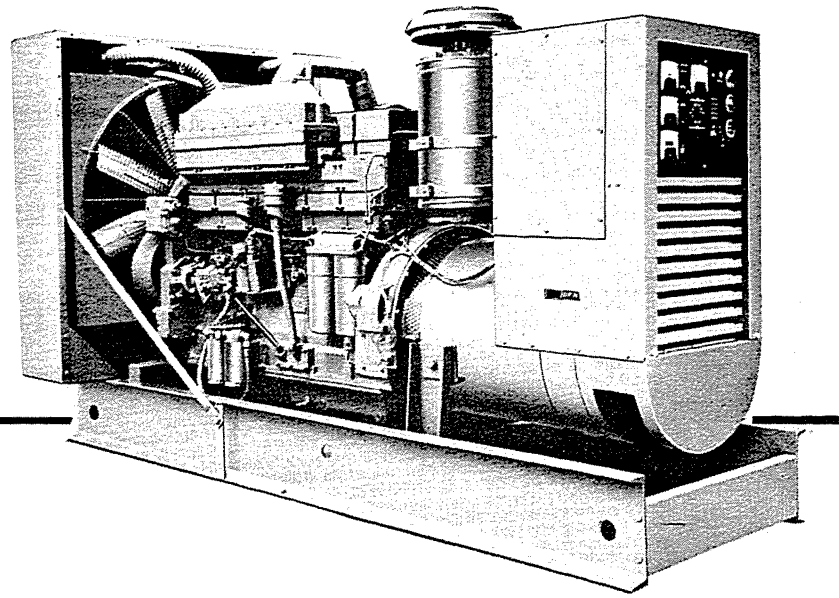
McGRAW-EDISON

Onan

Operators Manual

350 DFN

GenSet



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Safety Precautions

The following symbols in this manual signal potentially dangerous conditions to the operator or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

Read your manual and become thoroughly acquainted with it and your equipment before you start your unit. These recommendations and the following safety precautions are for your protection.

Fuels, electrical equipment, batteries, exhaust gases and moving parts present potential hazards that could result in serious, personal injury. Take care in following these recommended procedures.

WARNING ***This symbol is used throughout this manual to warn of possible serious personal injury or death.***

CAUTION ***This symbol refers to possible equipment damage.***

General

- Keep your electric generating set and the surrounding area clean and free from obstructions. Remove any debris from set and keep the floor clean and dry.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult your local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguisher rated ABC by NFPA.
- Make sure that all fasteners on the generating set are secure. Tighten supports and clamps, keep guards in position over fans, driving belts, etc.
- Do not wear loose clothing in the vicinity of moving parts, or jewelry while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts; cause shock or burning.
- If adjustment *must* be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.
- Do not work on this equipment when mentally or physically fatigued.
- 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. Bleed the system pressure first.

Protect Against Moving Parts

- Keep your hands away from moving parts.
- Before starting work on the generating set, disconnect batteries. This will prevent starting the set accidentally.

Fuel System

- DO NOT fill fuel tanks while engine is running, unless tanks are outside engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT SMOKE OR USE AN OPEN FLAME in the vicinity of the generator set or fuel tank. Internal combustion engine fuels are highly flammable.
- Fuel lines must be of steel piping, adequately secured, and free from leaks. Piping at the engine should be approved flexible line. Do not use copper piping on flexible lines as copper will work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.

Guard Against Electric Shock

- 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 surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages cause injury or death. DON'T tamper with interlocks.
- Follow all state and local electrical codes. Have all electrical installations performed by a qualified licensed electrician. Tag open switches.
- DO NOT SMOKE while servicing batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

Exhaust Gases Are Toxic

- Provide an adequate exhaust system to properly expel discharged gases. Inspect exhaust system daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secure and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

Keep the Unit and Surrounding Area Clean

- Make sure that oily rags are not left on or near the engine.
- Remove all oil deposits. Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and subsequent engine damage and may present a potential fire hazard.

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WARNING

ONAN RECOMMENDS THAT ALL SERVICE INCLUDING INSTALLATION OF REPLACEMENT PARTS ONLY BE DONE BY PERSONS QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE. TO PREVENT PERSONAL INJURY AND/OR EQUIPMENT DAMAGE IT IS IMPERATIVE THAT THE SERVICE PERSON BE QUALIFIED.

Introduction

ABOUT THIS MANUAL

This manual provides general information for operating and maintaining your Onan generator set. Study this manual carefully and observe all warnings and cautions. Using the generator set properly and following a regular maintenance schedule will result in longer unit life, better performance, and safer operation.

GENERATOR SET

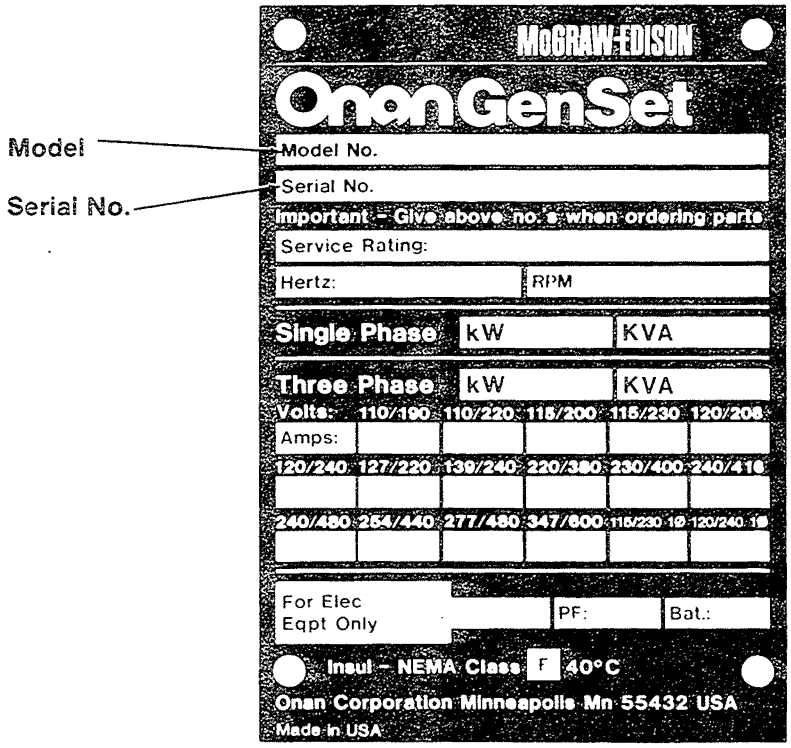
The generator set consists of an Onan generator driven by a Cummins engine. See the *SPECIFICATIONS* section for generator ratings. Refer to the Cummins operator's manual for more specific information about the engine.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact an Onan Distributor for assistance. Onan's factory trained Parts and Service representatives are ready to handle all your service needs.

When contacting an Onan Distributor, always supply the complete Model number and Serial number as shown on the Onan nameplate. The Onan nameplate is located on the side of the generator control box.

A separate identification nameplate is attached to the engine by the engine manufacturer. When requesting parts or service for the engine, always provide the engine manufacturer's model number, serial number, etc., to avoid confusion.



Onan Nameplate

Specifications

GENERATOR DETAILS

Type	Onan, Revolving Field, 4-Pole, Brushless
Rating	
60 Hertz Continuous Standby	350 kW (437.5 kVA at 0.8 PF)
50 Hertz Continuous Standby	290 kW (362.5 kVA at 0.8 PF)
AC Voltage Regulation	±2%
Phase	3

ENGINE DETAILS

Engine	Cummins, Model KTA-1150-G
Engine Speed	
50 Hertz Operation	1500 r/min
60 Hertz Operation	1800 r/min
Fuel	ASTM No. 2 Diesel
Fuel Pump Inlet Thread Size	7/8-14 UNF 2A
Fuel Return Outlet Thread Size	3/4-16 UNF 2A
Fuel Pump Maximum Lift	5 ft (1.52 m)
Exhaust Outlet (Pipe Tapped)	5 in.-NPT EXT
Starting System Voltage	24
Battery Requirements	
BCI Group Size	8D
Cold Cranking Amps @ 0° F (-18° C)	975
Amp Hour Capacity	225 (810 kC)
Battery Voltage	12
Quantity Required	2
Cooling System (Engine and Radiator)	23.5 gal (89 litre)
Engine Oil Capacity (Filter, Lines, and Crankcase)	12.5 gal (47.3 litre)

Installation

GENERAL

Most generator set installations must be engineered to insure that the generator set will function properly under the expected load conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing components. The complete installation must comply with all local and state building codes, fire ordinances and other regulations that may apply. Also refer to Onan Technical Bulletin T-030 for detailed installation information.

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 installation.
- Water supply (city water cooling).
- Accessibility for operation and servicing.
- Vibration isolation.
- Noise levels.

LOCATION AND MOUNTING

Generator set location depends upon related systems such as ventilation, wiring, fuel, and exhaust. Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions. Locate as near as possible to the main power fuse box. Figure 1 shows a typical installation.

Allow access space to the generator set for servicing, and provide adequate lighting around the unit. Wood floors should be covered with sheet metal extending 12 inches (305 mm) beyond the extremities of the set.

Mount and secure the generator set on a substantial and level base such as a concrete pad. For convenience in general servicing such as changing the crankcase oil, the surface of the mounting base should be at least 6 inches (152 mm) above the floor. Use anchored mounting bolts to secure the generator set to the base to prevent movement. Refer to unit outline drawing for proper spacing of mounting bolts and unit mounting dimensions.

Where vibration control is critical, spring type or pad type vibration isolators can be installed between the skid frame and mounting base. Refer to Onan Technical Bulletin T-030 for more detailed information.

VENTILATION

Generator sets create considerable heat which must be removed by proper ventilation. Outdoor installations rely on natural air circulation but indoor installations need properly sized and positioned vents for the required airflow.

Vents and Ducts

Locate vents so cool, incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement. See Figure 1.

Size vents and ducts large enough to allow the required flow rate of air. "Free area" of louvers, screens and ducts must be as large as the radiator area (when radiator is used). The inlet air vent should be 1-1/2 times the size of the radiator outlet vent.

Cooling air travels from the rear of Onan generator sets to the front (engine end).

Wind will restrict free airflow if it blows directly into the air outlet vent. Consider prevailing wind directions when planning vent locations.

Dampers

Dampers can be used in any system to block the airflow through the vents when the generator set is not running. This is sometimes necessary in cold climates to keep the generator enclosure at a normal temperature. Four types of dampers are available: automatic, manual, thermostatically controlled, and fixed. Refer to Onan Technical Bulletin T-030 for more detailed information.

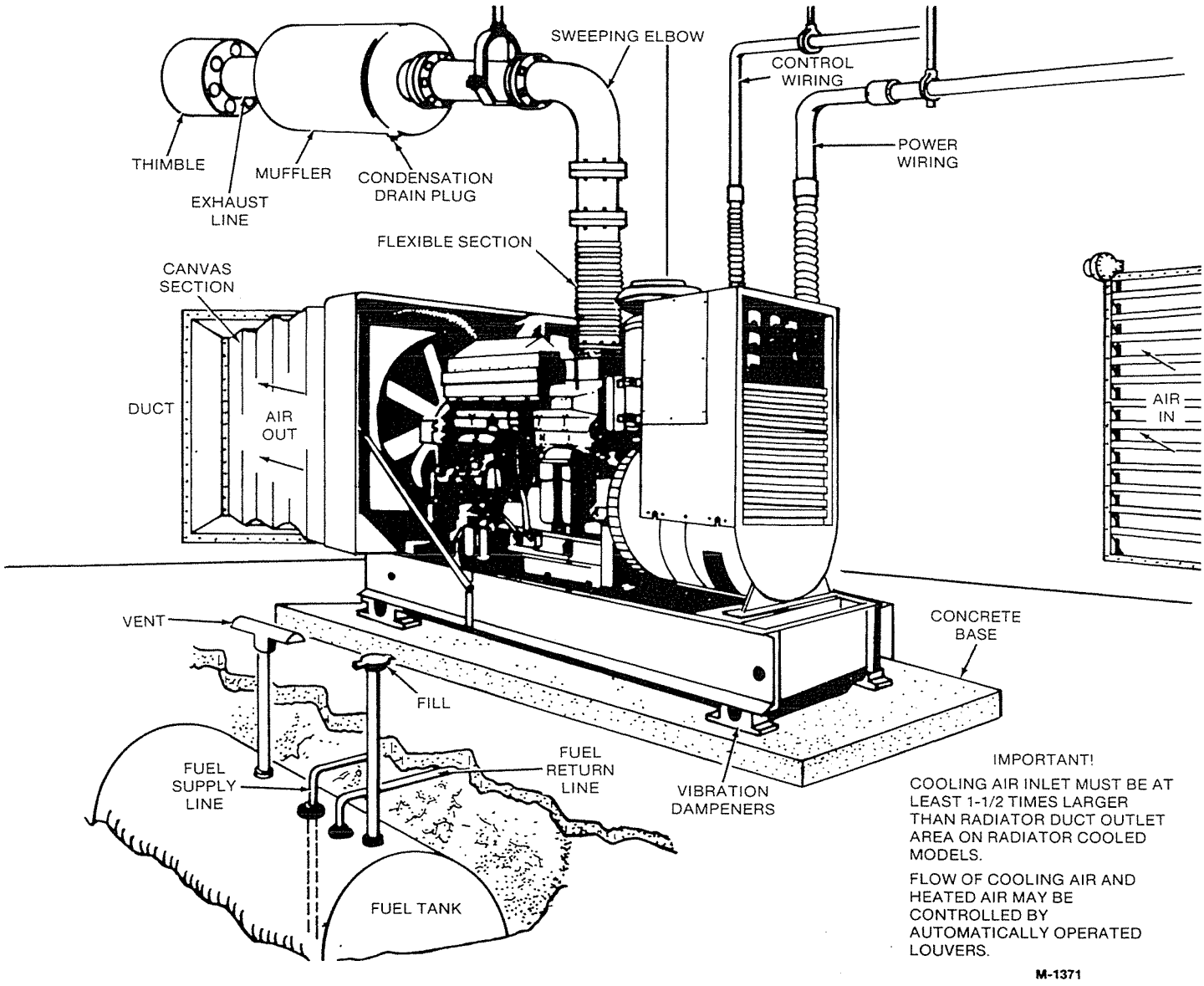


FIGURE 1. TYPICAL INSTALLATION

Radiator Set Ventilation Requirements

Radiator set cooling air is drawn past the rear of the set by a fan which blows air through the radiator. Locate the air inlet to the rear of set and near the floor. Make the inlet vent opening 1-1/2 times larger than the radiator.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The effective opening area should be 1.3 times as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow. Use a duct of sheet metal and canvas between the radiator and the air outlet opening to prevent recirculation of heated air and provide for flexible connection.

City Water Set Ventilation Requirements

City water cooled sets do not use a conventional radiator. Instead, a constantly changing water flow cools the engine. Sufficient air movement and fresh air must be available to cool the generator, disperse heat radiated from the engine, and to support combustion. Additional information is contained in Technical Bulletin T-030.

To provide sufficient airflow, ventilation fans may be required. Size the fans to remove all heat rejected to the room by the generator set, exhaust pipes, and other heat producing equipment. Maintaining a temperature differential of 20° to 30° F (11° to 17° C) is usually satisfactory.

COOLING SYSTEMS

A set mounted radiator with engine driven fan is standard on the generator set. Optional cooling systems include remote radiator cooling, city water cooling with standpipe, and city water cooling with heat exchanger. The following sections briefly cover the installation requirements for each system. Refer to Technical Bulletin T-030 for more detailed information.

Radiator Cooling (Standard)

The standard radiator cooling system (see Figure 1) uses a set mounted radiator with an engine driven pusher type fan to cool the generator set. Air is pulled from the generator end of the set across the engine and then forced through the radiator. An air duct adapter flange surrounds the radiator grill to allow mounting of the air discharge duct. Refer to the section on Ventilation for location and sizing of ducts and vents.

Remote Radiator (Optional)

Remote radiator cooling systems use a remote mounted radiator with electrically driven fans for generator set cooling. Removal of the radiator and fan from the set reduces the set enclosure ventilation requirements to the level of city water cooled sets without making the unit dependent on a continuous water supply. The remote radiator system can also be completely protected against freezing.

The two key design considerations in a remote radiator installation are the vertical distance (X) from the engine centerline to the radiator top and the horizontal distance (Y) from the engine front to the radiator centerline (see Figure 2). These distances determine if any additional equipment is required such as a surge tank, auxiliary pump, or hot well. Because of the many design considerations, all remote radiator installations must be engineered to insure that the system will function properly. Follow the instructions of the consulting engineer when installing a remote radiator system. Additional information is contained in Technical Bulletin T-030.

City Water Cooling (Optional)

City water cooling systems use either a standpipe or a heat exchanger for cooling the generator set. Both systems are dependent on an uninterruptible supply of cool water.

Heat Exchanger: This system uses a shell and tube type heat exchanger instead of the standard radiator and fan. Engine coolant circulates through the shell side of the heat exchanger while raw cooling water is pumped through the tubes. Engine coolant and raw water do not mix.

A heat exchanger system reduces set enclosure airflow and noise levels. Proper operation depends upon a constant supply of raw water for heat removal. The engine coolant side of the system can be protected from freezing while the raw water side cannot. See Figure 3 for a schematic of a heat exchanger system.

Standpipe: This system uses a mixing (tempering) tank for the standard radiator and fan. Cooling water circulating through the engine jacket is mixed with raw water in the tank. Because raw water flows through the engine jacket, it must not contain scale forming impurities or fouling of the engine water will occur.

Standpipe cooling reduces set enclosure airflow requirements and noise levels. Proper operation is dependent on a constant supply of cooling water. The system cannot be protected from freezing. See Figure 4 for a schematic of a standpipe system.

Cooling Connections: All heat exchanger and standpipe cooled sets must be connected to a pressurized supply of cold water. Make connections to the set with flexible pipe to absorb vibration. On the cool water line, install a solenoid valve to shut off the flow when the set is shut down and a rate of flow valve to control engine temperature. This valve can be either manual or automatic. Actual rate of flow will depend on inlet water temperature.

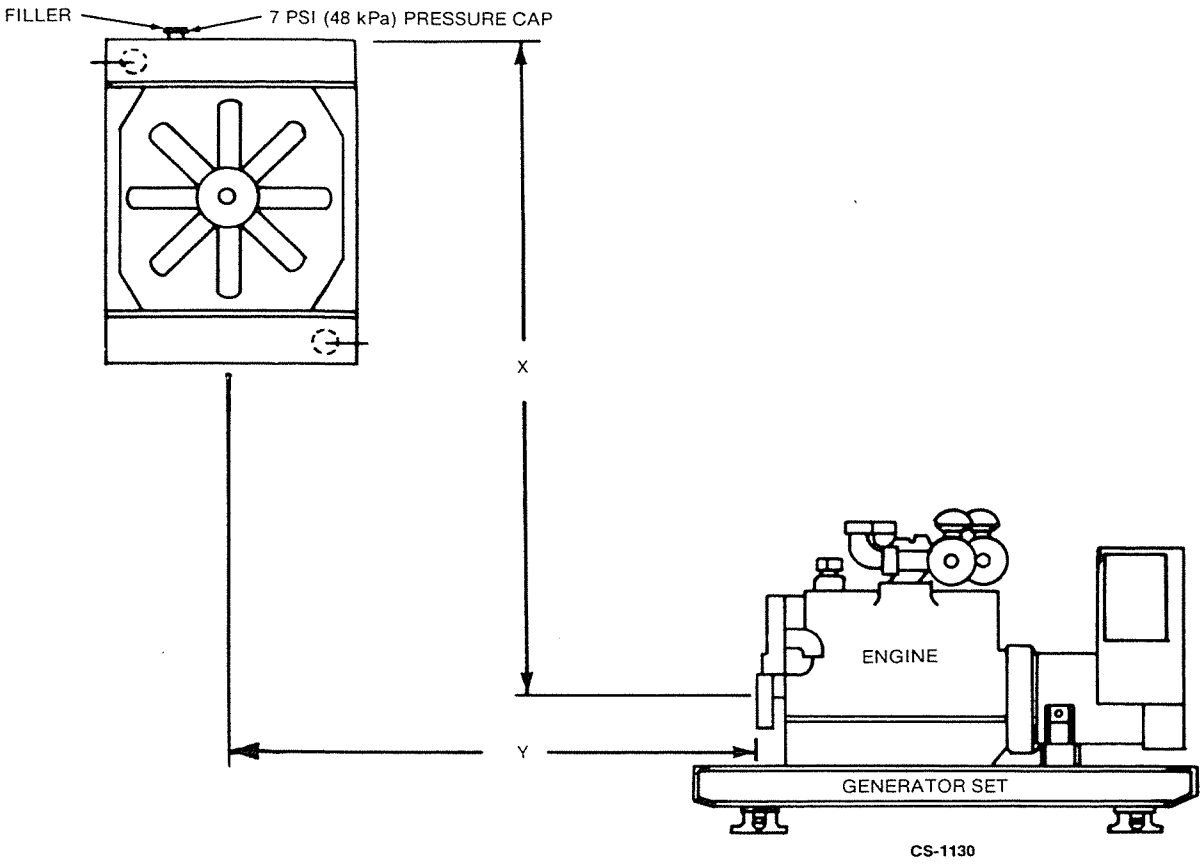


FIGURE 2. REMOTE RADIATOR INSTALLATION

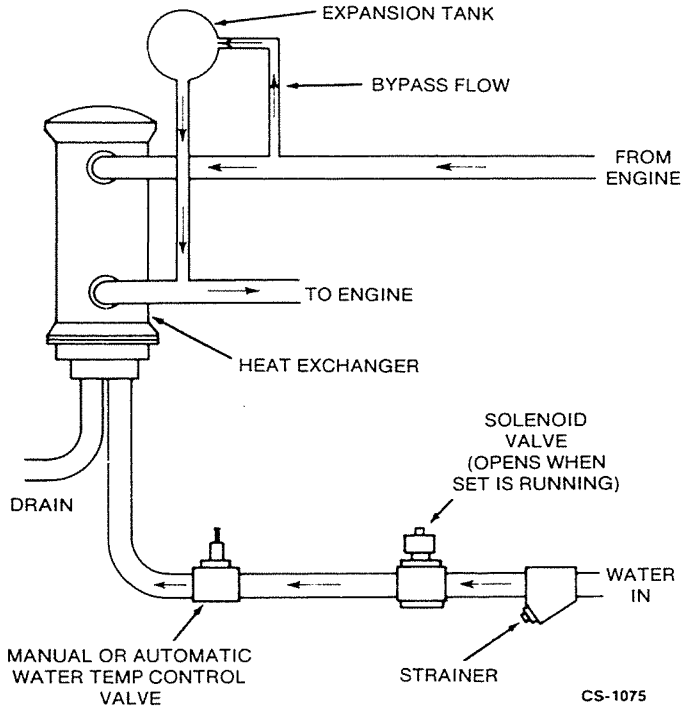


FIGURE 3. HEAT EXCHANGER

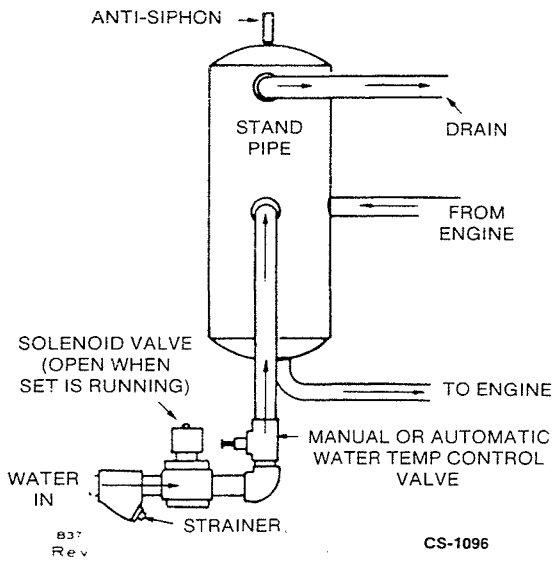


FIGURE 4. STANDPIPE

Adjust the valve to maintain water temperature between 165° to 195° F (74° to 91° C) while operating the unit at full load.

Before filling cooling system, check all hardware for tightness. This includes hose clamps, capscrews, fittings and connections. Use flexible coolant lines with heat exchanger, standpipe or remote mounted radiator.

Coolant Filter

One spin-on type corrosion filter (Figure 5) is standard equipment. This precharge filter is compatible with plain water and all ethelyne glycol base permanent antifreeze coolants. Refer to engine manufacturer's manual for instructions if a methoxy propanal base antifreeze is desired. Replace filter periodically as recommended in *MAINTENANCE* section.

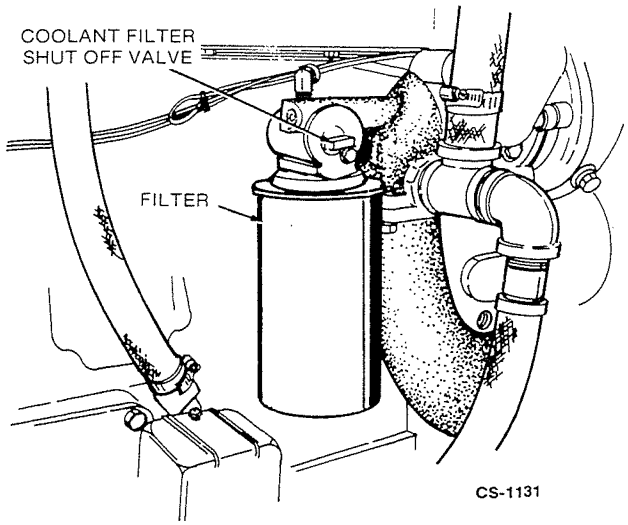


FIGURE 5. COOLANT FILTER INSTALLATION

CAUTION ***Do not use anti-freeze with an anti-leak formula. The stop-leak element can prevent or retard the flow through the filter, thereby eliminating the filtering process completely.***

EXHAUST SYSTEMS

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlet away from any air inlets to avoid exhaust gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, light loads, etc.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Use extreme care during installation to ensure a tight exhaust system.***

Use an approved thimble (see Figure 6) where exhaust pipes pass through walls or partitions. Build the thimble according to code requirements (see National Fire Protection Association bulletin, Volume 4, section 211, covering "Standards for Chimneys, Fireplaces, and Vents").

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Do not use exhaust heat to warm a room, compartment or storage area.***

Pitch a horizontal run of exhaust pipe *DOWNWARD* to allow any moisture condensation to drain away from the engine. If an exhaust pipe must be turned upward, install a condensation trap at the point where the rise begins (see Figure 7). Figure 1 shows a condensation drain plug in a muffler.

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for mufflers and piping. Use a section of flexible stainless steel tubing between the engine exhaust connection and the exhaust piping system to permit movement and thermal expansion. Shield exhaust lines if there is danger of personal contact. Allow at least 12 inches (305 mm) of clearance if the pipes pass close to a combustible wall or partition.

Refer to Technical Bulletin T-030 for the recommended maximum equivalent exhaust pipe length. The total exhaust system equivalent length includes the exhaust pipe, all fittings, and the muffler. Exceeding the recommended maximum length will create excessive back pressure in the system.

Exhaust Support

The exhaust pipes and muffler must be completely supported so no weight or stress is applied to the engine turbocharger. In some installations damping supports may be needed to reduce exhaust noise vibration transmission.

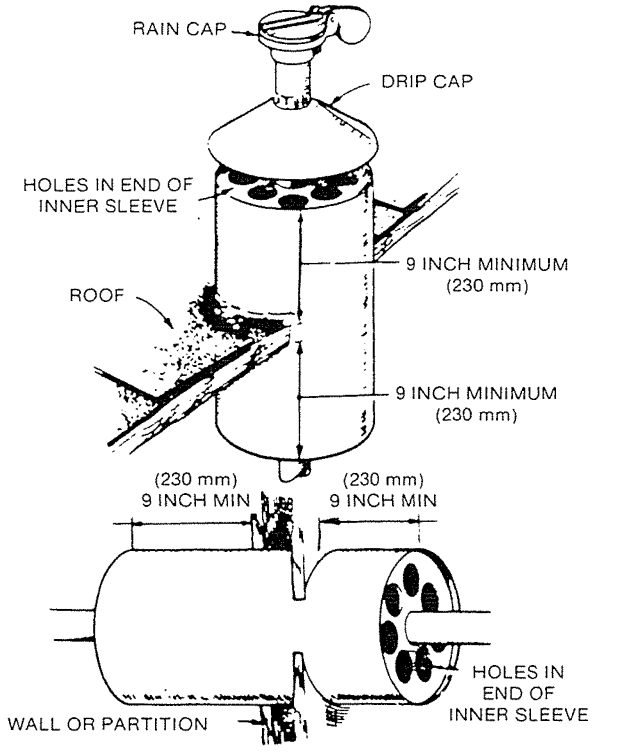


FIGURE 6. EXHAUST THIMBLE

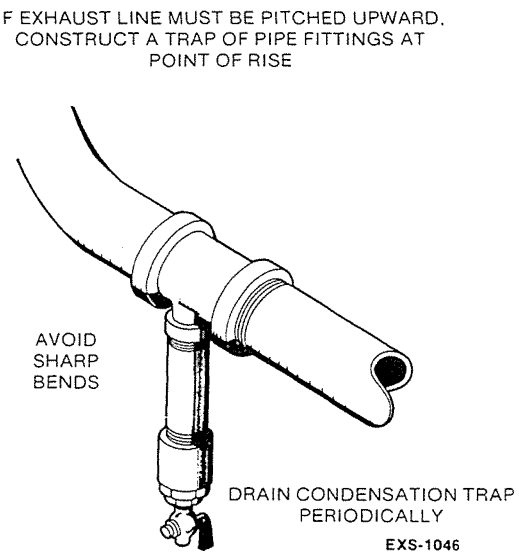


FIGURE 7. EXHAUST CONDENSATION TRAP

CAUTION ***Weight applied to the engine manifold or turbocharger can result in manifold or turbocharger damage.***

FUEL SUPPLY SYSTEMS

Check local regulations governing installation of fuel tanks before installing the fuel supply system.

General

In all fuel system installations, cleanliness is of the utmost importance. Make every effort to prevent entrance of moisture, dirt or contaminants of any kind. Clean all fuel system components before installing.

Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Onan can supply copper fuel lines with brass fittings if required. Never use galvanized fuel lines or fittings with diesel fuel as it tends to flake off and contaminate the fuel. Use a flexible section of tubing between the engine and fuel supply line to withstand vibration.

CAUTION ***Never use galvanized fuel lines, fittings or fuel tanks with diesel fuel systems. Condensation in the tank and lines combines with the sulfur in diesel fuel to produce sulfuric acid. The zinc coating on galvanized lines or tanks reacts with the acid and flakes off to contaminate the fuel.***

An electric solenoid shutoff valve in the supply line is always desirable and required for indoor automatic or remote starting installations. Connect the solenoid wires to the battery ignition circuit to open the valve during generator set operation.

Supply Tank

Locate the fuel tank as close as possible to the generator set and within the 5 foot (1.5 metre) lift capacity of the fuel pump if possible. Choose a tank that has sufficient capacity to keep the generator running continuously at full load for at least 36 hours. Onan can supply underground fuel tanks from 55 to 560 gallons (208 to 2120 litres) in capacity.

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

A typical underground fuel system consists of a main fuel tank, vent and fill pipes, fuel supply line, and fuel return line (see Figure 1). If the tank is installed below the lift capabilities of the standard fuel transfer pump, a day tank and auxiliary pump will also be required. If an overhead tank is installed, a day tank and float valve will be required to prevent fuel head pressures from being placed on the fuel system components. Refer to Technical Bulletin T-030 for examples of fuel supply systems that require a day tank.

Day Tank (If Used)

Day tanks are fuel transfer tanks which are used when the standard engine fuel pump does not have the capacity to draw the fuel from the supply tank; or the supply tank is overhead and presents problems of high fuel head pressure for the fuel return. See Figure 8.

Supply Tank Lower Than Engine: With this installation, the day tank is installed near the generator set and within the engine fuel pump lift capability, but below the fuel injection system. Install an auxiliary fuel pump as close as possible to the supply tank to pump fuel from the supply tank to the day tank. A float switch in the day tank controls operation of the auxiliary fuel pump.

The supply tank top must be below the day tank top to prevent siphoning from the fuel supply tank to the day tank.

Provide a return line from the engine injection system return connection to the day tank (near the top). Provide a day tank overflow line to the supply tank in case the float switch fails to shut off the fuel transfer pump.

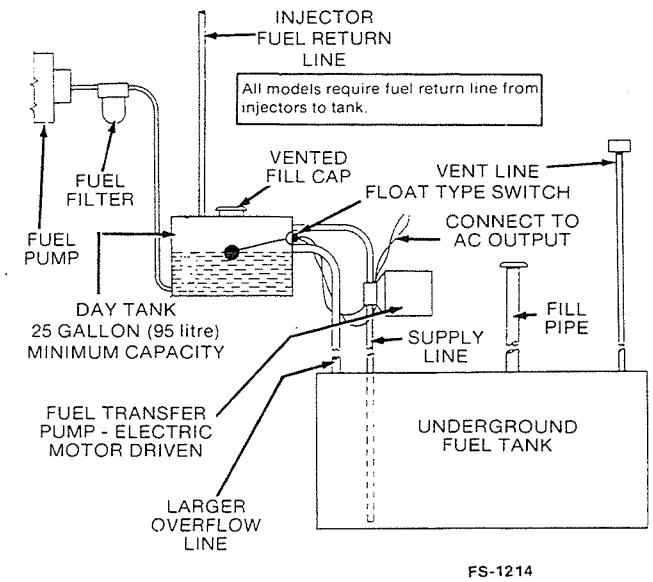


FIGURE 8. DAY TANK (TYPICAL)

Supply Tank Above Engine: Install the day tank near the generator set and within the engine fuel pump lift capability, but below the fuel injection system. Use fuel line at least as large as the fuel pump inlet. The engine fuel return line must enter the day tank.

Include a shutoff solenoid in the fuel line between the fuel supply tank and the day tank. It stops fuel flow when the generator set is off.

Engine Fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections by the factory. Flexible lines for connecting between the engine and the stationary fuel line are supplied as standard equipment. Refer to the *SPECIFICATIONS* section for the fitting sizes.

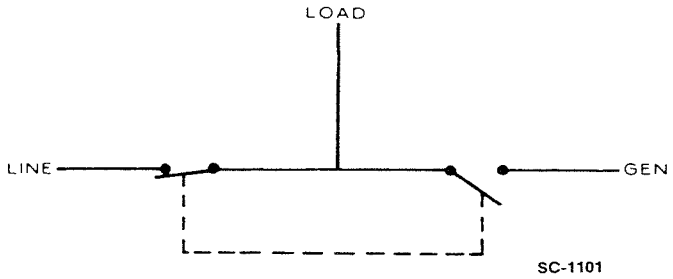
ELECTRICAL CONNECTIONS

Installing the generator set electrical system includes connecting the load and switchgear, installing the remote start control (if used), and connecting the batteries. The batteries should always be connected last to avoid accidental starting of the unit during installation.

General

Most local regulations require that wiring connections be made by a licensed electrician and that the installation be inspected and approved before operation. All connections, wire sizes, etc. must conform to the requirements of all electrical codes in effect at the installation site.

If the installation is for standby service, a double throw transfer switch must always be used. Connect this switch (either automatic or manual) so that it is impossible for commercial power and generator current to be connected to the load at the same time. See Figure 9. Instructions for connecting an automatic load transfer control are included with such equipment.



NOTE: SHOWN WITH LINE CONNECTED TO LOAD

FIGURE 9. LOAD TRANSFER SWITCH (TYPICAL FUNCTION)

Generator Voltage Connections

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

Generators can be divided into two groups, reconnectible and non-reconnectible. The reconnectible type generator can be wired to give one of several possible voltages. Non-reconnectible type generators produce only one specific voltage and cannot be wired to give a different voltage without extensive modifications. The following sections explain the connection procedure for each type of generator.

Non-reconnectible Generators (Voltage Code 5D, 6D, 7, or 9X): These generators are wired at the factory for a specific voltage and are not intended for reconnection. The voltage and corresponding current rating (amperes) are shown on the nameplate. For these generators, proceed to *LOAD CONNECTIONS*.

Reconnectible Generators (Voltage Code 17 or 517): Generators with voltage codes 17 (for 60 hertz) and 517 (for 50 hertz) are three phase and can be reconnected for the voltages shown in Figure 12. (If voltage and code are other than 17 or 517, see " Non-reconnectible Generators".) Most of these generators must be reconnected by the installer to give the voltage required for the installation. Before shipping, the factory tests the generator set output by connecting the generator to produce a particular test voltage. The installer must always check the bus bar and W22 jumper lead connections and reconnect to obtain the voltage desired.

Voltage Reference Transformer Lead: Reconnection lead W22 on TB21 is a jumper wire that conducts a single phase output from the generator to the appropriate tap on the voltage reference transformer. One end of this lead is connected to terminal 63 on the terminal board. The other end will be connected to a terminal marked H3, H4, or H5 (see Figure 10), depending on the voltage option required. Refer to Figure 12 for voltages available and correct hook-up.

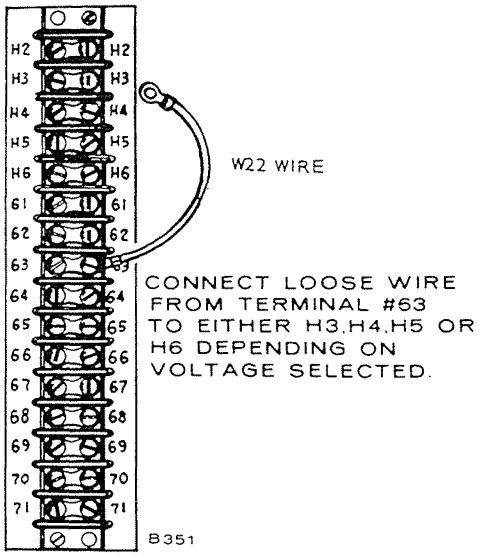


FIGURE 10. VOLTAGE REFERENCE TRANSFORMER LEAD

Reconnection Bars: Several reconnection bars are provided that can be bolted or unbolted (see Figure 9) to the main bus bars (L0, L1, L2, and L3). Bus bars and reconnection bars are made of tin plated aluminum to resist electrolytic corrosion. Select the voltage required and bolt the reconnection bars to the bus bars as shown in Figure 12. Do not overtighten the bolts.

Load Connections

Load Balancing: When connecting loads to the generator set, 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 can be used at the same time as long as each line current is about 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 line after connections (procedure following) by observing the control panel ammeter.

Connecting the Load: All loads are connected to the generator by bolting the load wires to the appropriate bus bars in the control box as indicated in Figure 11. The bus bars are stamped L0, L1, L2, and L3 to indicate the neutral and line connections (Figure 12). Use a section of flexible conduit at the control box to permit movement.

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 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.

WARNING ***Contact with electrically "hot" equipment might result in severe personal injury or death. It is extremely important that bonding and equipment grounding be properly done. All metallic parts which could become energized under abnormal conditions must be properly grounded.***

Typical requirements for bonding and grounding are given in the National Electrical Code, 1981, Article 250. All connections, wire sizes, etc. must conform to the requirements of the electrical codes in effect at the installation site.

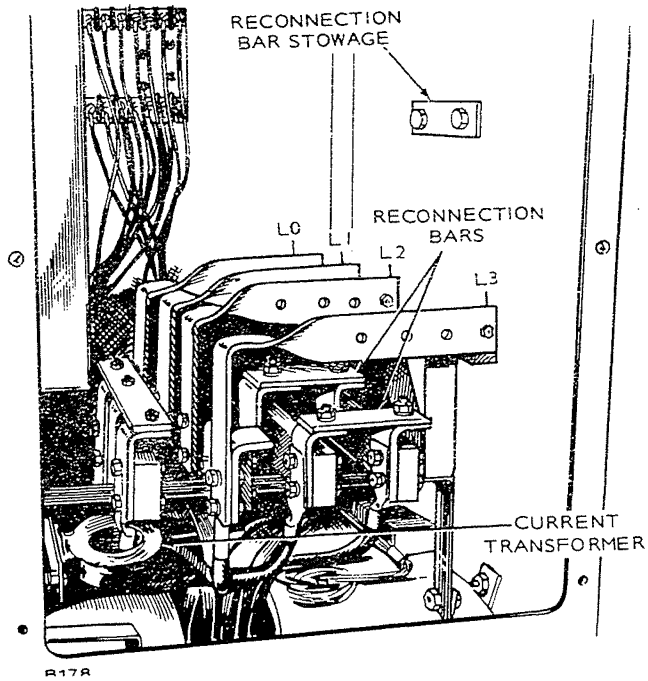
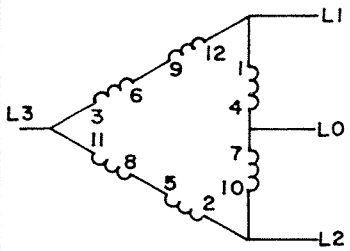
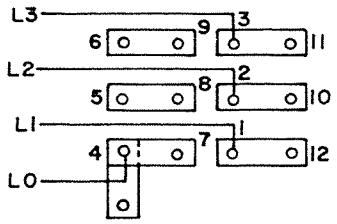
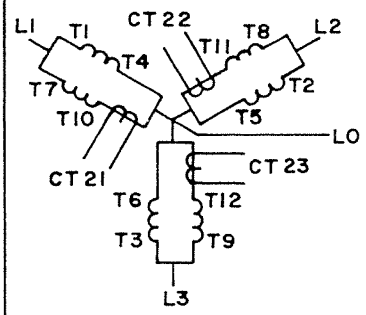
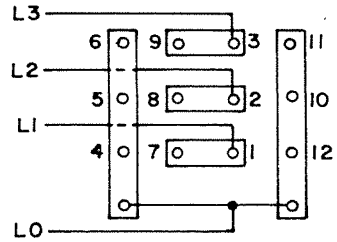
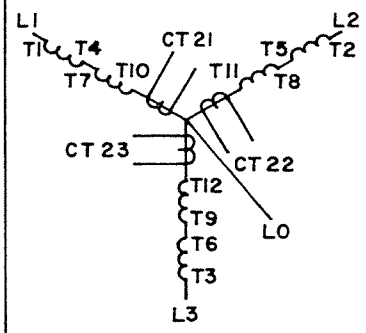
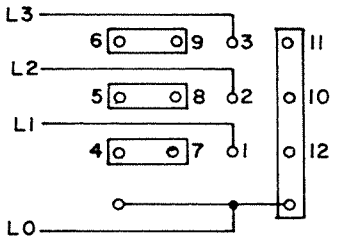
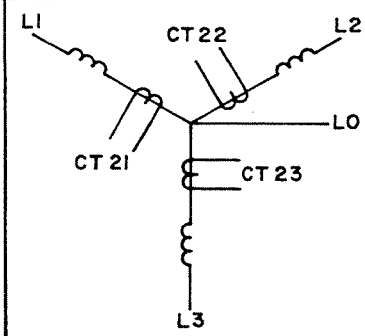
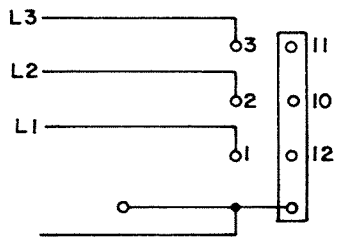


FIGURE 11. RECONNECTION BARS

NAMEPLATE VOLTAGE CODE	VOLTAGE	PHASE	FREQUENCY	CONNECT LEADS FROM TERMINAL 63 TO:	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM
5D	120/240	3	60	H5	SERIES DELTA		
6D	240/480	3	60	H5			
17	120/208	3	60	H3	PARALLEL WYE		
	127/220	3	60	H4			
	139/240	3	60	H5			
517	110/190	3	50	H3			
	115/200	3	50	H4			
	120/208	3	50	H4			
	127/220	3	50	H5			
7	220/380	3	60	H3	SERIES WYE		
17	240/416	3	60	H3			
	254/440	3	60	H4			
	277/480	3	60	H5			
517	220/380	3	50	H3			
	230/400	3	50	H4			
	240/416	3	50	H4			
	254/440	3	50	H5			
9X	347/600	3	60	H5	SERIES WYE		

SINGLE PHASE NOTE NOT AVAILABLE YB SERIES GENERATORS 98-2579(C)

FIGURE 12. VOLTAGE CONNECTIONS

Water Jacket Heater

A water jacket heater may be installed to keep engine coolant warm while engine is shut down (recommended for standby applications). It heats and circulates the coolant within the engine which reduces start-up time and engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

CAUTION ***The heater must not be operated while the cooling system is empty or when the engine is running or damage to the heater will occur.***

Figure 13 shows the heater connections. Connect the heater to a source of power that will be on during the time the engine is not running. Be sure the voltage rating is correct for the heater element rating.

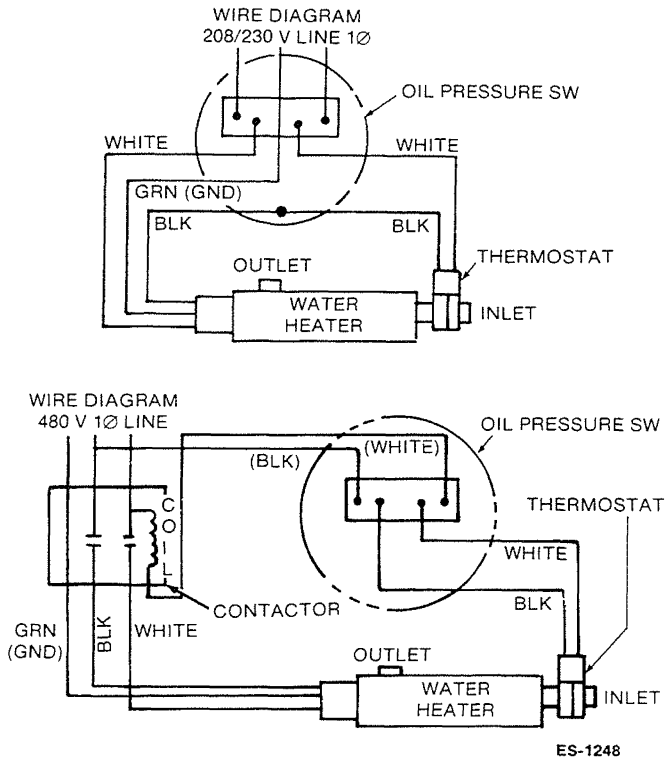


FIGURE 13. WATER HEATER WIRING DIAGRAMS

Remote Control Connections

Provision is made for addition of remote starting. This is accomplished with a 4 place terminal block located within the control box. Connect one or more remote switches across remote terminal and B+ terminal as shown in Figure 14. If the distance between the set and remote station is less than 1000 feet (305 m), use No. 18 AWG wire; between 1000 and 2000 feet (305 and 610 m), use No. 16 AWG wire.

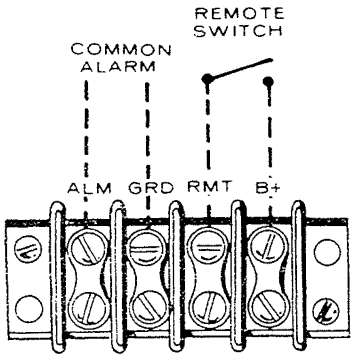


FIGURE 14. REMOTE CONTROL TERMINAL BLOCK TB1

PREPARING GENERATOR SET FOR OPERATION

Before attempting the initial start of the generator set, be sure it is serviced for operation. Refer to the engine manufacturer's manual and to the *MAINTENANCE* section of this manual for the proper procedures and recommended fuel, coolant, and lubricants. Service the following.

Lubrication

Before starting, fill the crankcase with the recommended oil, prime the lubrication system, and prelubricate the turbocharger.

Coolant

Before starting, fill the cooling system with recommended coolant. Then energize the coolant heater.

Fuel

Fill the fuel tanks with the recommended fuel and prime the fuel system.

Connect Starting Batteries

Starting the unit requires 24-volt battery current. Use two 12-volt (see *SPECIFICATIONS*) batteries for a normal installation. Connect the batteries in series (negative post of first battery to positive post of second) as in Figure 14A. Necessary battery cables are included. Service the batteries as necessary. Infrequent unit use (as in emergency standby service) may allow the batteries to self-discharge to the point where they cannot start the unit. If installing an automatic transfer switch that has no built-in charge circuit, connect a special float charger.

WARNING ***Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.***

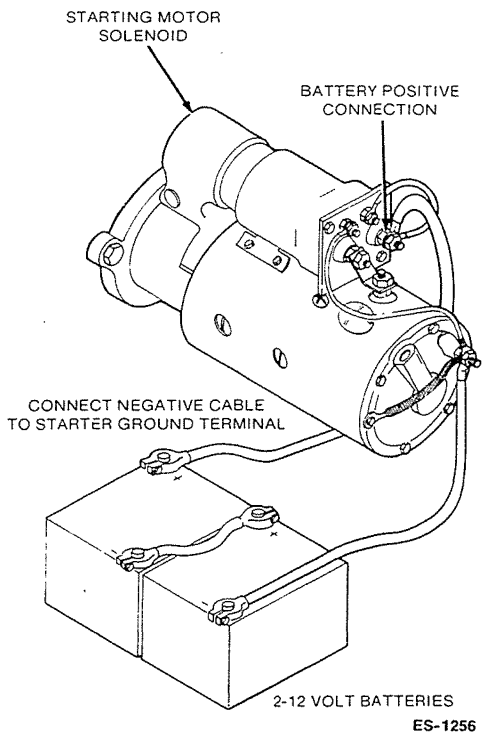


FIGURE 14A. BATTERY CONNECTIONS

INITIAL STARTING AND CHECKS

Before putting the generator set under load conditions, perform the following to verify the generator set will perform correctly.

1. Start the generator set. Move the Run-Stop-Remote Switch on the engine control panel to the RUN Position. The starter should crank the engine, and the engine should start within a few seconds.
2. Monitor the engine control panel and note the oil pressure, coolant temperature, and battery charge rate. Refer to the *OPERATION* section of this manual for normal readings. With the engine at operating temperature, all readings should stay within the normal range.
3. Check the generator set for fuel, oil, or coolant leaks. If you find any leaks, move the Run-Stop-Remote Switch to STOP. Have the leak repaired before performing the rest of the checks.
4. Check the exhaust system for leaks, visually and audibly. Note the security of the exhaust system supports. If you find any leaks, shut down the generator set immediately by moving the Run-Stop-Remote Switch to STOP.

WARNING ***Exhaust gas is deadly. For this reason, shut down the generator set immediately if you discover an exhaust leak or exhaust component needing replacement. Do not use the generator set until you have the exhaust system repaired.***

5. Note the AC instruments of the engine control panel. The frequency meter and voltmeter should indicate rated nameplate frequency and voltage. Use the phase selector switch to read each of the line-to-line voltages. If other than the nameplate ratings, see the troubleshooting tables in the *OPERATION* section.
6. Stop the generator set by moving the Run-Stop-Remote Switch to STOP. See the *OPERATION* section.

Operation

WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, a poisonous gas that might cause unconsciousness and death. It is an odorless and colorless gas formed during combustion of hydrocarbon fuels. Symptoms of carbon monoxide poisoning are:

- ***Dizziness***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Vomiting***
- ***Muscular Twitching***
- ***Throbbing in Temples***

If you experience any of these symptoms, get out into fresh air immediately, shut down the unit and do not use until it has been inspected.

The best protection against carbon monoxide inhalation is proper installation and regular, frequent inspections of the complete exhaust system. If you notice a change in the sound or appearance of exhaust system, shut the unit down immediately and have it inspected and repaired at once by a competent mechanic.

GENERAL

This section covers starting and operating the generator set. It is recommended that the operator read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the set to insure safe operation.

PRE-START 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 proper procedures.

Lubrication

Check the engine oil level. Keep the oil as near as possible to the full mark.

Coolant

The coolant level should come near the top of the radiator. Do not check while the coolant is hot.

WARNING ***Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

Fuel

Make sure the fuel tanks have sufficient fuel. See the *MAINTENANCE* section for recommended fuel.

WARNING ***Spilled fuel might ignite and cause serious personal injury or death. Never fill the fuel tank when the engine is running.***

CONTROL PANEL

The following describes the function and operation of the generator set controls. All instruments and control switches are located on the face of the control panel as illustrated in Figure 15. The control panel is separated into a DC panel for monitoring the engine and an AC panel for monitoring the generator.

DC Panel

Panel Light and Switch: Illuminates control panel.

Oil Pressure Gauge: Indicates pressure of lubricating oil in engine.

Water Temperature Gauge: Indicates temperature of circulating coolant in engine.

Battery Charge Rate DC Ammeter: Indicates the battery charging current from engine driven battery charging alternator.

Run-Stop-Remote Switch: Starts and stops the unit locally or from a remote location.

Reset Switch: Manual reset for engine monitor after malfunction shutdown.

Lamp Test: Press to test warning lamp bulbs (when engine is running only).

Warning Light: Indicates fault in engine operation.

AC Panel

AC Voltmeter: Indicates AC generator output voltage. Dual range instrument. Measurement range in use is shown on indicator light.

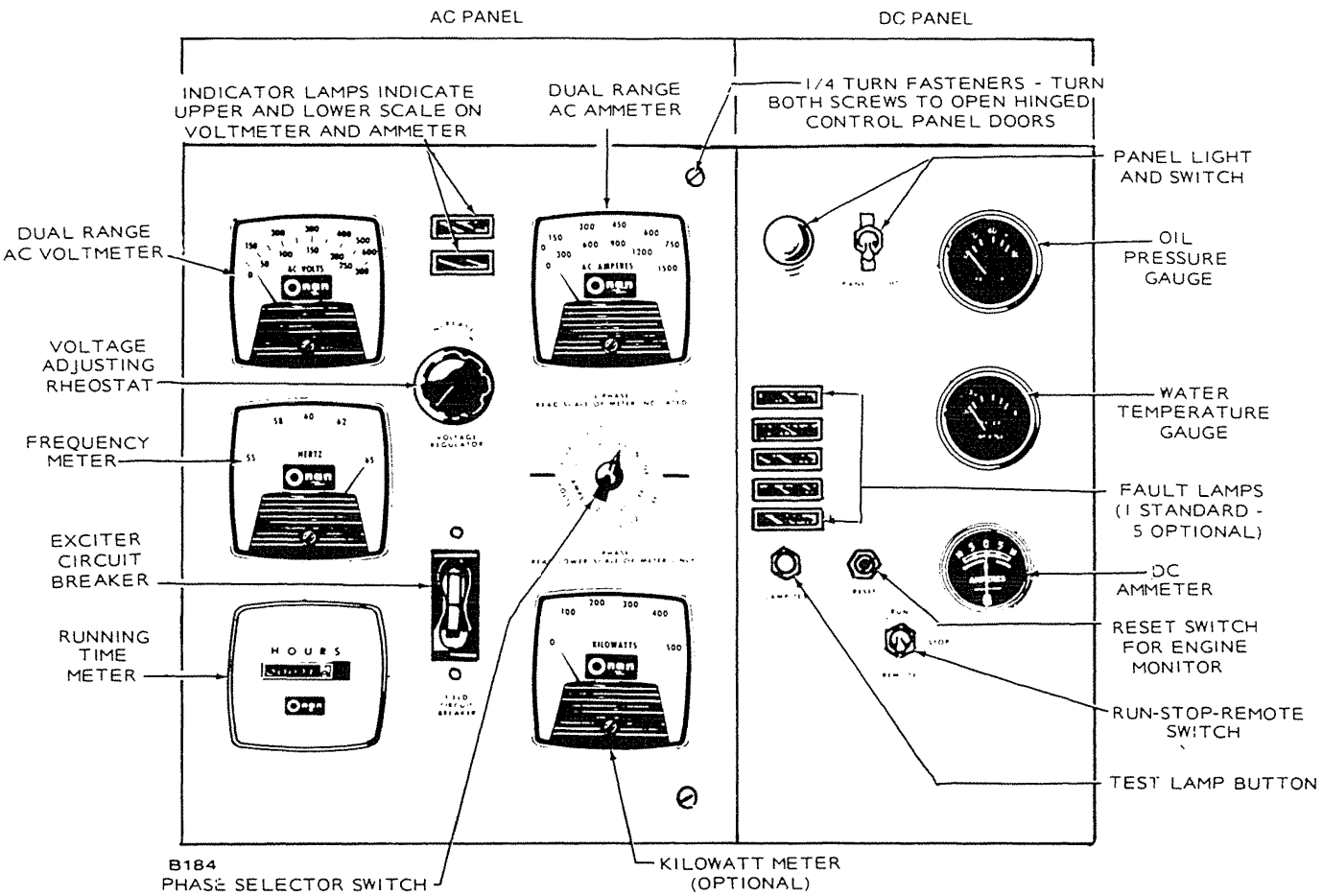


FIGURE 15. CONTROL PANEL

AC Ammeter: Indicates AC generator output current. Dual range instrument. Measurement range in use is shown on indicator light.

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

Voltage Regulator: Rheostat provides approximately plus or minus 5 percent adjustment of the rated output voltage.

Exciter Circuit Breaker: Prevents generator exciter and regulator from overheating in the event of certain failure modes.

Running Time Meter: Registers the total number of hours (to nearest 0.1 hr.) that the unit has run. Use it to keep a record for periodic servicing. Time is cumulative; meter cannot be reset.

Frequency Meter: Indicates the frequency of the generator output in hertz. It can be used to check engine speed (each hertz equals 30 r/min).

Optional Equipment (DC Panel)

Warning Lights: Eliminates the one "Fault" light and substitutes five indicator lights to give warning of—

A. Overcrank (failed to start)
B. Overspeed
C. Low oil pressure
D. High engine temperature
E. Low engine temperature

The correct response for the indicated fault situation is covered in the *TROUBLESHOOTING* section.

STARTING PROCEDURE

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

Starting At Control Panel

Move the Run-Stop-Remote Switch on the DC panel to the Run position. This will activate 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 reaches a speed of 450 to 570 r/min.

The starter will also disconnect if the engine does not run after being cranked for a specified period of time.

The starter will also disconnect if the engine does not run after being cranked for a specified period of time. The standard start control will disconnect the starter after 75 seconds of cranking if the engine does not start. The optional start control will allow the starter to crank for up to 15 seconds and then disconnect for about 10 seconds. This crank/rest cycle will terminate if the engine fails to start after three cranking tries.

Remote Starting

Move the Run-Stop-Remote Switch on the DC 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

Place the Run-Stop-Remote Switch on the 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.

Start Up Checks

Observe the oil pressure gauge immediately after the engine is started. A normal oil pressure reading is between 50 and 70 psi (345 and 485 kPa). The following gauges should also be checked for normal readings:

DC Ammeter - Normal charging rate is 10 to 30 amperes.

AC Voltmeter - Generator output voltage should be stable and not vary more than ±2% of the rated value while under load.

Frequency Meter - Generator frequency should be stable.

Water Temperature - Run the generator set for about 10 minutes and then check the water temperature gauge. The engine should stabilize at 165° to 195°F (74° to 91°C). Some city water cooled generator sets have a valve in the water supply line for manually adjusting the water flow. Open or close the valve as required to maintain the desired water temperature while set is running under rated load.

STOPPING

Run the generator set 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, turbocharger, and bearings. The turbocharger seals and bearings can be damaged by the sudden temperature rise that occurs when the engine is stopped under load.

To Stop: Move the Run-Stop-Remote Switch or the remote starting switch to the Stop position.

OPERATING RECOMMENDATIONS

Some of the following sections require that a load be connected to the generator set. This is usally done using a load transfer switch. Refer to the transfer switch Operators Manual for information on how the switch operates.

No-Load Operation

Hold periods of no-load operation to a minimum and avoid if possible. No-load operation allows combustion chamber temperatures to drop so low that the fuel does not burn completely. This results in carbon deposits which can clog injectors and cause piston rings and valves to stick. If it is necessary to run the engine for long periods at no load, connect a "dummy" electrical load to the generator.

Exercise Period

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts since the protective oil film tends to drain off during periods of non-use. The friction of dry piston rings on dry cylinder walls can cause scuffing and rapid wear.

To avoid excessive engine wear, exercise the generator set at least once a week for a minimum of 30 minutes. Run the set with a load applied to allow the engine to reach normal operating temperature. Exercising will keep the engine parts lubricated, maintain fuel prime, and prevent electrical relay contacts from oxidizing to insure reliable starts. Top off the fuel tank after each exercise period.

Onan automatic transfer switches have as an option an exerciser that can be preset to provide regular exercise periods. Typically, the exerciser can be set for time of start (AM or PM), length of run, and day of week.

High/Low Operating Temperatures

The following recommendations apply when operating the generator set in high (above 95°F/35°C) or low (below 50°F/10°C) ambient temperatures:

Low Temperatures:

1. Use the correct viscosity oil for the lowest expected ambient temperature conditions. If it is necessary to change oil, drain the oil only when engine is warm.
2. Use only fresh diesel fuel and keep the fuel tank completely filled to prevent condensation of moisture.
3. Keep the batteries fully charged and keep all battery connections clean and free of corrosion.
4. Use a water jacket heater connected to a separate source of power. The recommended optional heater available from Onan will assure reliable starting. Be sure the voltage of the separate

power source is correct for the heater element rating. Various voltage and phase combinations are available.

High Temperatures:

1. Remove any objects that may obstruct the airflow to and from the generator set vent openings.
2. Remove any debris that may have collected on the radiator cooling fins.
3. Keep the cooling system clean and free of scale and rust deposits. The maximum recommended engine operating temperature is 200°F (93°C).
4. Use the correct viscosity oil for the ambient temperature conditions.

Power Rating Factors

The generator set power rating applies to sets used in continuous 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 #2 diesel fuel and operating at an altitude of 500 feet (15 m) with an ambient temperature of 85°F (30°C). For a rating relative to other applications, altitudes, cooling systems, ambient temperatures, or fuels, contact an authorized Onan Distributor.

OUT-OF-SERVICE PROTECTION

If a generator set remains out of service for three or four weeks, special precautions must be taken to protect the engine from rust and corrosion. Contact the engine manufacturer for the recommended engine storage procedure.

The generator and control do not require any special storage procedures other than covering to prevent the entrance of dirt and moisture. The battery should be disconnected and stored in a cool, dry place. On a monthly basis, measure the specific gravity of the battery and check the electrolyte level. Add distilled water if below the split ring and charge if the specific gravity is below 1.250 at 77°F (25°C).

Returning Unit To Service: Generator sets that have been in storage require complete servicing and a thorough inspection before they can be returned to normal use. Contact the engine manufacturer for the recommended return to service procedures before starting the engine. Remove all protective covering from the generator and control and wipe off any accumulations of dust or dirt. Do not reconnect the battery until engine service is complete.

TROUBLESHOOTING

The generator set has a number of sensor units that continuously monitor the engine for abnormal conditions such as low oil pressure or high coolant temperature. If an abnormal condition does occur, the engine monitor will activate a fault lamp and external alarm and may also stop the engine depending on the condition. If the generator set does shut down, the operator may be able to restart the set after making certain adjustments or corrections. The following sections describe the operation of the fault condition system and suggested troubleshooting procedures for the operator.

The standard control has a single fault lamp for indicating malfunctions and an external alarm for alerting the operator. The optional control has five fault lamps and an external alarm. See Table 1 for the fault lamp options.

TABLE 1. FAULT LAMP OPTIONS

SYSTEM	FAULT	FAULT LAMP	STOP ENGINE	EXTERNAL ALARM
STANDARD SINGLE LIGHT	Overcrank	x	x	x
	Overspeed	x	x	x
	Low Oil Pressure	x	x	x
	High Engine Temperature	x	x	x
5 LIGHT	Overcrank	x	x	x
	Overspeed	x	x	x
	Low Oil Pressure	x	x	x
	High Engine Temperature	x	x	x
	Low Engine Temperature	x		
5 LIGHT PRE-ALARM	Overcrank	x	x	x
	Overspeed	x	x	x
	Pre Low Oil Pressure	x		x
	Low Oil Pressure	x	x	x
	Pre High Engine Temperature	x		x
	High Engine Temperature	x	x	x
	Low Engine Temperature	x		

If the external alarm is activated, check the control panel to determine which fault lamp is lit. The procedures to follow for locating a problem and making corrections are covered in Tables 2 and 3. If a major problem is indicated, contact your Onan Distributor or the engine manufacturer for service.

Resetting The Control

The external alarm and fault lamp can be deactivated by placing the Run-Stop-Remote Switch in the Stop position and pressing the Reset button. Locate the problem and make the necessary corrections before restarting the generator set.

TABLE 2
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Engines with only one fault lamp)

SYMPTOM	CORRECTIVE ACTION
1. Engine stops cranking and fault lamp lights, after cranking approximately 75 seconds.	1. Check for empty fuel tank, fuel system leaks, or plugged fuel filters and/or supply lines. Correct as required.
2. Fault lamp lights immediately after engine starts and unit shuts down.	2. Indicates possible overspeed condition. Check the governor and throttle linkage for binding and freedom of movement. Check electronic governor connections. Contact an Onan Distributor or the engine manufacturer if linkage is not at fault.
3. Fault lamp lights and engine shuts down after running for a period.	3. Check oil level and replenish if necessary. Check coolant level of radiator and heat exchanger sets and replenish if necessary. Check for slipping drive belts or for obstructions to the airflow. Check water flow valve on city water cooled sets and adjust if necessary. Contact an Onan Distributor or the engine manufacturer if none of the above.
4. Engine runs, shuts down and cranks for 75-seconds. Cranking cycle stops; fault lamp lights.	4. Check for dirty fuel filters and replace if necessary. (See *MAINTENANCE* section) Check for dirty or plugged air filters and replace if necessary. (See *MAINTENANCE* section)
5. Fault lamp lights, no fault exists.	5. Engine monitor board or sensor malfunction. Contact an Onan Distributor.

TABLE 3
TROUBLESHOOTING ENGINE SHUTDOWN SYSTEM
(Units with five fault lamps)

SYMPTOM	CORRECTIVE ACTION
1. Overcrank fault lamp lights and engine stops cranking after approximately 75-seconds.	1. Check for empty fuel tank, fuel system leaks, or plugged fuel filters, and/or supply lines. Correct as required.
2. Engine runs, shuts down, cranks for 75-seconds, cranking cycle stops, overcrank light ON.	2. Check for dirty fuel filters and replace if necessary. (See *MAINTENANCE* section). Check for dirty or plugged air filters and replace if necessary. (See *MAINTENANCE* section)
3. Low oil pressure shutdown.	3. Check oil level and replenish if necessary. Contact an Onan Distributor if oil level is correct.
4. High engine temperature shutdown.	4. Check coolant level of radiator and heat exchanger sets and replenish if necessary. Check for slipping drive belts or for obstructions to the airflow. Check water flow valve on city water cooled sets and adjust if necessary. Contact an Onan Distributor or the engine manufacturer if none of the above.
5. Overspeed shutdown.	5. Check the governor and throttle linkage for binding and freedom of movement. Check wire connections on electronic governor. Contact an Onan Distributor or the engine manufactuer if linkage is not at fault.
6. Overspeed light on, no shutdown. Low oil pressure light ON. No shutdown. High engine temperature light ON. No shutdown.	6. Engine monitor board or sensor malfunction. Contact an Onan Distributor.

Maintenance

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. The table below covers the recommended service intervals for a generator set on STANDBY service. If the set will be subjected to extreme operation conditions, the service intervals should be reduced accordingly. Some of the factors that can affect the maintenance schedule are 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 Onan Distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever comes first. Use the table to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

TABLE 4. MAINTENANCE SCHEDULE

WARNING ***Accidental starting of the set might cause severe personal injury or death. Disconnect the battery cable when repairs are made to the engine, controls, or generator.*** **SERVICE THESE ITEMS**	**SERVICE TIME**				
	Daily or after 8 hours	**Weekly or after 50 hours**	**Monthly or after 100 hours**	**6 Months or after 250 hours**	**Yearly or after 500 hours**
Inspect Set	X[1]				
Check Coolant Heater	X				
Check Oil Level		X			
Check Coolant Level		X			
Check Air Cleaner (clean if required)		X[2]			
Check Battery Charging System		X			
Check Anti-freeze and DCA Concentration			X		
Check Drive Belt Tension			X[3]		
Check Fuel Level			X		
Drain Exhaust Condensate Trap			X		
Check Battery Specific Gravity			X		
Check Generator Air Outlet			X		
Clean Generator Assembly				X	
Change Crankcase Oil and Filter				X[2]	
Drain Sediment From Fuel Tanks				X[4]	
Change Water Filter				X	
Clean Crankcase Breather				X[2]	
Change Air Cleaner Element				X[2]	
Check Governor Linkage				X	
Change Fuel Filters				X	
Clean Cooling System					X
Tighten Exhaust Capscrews					X

1 - Check for oil, fuel, cooling, and exhaust system leaks. Check exhaust system audibly and visually with set running and repair any leaks immediately.

2 - Perform more often in extremely dusty conditions.
3 - Visually check belts for evidence of slippage.
4 - Drain 1 cup of fuel to remove water and sediment.

SET INSPECTION

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected to insure continued safe operation.

Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly including the exhaust manifold, muffler, and exhaust pipe. 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, have them corrected immediately.

WARNING ***Inhalation of exhaust gases might result in serious personal injury or death. Be sure deadly exhaust gas is piped outside and away from 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 leaks. Check any flexible sections for cuts, 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.

WARNING ***Ignition of fuel might cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.***

DC Electrical System

Check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always connect the negative battery cable last to reduce the possibility of arcing.

WARNING ***Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.***

Mechanical

Follow warning below before proceeding. With the generator set 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. With the set running, listen for any unusual noises that may indicate mechanical problems and check the oil pressure frequently. Investigate anything that indicates possible mechanical problems.

WARNING ***Accidental starting of the generator set might cause severe personal injury or death. Place the control switch in STOP position and disconnect the battery cable before inspecting set.***

LUBRICATION SYSTEM

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

Oil API Classification

The lubricating oil recommended for turbocharged diesel engines is API (American Petroleum Institute) Class CC/CD with a maximum sulphated ash content of 1.85 percent. Oils in this class satisfy the engine manufacturer's recommendations for satisfactory operation under most conditions. A book entitled "Lubricating Oils Data Book" is available from EMA (Engine Manufacturers Association) that lists the commercially available oils by brand name and the corresponding API classification. Once an oil is selected, do not mix it with oils of another classification or brand.

Oil Viscosity

The viscosity of an oil is a measure of its resistance to flow at certain specified temperatures. Oils that can meet both low (0°F or -18°C) and high (212°F or 100°C) temperature flow requirements are labeled as multigrade or multiviscosity oils. Multigrade oils that meet the API classification requirements are recommended for use in the engine by the engine manufacturer. The use of a multigrade oil will improve oil control, improve engine cranking in cold weather, maintain adequate lubrication, and may also contribute to improved fuel economy.

Table 5 shows the oil viscosity grades that are recommended for various ambient temperatures. Use only the viscosity grades shown in the table. The engine manufacturer does not recommend the use of a single grade oil.

TABLE 5

AMBIENT TEMPERATURE	SAE VISCOSITY GRADE
-13°F (-25°C) and below	See following section
-13°F to 95°F (-25°C to 35°C)	10W-30
14°F (-10°C) and above	15W-40
30°F (0°C) and above	20W-40

When selecting the oil viscosity, pick the grade that is right for the lowest temperature expected. Oil that is too thick may result in a lack of lubrication when the engine is started. Use a lower grade of oil as the ambient temperature reaches the lower end of the scale (see Table 5).

Oil Viscosity for Extreme Cold

The engine manufacturer recommends using a ***synthetic*** lubricating oil when the ambient temperature is consistently below -13° F (-25° C) and there is no provision to keep the engine warm. Use an SAE5W grade ***synthetic*** oil provided it meets the following requirements:

- API class CC/CD
- Sulphated ash content does not exceed 1.85 percent.
- Pour point is 9°F (5°C) below the lowest expected temp (minimum).
- Viscosity is 10,000 mPa•s (maximum) at -31°F (-35°C) and 4.1 mm^2/s (minimum) at 212°F (100°C).

Do not use a petroleum base 5W grade oil for extreme cold since it usually will not perform satisfactorily.

Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in the Maintenance Table. The oil dipstick and oil fill are located on the left side of the engine (see Figure 16). The dipstick is stamped with an H (high) and an L (low) to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 15 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

WARNING ***Crankcase pressure could blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating.***

Keep the oil level as near as possible to the H (high) mark on the dipstick. Remove the oil fill cap and add oil of the same API and brand when necessary.

CAUTION ***Do not operate the engine with the oil level below the L (low) mark or above the H (high) mark. Overfilling may cause foaming or aeration of the oil while operation below the low mark may cause loss of oil pressure.***

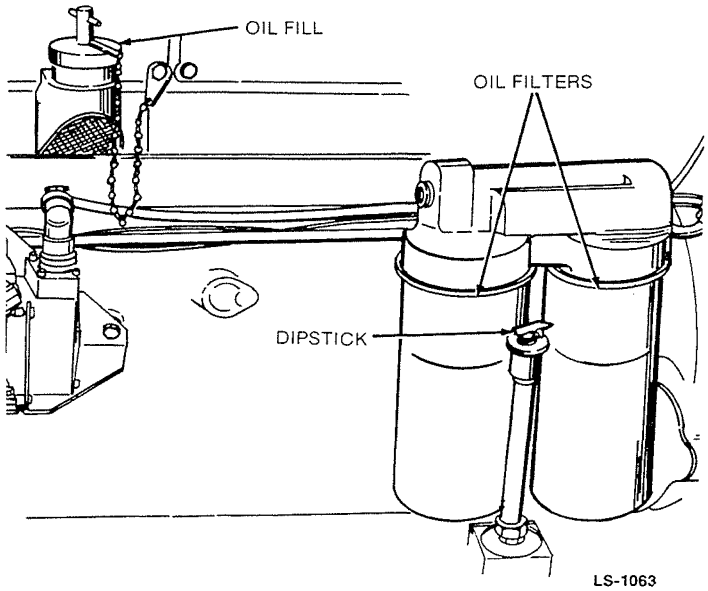


FIGURE 16. ENGINE OIL LEVEL

Oil and Filter Change

Change the oil and filter at the intervals recommended in the maintenance table. Use oil that meets the engine manufacturer's API Classification and viscosity requirements as indicated in the previous section.

Engine Oil Change

1. Bring the engine up to operating temperature and then shut it off.
2. Remove the oil drain plug or open the drain valve and collect the engine oil in a pan. When the crankcase is drained, replace the drain plug and torque it to 60 to 70 ft. lbs (81 to 95 N•m).
3. Fill the crankcase to the H mark on the dipstick.
4. Start the engine and check for oil leaks.
5. Shut off the engine and wait 15 minutes before checking the oil level. Add oil if required.

Oil Filter Change

1. Unscrew the "spin-on" type oil filter and discard (see Figure 16).

CAUTION ***Check the torque on the adapter mounting capscrew. If the capscrew is not tightened to within 25 to 35 ft.-lbs. (34 to 47 N•m), it may rotate when the filter is removed.***

2. Apply a light coat of oil to the gasket sealing surface and fill the replacement filter with oil.
3. Install a new filter and gasket, and tighten by hand until the gasket just touches the filter band. Tighten an additional one-half to three-fourths of a turn.
4. Start the engine and check for leaks.
5. Shut the engine off and wait 15 minutes before checking the oil level. Add oil if required.

BATTERIES

Check the condition of the starting batteries at the interval specified in the Maintenance Table. See that connections are clean and tight. A light coating of non-conductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity and recharge if below 1.260.

WARNING ***Ignition of explosive battery gases might cause severe personal injury. Do not smoke while servicing batteries.***

COOLING SYSTEM

The cooling system on each set is drained prior to shipping and must be refilled (radiator and heat exchanger) or connected to a cooling water source (city water) before being operated. The cooling system capacity of the standard unit with set mounted radiator is shown in the *SPECIFICATIONS* section.

CAUTION ***The heater must not be operated while the cooling system is empty or when the engine is running or damage to the heater will occur.***

Coolant Level

Check the coolant level during shutdown periods at the intervals specified in the Maintenance Table. Remove the radiator cap after allowing the engine to cool and if necessary, add coolant until the level is near the top of the radiator. Use a coolant solution that meets the engine manufacturer's coolant requirements.

WARNING ***Contact with hot coolant might result in serious burns. Allow cooling system to cool before releasing pressure and loosening tank heater lines.***

CAUTION ***High Engine Temperature Cutoff will shut down engine in an overheat condition only if coolant level is sufficiently high to physically contact shutdown switch. Loss of coolant will allow engine to overheat without protection of shutdown device and cause severe damage to the engine. It is therefore imperative that adequate engine levels be maintained, to ensure operational integrity of cooling system and engine coolant overheat shutdown protection.***

Coolant Requirements

The water used for engine coolant should be clean, low in mineral content, and free of any corrosive chemicals such as chloride, sulphate, or acid. Generally, any water that is suitable for drinking can be treated for use as engine coolant.

A satisfactory engine coolant inhibits corrosion and if necessary, protects against freezing. To prevent corrosion, the water used for coolant must be precharged with a chemical additive. New engines are shipped with a precharge water filter that automatically adds an anti-corrosion chemical to the coolant.

The precharge water filter is compatible with plain water and all permanent type antifreezes EXCEPT those with a methoxy propanol base.

Cooling systems that are subject to freezing conditions must also be protected with a permanent type antifreeze. Mix the water and antifreeze in the proportion recommended by the supplier for the lowest expected ambient temperature. Do not use an antifreeze that contains anti-leak additives. The water filter element will trap the additives and possibly become clogged.

WARNING ***Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

Filling the Cooling System (Standard Radiator and Heat Exchanger Sets)

Remove the cooling system pressure cap and fill the system with water or a water/anti-freeze mixture. On the initial fill, the precharge water filter will automatically add the required anti-corrosion chemicals to the cooling system.

When the engine is first started, remove the pressure cap and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable.

CAUTION ***Be sure the electric solenoid valve used with city water cooled sets is open before initial starting of unit to allow coolant chambers to fill. Otherwise overheating and damage to the engine might result.***

Remote Radiator Coolant Precharge

The large quantities of coolant used in a remote radiator installation will require precharging with a separate anticorrosion additive. The precharge water filter will not provide adequate anti-corrosion protection for the large capacities of most remote systems.

A separate precharge additive (Liquid DCA) is available from the engine manufacturer. The following recommendations are provided for mixing the coolant with the engine manufacturer's precharge additive:

1. Flush and drain all tanks and piping to remove any possible contaminants.
2. Determine the total capacity of the system including the remote radiator, any tanks required, the engine, and the piping.

3. Calculate the proportions of water and antifreeze that are needed to provide protection against freezing (if required).
4. Multiply the desired DCA addititve concentration times the total capacity of the system to determine the amount of additive required. A concentration of 1 DCA unit per gallon (0.27 DCA units per litre) is considered acceptable.
5. Add water to the system along with small amounts of DCA additive. Agitate the water so the DCA liquid mixes with the water. The temperature of the water should be above 50° F (10° C).
6. Add the antifreeze last while maintaining a continuous agitation to keep the coolant in solution. Both the DCA additive and antifreeze will settle in the bottom of the system if not mixed thoroughly.

Testing the DCA Concentration: Over a period of time, the DCA additive will become depleted and it will be necessary to add more DCA chemical to maintain adequate corrosion protection. The engine manufacturer has a testing kit available for measuring the concentration of DCA chemical in the system. Determine the DCA concentration before adding more DCA to the system. Too low a concentration will allow corrosion to start. Too great a concentration may cause sludge to form in the water filter. Instructions for testing the coolant are provided with the kit.

Standpipe Cooled Sets

With a standpipe cooled set, cooling water is discharged and replaced rather than being cooled and recirculated. The cooling water must be clean and free of any contaminents to prevent the engine water jacket passages from becoming clogged.

CAUTION ***Be sure that the electric solenoid valve used with city water cooled sets is open before initial starting of unit to allow coolant chambers to fill. Otherwise overheating and damage to the engine might result.***

Coolant Heater

Check the operation of the coolant heater by verifying that hot coolant is being discharged from the outlet hose (see Figure 17). For efficient operation and maximum life, clean the coolant heater whenever the cooling system is drained for flushing.

To Service:

1. Remove AC power from coolant heater.

WARNING ***Failure to remove AC power presents a shock hazard and might cause serious personal injury or death.***

2. Allow heater to cool before proceeding.

WARNING ***Contact with hot coolant might result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.***

3. Remove the head and valve assembly.
4. Clean any scale deposits out of the tank.
5. Remove heating element and scrape off any scale deposits that have accumulated on the sheathing.

CAUTION ***When reassembling threaded aluminum parts, be sure to use anti-seize compound.***

6. Restore AC power to heater after system has been filled with coolant.

Water Filter Change

When changing the water filter on a new engine, replace the DCA precharge element filter with the DCA service element filter. After the third element change, check the DCA concentration to ensure that adequate corrosion protection is maintained. Each time the cooling system (set mounted radiator) is drained, install a new DCA precharge element water filter to bring the DCA concentration up to the recommended level.

To Service:

1. Close the shutoff valve on the top of the filter head (see Figure 18).
2. Unscrew the water filter and discard.

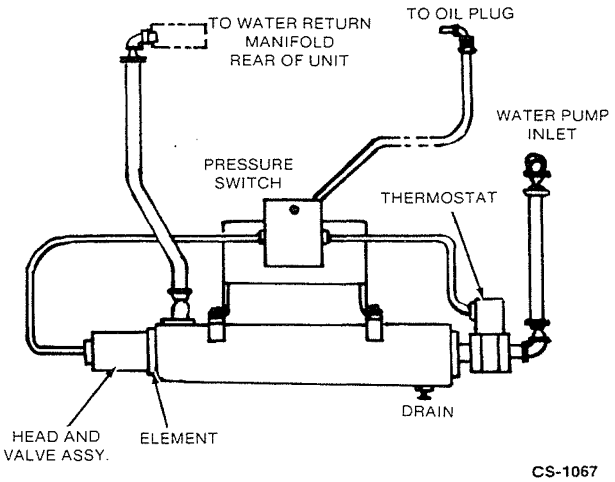


FIGURE 17. COOLANT HEATER

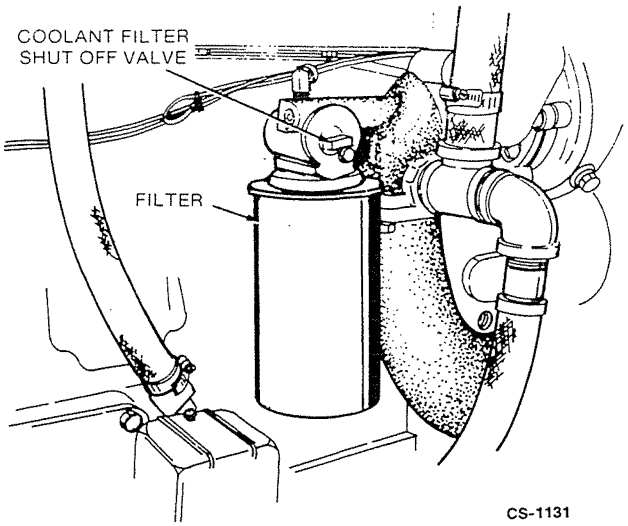


FIGURE 18. WATER FILTER

3. Apply a light coat of lubricating oil to the gasket surface.
4. Install a new filter and tighten by hand until the seal just touches the filter head. Tighten an additional one-half to three-fourths turn.
5. Open the shutoff valve.

CAUTION ***Do not use antifreeze with an anti-leak formula. The stop leak element can prevent or retard the coolant flow through the filter, thereby eliminating the filtering process completely.***

Flushing and Cleaning

The cooling system must be clean and free of rust and scale if it is to perform properly. Use only coolant that meets the engine manufacturer's requirements.

Chemical Cleaning: Thoroughly clean the cooling system if rust and scale have collected on the engine water jacket or in the radiator. Rust and scale slow down heat absorption and can block the coolant flow. Use a good cooling system cleaner such as sodium bisulphate or oxalic acid and follow the instructions provided by the supplier. Follow up by neutralizing and flushing with clean water.

Flushing: Flush the radiator and block after cleaning or before refilling the system with new coolant. Open the upper and lower radiator hose connections and install the radiator cap. Attach a flushing gun nozzle to the lower radiator hose connection and let the water run until the radiator is full. When full, gradually apply air pressure to avoid damaging the core.

CAUTION ***Excessive air pressure while starting the water flow could split the radiator core. Apply air pressure gradually to avoid damage.***

Shut off the air and allow the radiator to refill. Repeat flushing procedure until the water coming from the radiator is clean.

To flush the engine block, first remove the thermostat to allow the water to fill the block. Attach the flushing gun to the upper radiator hose and fill the block with water. Restrict the lower radiator hose opening until the block is filled. Apply air pressure and force water from the lower opening. Repeat until the water coming from lower radiator hose is clean.

Replace the thermostat and all hoses and refill cooling system.

Heat Exchanger Plugs

Check the zinc plugs in the heat exchanger and replace if they are eroded to less than half their original length. The frequency of replacement is dependent on the chemical reaction that occurs when the plugs are in contact with the raw water.

FUEL SYSTEM

The engine has been primarily designed to operate on No. 2 diesel fuels since such fuels have a higher energy content and are generally lower in cost. The engine will also operate satisfactorily on No. 1 fuel or other similar fuels if they meet certain specifications. Consult the engine manufacturer for the specific requirements if using a non-standard 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.

WARNING ***Ignition of fuel might cause serious personal injury or death by fire or explosion. Do not permit any flame, cigarette, or other igniter near the fuel system.***

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the engine is used. In cold weather, warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel level is low, the upper portion of the tank tends to form condensation. In warm weather, both the fuel and the tank will be warm during the daytime. At night, cool air tends to lower 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 tend to form condensation.

Condensation (water) can cause clogging of fuel filters as well as freezing problems. In addition, water mixing with the sulphur in the fuel forms acid which can corrode and damage engine parts.

Fuel Filters

Two spin-off type fuel filters (see Figure 19) with bottom drain plugs are used. At the interval recommended in the maintenance table, remove both filters and discard. Fill the new filters with diesel fuel and put a light coat of fuel on the sealing gasket. Install and tighten by hand until the gasket just touches the filter head. Tighten an additional one-half to three-fourths of a turn. Periodically remove the drain plug to drain off moisture and sediment.

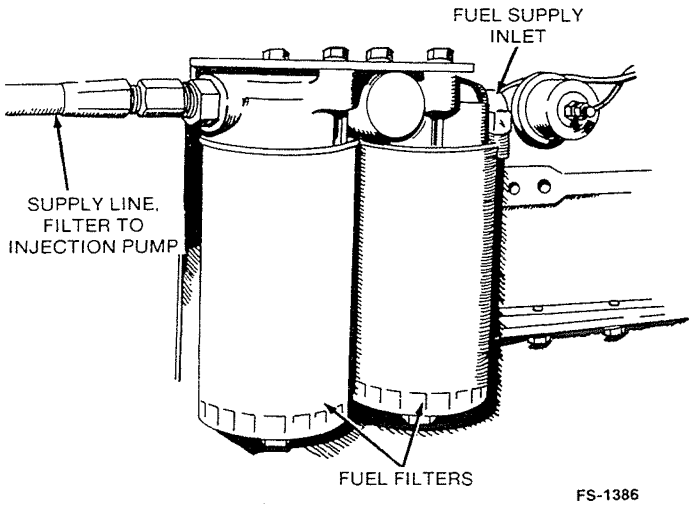


FIGURE 19. FUEL FILTERS

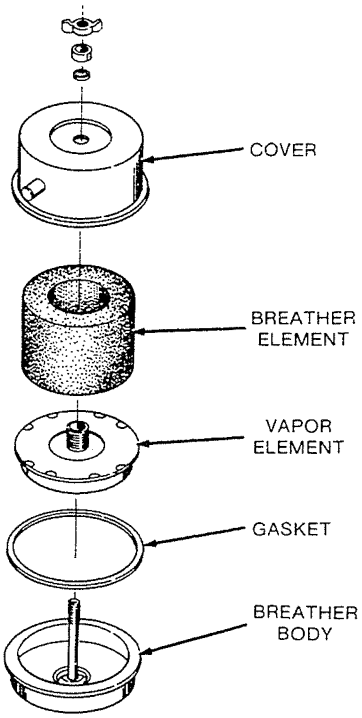


FIGURE 20. CRANKCASE BREATHER

CRANKCASE BREATHERS

Remove and clean the crankcase breathers at the interval specified in the maintenance table.

To Service

1. Remove the wing nut, flat washer, and rubber washer (see Figure 20).
2. Remove cover and lift out breather element, vapor element, and gasket.
3. Discard the breather element and clean the remaining parts in parts cleaning solvent. Dry thoroughly with low pressure compressed air.
4. Inspect all parts and replace any that are cracked, dented, or otherwise unserviceable.
5. Reassemble in the sequence shown using a new breather element. Tighten wing nut securely.

AC GENERATOR

General

There are no brushes, brush springs or collector rings on these generators, therefore they require very little servicing. Periodic inspections, to coincide with engine oil changes, will ensure good performance.

Remove the grill section and inspect the rotating rectifier assembly to make sure the diodes (see Figure 21) are free of dust, dirt, and grease. Excessive foreign matter on these diodes and heat sinks will cause the diodes to overheat and will result in their failure. Blow out the assembly periodically with filtered low pressure air.

Check generator voltage. It may be necessary to make a slight readjustment of the voltage rheostat to obtain the preferred voltage at average load.

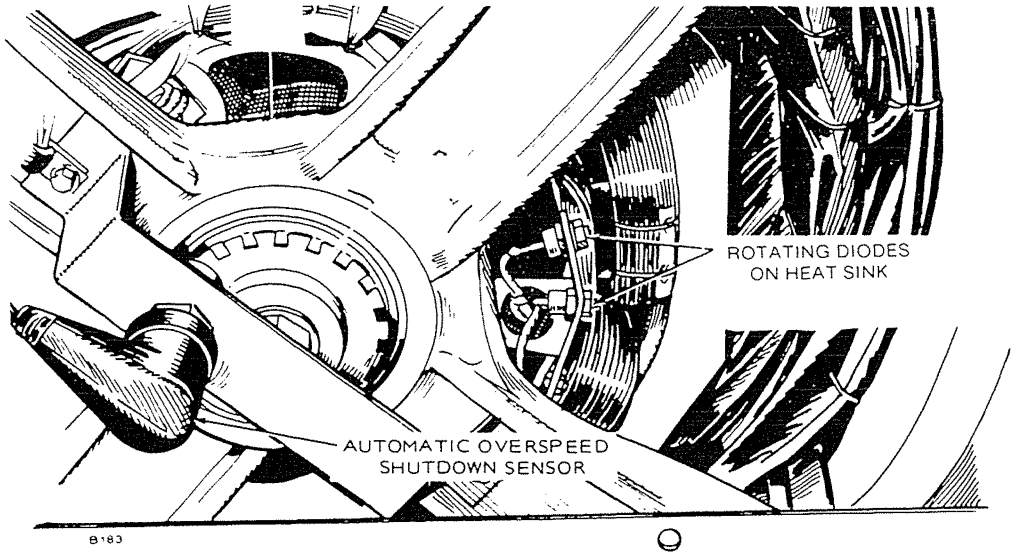


FIGURE 21. RECTIFIER ASSEMBLY

Generator Bearing

Have the bearing inspected for wear every 1000 hours by an Onan Distributor. If the unit is used for "prime power," have the bearing replaced every 10,000 hours or after two years. If the unit is used for "standby power," have the bearing replaced every five years.

AIR CLEANER

Check the air cleaner and service the filter element at the intervals recommended in the maintenance table (see Figure 22). The air cleaner contains a paper cartridge filter element which can be cleaned and reused or discarded and replaced.

To Service

1. Loosen the eight attaching bolts and lift off the air cleaner head.
2. Remove the air filter element from the filter housing.
3. To clean, blow low pressure compressed air (30 psi/207 kPa) through the element from the clean side. Hold the nozzle at least 1 inch (25 mm) away to avoid damaging the element.
4. Soak the filter for at least 15 minutes in water and Donaldsons D1400 solvent to remove soot and carbon as well as dirt.
5. Rinse with clean water (low pressure) and allow to air dry. Do not blow dry with compressed air. Reinstall when filter element is dry. Replace the filter after several cleanings to avoid restricting the airflow.

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

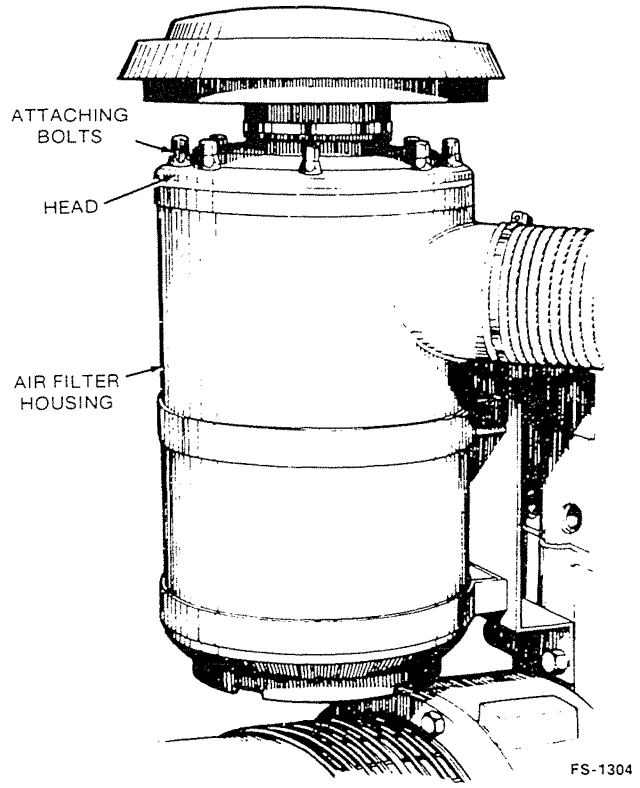


FIGURE 22. AIR CLEANER

Onan Corporation
A Subsidiary of
McGraw-Edison Company
1400 73rd Avenue N.E.
Minneapolis, MN 55432

612 574-5000
Telex 29 0476 (U.S.)
Telex 29 0856 (outside U.S.)
TWX 910 576-2833
Cable ONAN