

AWARNING Accidental starting of the generator set while working on it can cause severe personal injury or death. Prevent accidental starting by disconnecting the starting battery cables (negative [–] first).

Arcing can Ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (--) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (--) cable first, and reconnect it last.

HOURS OF OPERATION	MAINTENANCE TASK
8	 Inspect exhaust system Inspect generator set Check fuel supply; See Note 1 Check oil level
50	 See Note 2 Check air cleaner; See Note 3 Change crankcase oil after first 50 hours
100	 Clean governor linkage Change crankcase oil (or annually); See Note 3 Clean sediment bowl and filter on fuel transfer pump; See Note 1 Replace oil filter Check battery condition
200	Clean crankcase breather
500	 Check start-disconnect circuit Check valve clearances; See Note 4 Clean crankcase breather tube
600	Change primary fuel filter
1500	Check torsional washers for corrosion; See Note 5
2000	 Grind valves (if required); See Note 4 Check nozzle spray pattern; See Note 4 Clean generator
3000	Change secondary fuel filter
5000	General overhaul (if required); See Note 4

TABLE 9-1. MAINTENANCE SCHEDULE

- 1. Water or foreign material in fuel can ruin the injection system. If daily inspection shows water or excessive dirt in sediment bowl, fuel handling and storing facilities should be checked and situation corrected. Primary and secondary fuel filters can be replaced following correction of fuel contamination problem.
- 2. Tighten head bolts and adjust valve clearance after first 50 hours on new and overhauled engines, and then adjust valve clearance each 500 hours thereafter.
- 3. Perform more often in extremely dusty conditions.
- 4. Contact an authorized service center for service.
- 5. Check yearly on non-commercial sets.

GENERATOR SET INSPECTION

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. Section 6 of this manual covers the areas that should be frequently inspected for continued safe operation.

LUBRICATION SYSTEM

The engine oil was drained from the crankcase before shipment. Before the initial start, the lubrication system must be filled with oil of the recommended classification and viscosity. Refer to *Specifications* section for the lubricating oil capacity.

Oil Recommendations

The use of quality engine lubricating oils combined with appropriate oil drain and filter change intervals are critical factors in maintaining engine performance and durability.

Use SAE 15W40 oil that meets the American Petroleum Institute (API) Classification CC/CD, CD/SG or CE/SG. Table 9-2 shows the preferred oil grades for ambient temperatures indicated.

CC/CD or CD/SG engine oils can be used in areas where CE oil is not yet available, but the oil change interval must be reduced to one half the interval given in the Maintenance Schedule.

The use of a multi-viscosity lubricating oil has been found to improve oil consumption control and improve engine cranking in cold temperatures while maintaining lubrication at high operating temperatures. While 15W-40 oil is recommended for most climates, refer to Table 9-2 for oil viscosity recommendations for extreme climates.

A CAUTION Limited use of low viscosity oils, such as 10W-30 may be used for easier starting and providing sufficient oil flow at ambient temperatures below 23° F (-5° C). However, continuous use of low viscosity oils can decrease engine life due to wear. Refer to the accompanying chart.

In extremely dusty or dirty conditions, oil should be changed more frequently. When adding oil between changes, use the same brand as already in the engine. Various brands of oil may not be compatible when mixed.

Engine Oil Level

A CAUTION Do not operate the engine with the oil level below the LOW mark or above the FULL mark. Overfilling can cause foaming or aeration of the oil while operation below the ADD mark can cause loss of oil pressure.

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance Schedule. The oil dipstick and oil fill are located on the side of the engine (Figure 9-1). The dipstick is stamped with FULL and LOW to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 10 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

Keep the oil level as near as possible to the FULL mark on the dipstick. Remove the oil fill cap and add oil of the same quality and brand when necessary.

FIGURE 9-1. OIL LEVEL INDICATOR

Oil Change

AWARNING Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.

Change the oil and filter at the intervals recommended in the Maintenance Schedule.

Stop the engine and drain the crankcase oil while the engine is still hot. Place a pan under the drain outlet and remove the oil drain plug or open the oil drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Replace oil filter if necessary before adding oil.

Refill with oil of the correct API designation and SAE viscosity grade for the temperature conditions (refer to Table 9-2).

AWARNING Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.

Check the oil level indicator after every 8 hours of operation, and maintain the oil level at the FULL mark (Figure 9-3). Refer to the *Specifications* section for crankcase and filter capacity.

Oil Filter Change

<u>AWARNING</u> Hot crankcase oil can cause burns if it is spilled or splashed on skin. Keep fingers and hands clear when removing the oil drain plug and wear protective clothing.

Place a container under the oil filter and remove the filter by turning it counterclockwise. Clean the filter mounting area. Coat the oil filter gasket with clean oil. To install the new filter, turn the filter on clockwise until the gasket touches the mounting base, then tighten 1/2 turn.

FUEL SYSTEM

Use only high-quality fuel in this generator set. Fuel quality is important in obtaining dependable performance and satisfactory engine life. Fuel must be clean, completely distilled, well refined, and noncorrosive to fuel system parts.

AWARNING Ignition of fuel can cause severe personal injury or death by fire or explosion. Do not permit any flame, cigarette, spark, pilot light, arcing equipment or other igniter near the fuel system.

Fuel Recommendations

Use ASTM 2-D (No. 2 Diesel) or ASTM 1-D (No. 1 Diesel) fuel with a minimum Cetane number of 45. Number 2 diesel fuel gives the best economy and performance under most operating conditions. Use number 1 diesel fuel when ambient temperatures are below 0° C (32° F), or during long periods of light engine load.

The fuel's viscosity must be kept above 1.3 cSt to provide adequate fuel system lubrication.

Fuels with Cetane numbers higher than 45 may be needed in higher altitudes or when extremely low amblent temperatures are encountered to prevent misfires and resultant excessive smoke.

Use low-sulfur-content fuel with a cloud point at least 10 degrees below the lowest expected fuel

temperature. (Cloud point is the temperature at which wax crystals begin to form in diesel fuel.)

Fuel Handling Precautions

Take appropriate precautions to prevent the entrance of dirt, water or other contaminants into the fuel system. Filter or strain the fuel as the tank is filled.

A CAUTION Due to the precise tolerances of diesel injection systems, dirt or water in the fuel can cause severe damage to both the injection pump and injector nozzles. Take special precautions to keep the fuel clean and free of water.

To avoid condensation problems, keep fuel tanks as full as possible. In cold weather, warm fuel returning from the engine heats the fuel in the supply tank. If the fuel level is low, condensation tends to form in the upper portion of the tank. In warm weather, the fuel and the tank will both be warm during the daytime. At night, cool air lowers the temperature of the tank more rapidly than the temperature of the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly and condensation will tend to form.

Condensation (water) can clog fuel filters as well as causing freezing problems. Also, water mixing with the sulfur in the fuel forms acid which can corrode and damage engine parts.

Fuel Filters

The filters are spin-off, throw-away units. A water drain is situated at the bottom of the filter case (Figure 9-2). This should be used to drain off moisture either daily or at the end of every exercise period, depending on unit application.

The drain plug on the fuel filter can tolerate only a limited amount of torque. Use two wrenches in combination for breaking the plug loose and for final tightening.

Change the primary and secondary fuel filters at the intervals recommended in the Maintenance Schedule. Change the fuel filters by removing the washer and capscrew on top of the fuel filter body.

FIGURE 9-2. DUAL FUEL FILTERS

Fuel Pump Sediment Bowl

Remove the sediment bowl from the fuel filter body (Figure 9-3). Clean out any contaminants from sediment bowl. When re-installing the sediment bowl, make sure that gasket and screen are in place.

FIGURE 9-3. FUEL PUMP SEDIMENT BOWL

Priming the Fuel System

The fuel system must be primed before initial startup or after the engine has run out of fuel. Prime the fuel system as follows.

- 1. Check fuel level in fuel tank and open shutoff valve.
- 2. Loosen the fuel filter-to-injection pump line at the injection pump fuel inlet fitting (Figure 9-4).
- 3. Actuate the hand priming lever on the fuel transfer pump until the fuel flows from the fit-ting.

If the pump lobe of the camshaft is up (no restriction can be felt when moving priming lever), crank the engine one revolution to permit hand priming:

- 4. Tighten the fuel line at the injection pump inlet.
- 5, Actuate the hand priming lever several more times to prime the injection pump.
- 6. When finished, return priming lever inward (disengaged position) to permit normal pump operation.

AIR CLEANERS

A CAUTION Filters should be handled with care to prevent damage. If the filter does become damaged, install recommended replacement part.

After every 50 hours of operation, remove and clean the filter element (Figure 9-5). After washing the element in solvent, dip the element in engine oil and squeeze it as dry as possible.

FIGURE 9-5. POLYURETHANE FOAM AIR CLEANER

CONTRACTOR MODEL AIR CLEANER

- 1. Remove pre-cleaner (Figure 9-6) and wash out dirt. Dry and reinstall.
- 2. Loosen clamp and remove end cover.
- 3. Remove thumbscrew and take out element. Wash element in detergent and water (use new element after 6 washings). Dry and reinstall.
- 4. Remove air cleaner baffle from cover, wash out dirt, and reinstall in cover.
- 5. Install cover with "TOP" up and tighten clamp.

FIGURE 9-6. CONTRACTOR MODEL AIR CLEANER

GOVERNOR LINKAGE

Every 100 hours, carefully pull the neoprene governor ball joints apart and clean them. Do not lubricate these joints. See Figure 9-7.

ACAUTION Some solvents can damage the neoprene governor ball joints. Read the manufacturer's recommendations before using any lubricants or solvents near the ball joints.

FIGURE 9-7. GOVERNOR BALL JOINT

BATTERIES

<u>AWARNING</u> Ignition of explosive battery gases can cause severe personal injury. Do not smoke or allow any source of ignition while servicing batterles.

Check the condition of the starting battery at the interval specified in the maintenance schedule. To prevent dangerous arcing, always disconnect the negative ground strap from the battery before working on any part of the electrical system or the engine. Disregard the sections on Checking Specific Gravity and Checking Electrolyte Level if using a "maintenance-free" battery.

AWARNING Arcing can ignite the explosive hydrogen gas given off by batteries, causing severe personal injury. Arcing can occur if the negative (–) battery cable is connected and a tool being used to connect or disconnect the positive (+) battery cable accidentally touches the frame or other grounded metal part of the set. To prevent arcing, always remove the negative (–) cable first, and reconnect it last.

A CAUTION Always disconnect a battery charger from its AC source before disconnecting the battery cables. Otherwise, disconnecting the cables can result in voltage spikes high enough to damage the DC control circuits of the set.

Cleaning Batteries

Keep the batteries clean by wiping them with a damp cloth whenever dirt appears excessive.

If corrosion is present around the terminal connections, remove battery cables and wash the terminals with an ammonia solution or a solution consisting of 1/4 pound of baking soda added to 1 quart of water. Be sure the vent plugs are tight to prevent cleaning solution from entering the cells.

After cleaning, flush the outside of the battery and surrounding areas with clean water.

Keep the battery terminals clean and tight. After making connections, coat the terminals with a light application of petroleum jelly or non-conductive grease to retard corrosion.

Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. Correct the reading by adding four gravity points (0.004) for every ten degrees the electrolyte temperature is above 80° F (27° C). A fully charged battery will have a corrected specific gravity of 1.260. Charge the battery if the reading is below 1.215.

Checking Electrolyte Level

ACAUTION Do not add water in freezing weather unless the engine will run long enough (two to three hours) to assure a thorough mixing of water and electrolyte.

Check the level of the electrolyte (acid and water solution) in the batteries at least every 200 hours of operation.

Fill the battery cells to the bottom of the filler neck. If cells are low on water, add distilled water and recharge. If one cell is low, check case for leaks. Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

CRANKCASE BREATHER

Clean the crankcase breather at the intervals recommended in the Maintenance Schedule.

To clean the crankcase breather, remove hose clamp, breather hose, breather cap clamp and insulator halves to release breather cap and valve assembly (Figure 9-8). Wash cap, valve assembly and baffle in suitable solvent. Dry and reinstall.

FIGURE 9-8. CRANKCASE BREATHER

CRANKCASE BREATHER TUBE

Clean the crankcase breather tube at the intervals recommended in the Maintenance Schedule.

To clean the crankcase breather tube, remove both rocker covers (Figure 9-9). The breather tube itself is installed with a sealant on the threads to prevent oil leakage into the intake manifold; it should NOT be removed. A small wire, nail or drill bit inserted through from the top can be used to clean out the breather hole. The breather hole seldom needs cleaning. A 500 hour interval coincides with the valve lash adjustments, because the rocker box covers must also be removed at that time.

FIGURE 9-9. CLEANING BREATHER

TORSIONAL WASHERS

Four torsional washer assemblies are bolted inside the flywheel pulley hub (Figure 9-10). When functioning properly, they react to relieve torsion stresses on the crankshaft. Inspect the assemblies periodically for movement of washers and freedom from corrosion (1500 hours commercial, yearly non-commercial). If condition is questionable, contact an Onan service center or distributor.

FIGURE 9-10. TORSION WASHER ASSEMBLY

OUT-OF-SERVICE PROTECTION

The inherent lubricating qualities of No. 2 diesel fuel normally should protect the cylinders of a diesel engine for at least 30 days when the unit is not in service. To protect an engine that will be out of service for more than 30 days, proceed as follows:

- 1. Exercise the generator set as described in the *Operation* section until the engine is up to operating temperature.
- 2. Shut down the engine. Disconnect battery and store in a cool, dry place. Connect battery to a charger every 30 days to maintain it at full charge.
- 3. Drain the oil base while it is still warm. Refill and attach a warning tag indicating the viscosity of oil used.
- 4. Service the air cleaner.
- 5. Clean throttle and governor linkage and protect by wrapping with a clean cloth.
- 6. Plug the intake and exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
- 7. Clean and wipe the entire unit. Coat parts susceptible to rust with a light coat of grease or oil.
- 8. Provide a suitable cover for the entire unit after unit has cooled down.

RETURNING A UNIT TO SERVICE

- 1. Remove the cover and all protective wrapping. Remove the plug from the intake and exhaust outlet.
- 2. Check the warning tag on the oil base and verify that the oil viscosity is still correct for the existing ambient temperature.
- 3. Clean cooling fin areas.
- 4. Clean and check the battery. Measure the specific gravity (1.260 at 80° F [27° C]) and verify that the level is at the split ring. If the specific gravity is low, charge until the correct value is obtained. If the level is low, add distilled water and charge until the specific gravity is correct. DO NOT OVERCHARGE.

<u>AWARNING</u> Ignition of explosive battery gases can cause severe personal injury. Do not smoke or allow any ignition source while servicing batteries.

- 5. Connect the starting battery (ground terminal last).
- 6. Prime the fuel system.
- 7. Remove all loads before starting the engine.
- 8. Start engine and observe oil pressure gauge and charge rate ammeter.
- 9. After start, apply load to at least 50 percent of rated capacity.
- 10. Unit is ready for service and load may be applied.

10. Maintenance Record

Keep a record of all periodic and unscheduled maintenance. Record the service date and the number of operating hours from the hour meter. Refer to the Maintenance Schedule in Section 8 for the time interval between maintenance procedures. Record the name and address of your Onan service center and keep all of your service receipts.

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14. 14.

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DATE	HOUR METER READING	SERVICE PERFORMED / NOTES
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Record the name, address, and phone number of your authorized Onan service center.

DATE	HOUR METER READING	SERVICE PERFORMED / NOTES
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11. Wiring Diagrams

GENERAL

This section consists of the schematic and connection wiring diagrams referenced in the text. The following drawings are included.

- Page 11-3 Customer Connections at the Engine Monitor Board.
- Page 11-4 Customer Connections at the Auxiliary Relay Board.
- Page 11-5 Generator Reconnection Diagram

TB1-10 (SWITCHED B+ OUTPUT) OUTPUT TO RELAY K12, FUSED AT 20 AMPS, ENERGIZED WHEN THE START SIGNAL IS APPLIED AND DE-ENERGIZED AT SHUTDOWN (NORMAL AND FAULT)

TB1-9 (B+ INPUT) BATTERY POSITIVE (+) CONNECTION

TB1-8 (START SOLENOID) OUTPUT TO RELAY K11, FUSED AT 20 AMPS

TB1-7 (B+ OUTPUT) OUTPUT TO TIME DELAY START/STOP MODULE A15, FUSED AT 15 AMPS, AVAILABLE WHEN THE STARTING BATTERIES ARE CONNECTED

TB1-6 (REMOTE START) CONNECTED TO TIME DELAY START/STOP MODULE A15. CONNECT REMOTE START CONTACT OF THE AUTOMATIC TRANSFER SWITCH TO TERMINAL TB1-5 OF MODULE A15.

TB1-5 (GROUND)

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TB1-4 (COMMON ALARM B+ OUTPUT) 4 AMP RATED DEVICE MAXIMUM TB1-3 (RUN) CONNECTED TO TIME DELAY START/STOP MODULE A15 TB1-2 (DC DISCONNECT) CONNECTED TO TIME DELAY START/STOP MODULE A15

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR **TROUBLESHOOTING, REFER TO THE** WIRING DIAGRAM PACKAGE THAT WAS **INCLUDED WITH YOUR GENSET.**

> TB2-1 (FAULT 2) GROUND INPUT FROM SENDER TB2-2 (FAULT 2) GROUND OUTPUT TO LIGHT/RELAY* TB2-3 (FAULT 1) GROUND INPUT FROM SENDER TB2-4 (FAULT 1) GROUND OUTPUT TO LIGHT/RELAY* TB2-5 (REMOTE RESET) MOMENTARY CONTACT TO GROUND TB2-6 (OVERCRANK FAULT) GROUND OUTPUT TO LIGHT/RELAY* TB2-7 (OVERSPEED FAULT) GROUND OUTPUT TO LIGHT/RELAY* TB2-8 (HIGH ENGINE TEMPERATURE FAULT) GROUND OUTPUT TO LIGHT/RELAY* TB2-9 (LOW OIL PRESSURE FAULT) GROUND OUTPUT TO LIGHT/RELAY* TB2-10 (PRE-HIGH ENGINE TEMPERATURE WARNING) GROUND OUTPUT TO LIGHT/RELAY* TB2-11 (PRE-LOW OIL PRESSURE WARNING) GROUND OUTPUT TO LIGHT/RELAY* TB2-12 (SWITCH OFF WARNING) GROUND OUTPUT TO LIGHT/RELAY* TB2-13 (LOW ENGINE TEMPERATURE WARNING) GROUND OUTPUT TO LIGHT/RELAY* TB2-14 (LOW FUEL WARNING) GROUND INPUT FROM SENDER TB2-15 (LOW FUEL WARNING) GROUND OUTPUT TO LIGHT/RELAY* TB2-16 (EMERGENCY SHUT DOWN) MOMENTARY CONTACT TO GROUND

CUSTOMER CONNECTIONS AT THE ENGINE MONITOR BOARD

300-281

THE TERMINALS IN THE SHADED BOXES ARE FOR CUSTOMER CONNECTIONS

CUSTOMER CONNECTIONS AT THE AUXILIARY RELAY BOARD

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR TROUBLESHOOTING, REFER TO THE WIRING DIAGRAM PACKAGE THAT WAS INCLUDED WITH YOUR GENSET.

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3 PHASE RECONNECTABLE, 12 LEAD

RECONNECTION DIAGRAMS 11-5

34.

Station of

NOTES:

347/600

CONNECT

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- ABOVE 300 VOLTS AC, TERMINALS | & 2: BELOW 300 VOLTS AC, TERMINALS | & 3.
- REGULATOR ONLY.
- LIEU OF MARKING AS FOLLOWS:

 - GEN-7

THIS IS A REPRESENTATIVE (GENERIC) SCHEMATIC/WIRING DIAGRAM. FOR **TROUBLESHOOTING, REFER TO THE** WIRING DIAGRAM PACKAGE THAT WAS **INCLUDED WITH YOUR GENSET.**

347/600V V4-VI 60HZ

TERMINALS 2/3 ARE COMMON AND CONNECTED TO GROUND.

2. DESIGNATIONS V4-V1,-V2 OR -V3 INDICATE CONNECTION OF JUMPER WIRE ON VOLTAGE REGULATOR, VR21. JUMPER MUST BE CONNECTED IN ACCORDANCE WITH OUTPUT VOLTAGE AND FREQUENCY. ALSO, THE LEAD FROM X1-1 MUST BE RECONNECTED TO VR21-6 FOR 60HZ OR VR21-5 FOR 50HZ. THESE INSTRUCTIONS APPLY TO 300-1540

3. WHEN 300-0688 SWITCHING REGUALTOR IS USED, A JUMPER IS INSTALLED ON VR21 BETWEEN TBI-7 AND TBI-8 FOR 50HZ. THIS JUMPER IS REMOVED FOR 60 HZ. 4. GENERATOR VOLTAGE SENSING LEADS GEN-4,-5,-6,-7, & -8 MUST BE CONNECTED TO GENERATOR OUTPUT LEADS AS SHOWN FOR PROPER METERING AND VOLTAGE REGUALATOR OPERATION. LEADS MAY BE COLOR CODED IN GEN-4 LT GRN/BLK GEN-5 TAN/BLK GEN-6 RED/BLK YEL/BLK GEN-8 DK BLU/BLK INSULATE AND TIE BACK ANY UNUSED LEADS.

NO. 625-2758 1 of 1	
REV. A	
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Onan Corporation 1400 73rd Avenue N.E. Minneapolis, MN 55432 Telex: 275477 Fax: 612-574-8087

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