



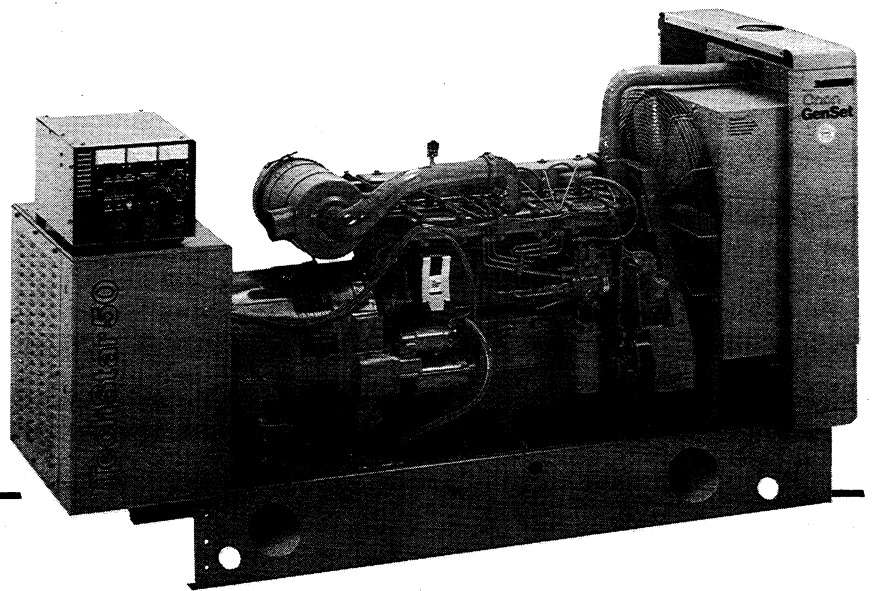
Operators Manual

TechStar[®]

DL4B-DL6B-DL6TB

GenSet

- **Four and Six Cylinder
Diesel Driven Generators**
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934-0121
SPEC A-B
8-84

Replaces Copy
Dated 10-83

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.

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

⚠ WARNING *This symbol refers to a hazard or unsafe practice which can result in severe personal injury or death.*

⚠ 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 and explosion 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, 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.
- Do not smoke while servicing lead acid batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

- Provide an adequate exhaust system to properly expel discharged gases. 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 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 DIRECTLY 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.
- 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.

Important Safety Precautions

Read and observe these safety precautions when using or working on electric generators, engines and related equipment. Also read and follow the literature provided with the equipment.

Proper operation and maintenance are critical to performance and safety. Electricity, fuel, exhaust, moving parts and batteries present hazards that can cause severe personal injury or death.

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

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

- Used engine oil, and benzene and lead, found in some gasoline, have been identified by government agencies as causing cancer or reproductive toxicity. When checking, draining or adding fuel or oil, do not ingest, breathe the fumes, or contact gasoline or used oil.
- Do not fill tanks with engine running. Do not smoke around the area. Wipe up oil or fuel spills. Do not leave rags in engine compartment or on equipment. Keep this and surrounding area clean.
- Inspect fuel system before each operation and periodically while running.
- Equip fuel supply with a positive fuel shutoff.
- Do not store or transport equipment with fuel in tank.
- Keep an ABC-rated fire extinguisher available near equipment and adjacent areas for use on all types of fires except alcohol.
- Unless provided with equipment or noted otherwise in installation manual, fuel lines must be copper or steel, secured, free of leaks and separated or shielded from electrical wiring.
- Use approved, non-conductive flexible fuel hose for fuel connections. Do not use copper tubing as a flexible connection. It will work-harden and break.

EXHAUST GAS IS DEADLY

- Engine exhaust contains carbon monoxide (CO), an odorless, invisible, poisonous gas. Learn the symptoms of CO poisoning.
- Never sleep in a vessel, vehicle, or room with a genset or engine running unless the area is equipped with an operating CO detector with an audible alarm.
- Each time the engine or genset is started, or at least every day, thoroughly inspect the exhaust system. Shut down the unit and repair leaks immediately.

- Warning: Engine exhaust is known to the State of California to cause cancer, birth defects and other reproductive harm.

Make sure exhaust is properly ventilated.

- Vessel bilge must have an operating power exhaust.
- Vehicle exhaust system must extend beyond vehicle perimeter and not near windows, doors or vents.
- Do not use engine or genset cooling air to heat an area.
- Do not operate engine/genset in enclosed area without ample fresh air ventilation.
- Expel exhaust away from enclosed, sheltered, or occupied areas.
- Make sure exhaust system components are securely fastened and not warped.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not remove any guards or covers with the equipment running.
- Keep hands, clothing, hair, and jewelry away from moving parts.
- Before performing any maintenance, disconnect battery (negative [–] cable first) to prevent accidental starting.
- Make sure fasteners and joints are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- If adjustments must be made while equipment is running, use extreme caution around hot manifolds and moving parts, etc. Wear safety glasses and protective clothing.

BATTERY GAS IS EXPLOSIVE

- Wear safety glasses and do not smoke while servicing batteries.
- Always disconnect battery negative (–) lead first and reconnect it last. Make sure you connect battery correctly. A direct short across battery terminals can cause an explosion. Do not smoke while servicing batteries. Hydrogen gas given off during charging is explosive.
- Do not disconnect or connect battery cables if fuel vapors are present. Ventilate the area thoroughly.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can be ignited by equipment operation or cause a diesel engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. **Do not operate diesel equipment where a flammable vapor environment can be created by fuel spill, leak, etc., unless equipped with an automatic safety device to block the air intake and stop the engine.**

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

- Hot coolant is under pressure. Do not loosen the coolant pressure cap while the engine is hot. Let the engine cool before opening the pressure cap.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Do not service control panel or engine with unit running. High voltages are present. Work that must be done while unit is running should be done only by qualified service personnel.
- Do not connect the generator set to the public utility or to any other electrical power system. Electrocutation can occur at a remote site where line or equipment repairs are being made. An approved transfer switch must be used if more than one power source is connected.
- Disconnect starting battery (negative [-] cable first) before removing protective shields or touching electrical equipment. Use insulative mats placed on dry wood platforms. Do not wear jewelry, damp clothing or allow skin surface to be damp when handling electrical equipment.
- Use insulated tools. 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.
- With transfer switches, keep cabinet closed and locked. Only authorized personnel should have cabinet or operational keys. Due to serious shock hazard from high voltages within cabinet, all service and adjustments must be performed by an electrician or authorized service representative.

If the cabinet must be opened for any reason:

1. Move genset operation switch or Stop/Auto/Handcrank switch (whichever applies) to Stop.
2. Disconnect genset batteries (negative [-] lead first).
3. Remove AC power to automatic transfer switch. If instructions require otherwise, use extreme caution due to shock hazard.

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training are required to work on or around medium voltage equipment. Operation and maintenance must be done only by persons trained and qualified to work on such devices. Improper use or procedures will result in severe personal injury or death.
- Do not work on energized equipment. Unauthorized personnel must not be permitted near energized equipment. Induced voltage remains even after equipment is disconnected from the power source. Plan maintenance with authorized personnel so equipment can be de-energized and safely grounded.

GENERAL SAFETY PRECAUTIONS

- Do not work on equipment when mentally or physically fatigued or after consuming alcohol or drugs.
- Carefully follow all applicable local, state and federal codes.
- Never step on equipment (as when entering or leaving the engine compartment). It can stress and break unit components, possibly resulting in dangerous operating conditions from leaking fuel, leaking exhaust fumes, etc.
- Keep equipment and area clean. Oil, grease, dirt, or stowed gear can cause fire or damage equipment by restricting airflow.
- Equipment owners and operators are solely responsible for operating equipment safely. Contact your authorized Onan/Cummins dealer or distributor for more information.

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

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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.

HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact an Onan Distributor for assistance. Onan 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.

OnanGenSet

Model No.

Serial No.

Important - Give above no.'s when ordering parts

Service Rating:

Hertz: RPM:

Single Phase kW KVA

Three Phase kW KVA

Volts: 110/190 110/220 115/200 115/230 120/208

Amps:

120/240 127/220 139/240 220/380 230/400 240/416

240/480 254/440 277/480 347/600 115/230 18 120/240 18

For Elec PF: Bat.:

Eqpt Only

Ineul - NEMA Class F Amb 40°C

Onan Corporation Minneapolis Mn 55432 USA

Made in USA 99-1034

Onan Nameplate

WARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS MIGHT RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Specifications

GENERATOR DETAILS

| | |
|----------------------------------|---|
| Type | Onan YHB Revolving Field, 2-Pole, Brushless |
| Phase | 3 |
| Three Phase Ratings | |
| 60 Hertz Continuous Standby | |
| 33.0 DL4B | 33 kW (41.2 kVA at 0.8 PF) |
| 50.0 DL6B | 50 kW (62.5 kVA at 0.8 PF) |
| 70.0 DL6TB | 70 kW (87.5 kVA at 0.8 PF) |
| 50 Hertz Continuous Standby | |
| 30.0 DL4B | 30 kW (37.5 kVA at 0.8 PF) |
| 45.0 DL6B | 45 kW (56.3 kVA at 0.8 PF) |
| 63.0 DL6TB | 63 kW (78.8 kVA at 0.8 PF) |
| Random Frequency Variation | + or - 0.5 percent |
| Random Voltage Variation | + or - 0.5 percent |

ENGINE DETAILS

| | |
|---|--------------------|
| Engine | |
| DL4B | Onan L423D |
| DL6B | Onan L634D |
| DL6TB | Onan L634T |
| Engine Speed | |
| 60 Hertz | 3600 r/min |
| 50 Hertz | 3000 r/min |
| Fuel | 2-D Diesel |
| Fuel Pump Inlet Thread Size | 1/4 NPTF |
| Fuel Return Outlet Thread Size | 1/8 NPTF |
| Fuel Pump Maximum Lift | 6 Ft. (1.8 m) |
| Exhaust Outlet Size | |
| DL4B, DL6B | 2 In. NPT External |
| DL6TB | 3 In. NPT External |
| Starting System Voltage | 12 |
| DL4B Battery Requirements | |
| BCI Group Size | 31 |
| Reserve Capacity | 95 |
| Cold Cranking Amperes (at 0°F/-18°C) | 530 |
| Battery Voltage | 12 |
| Quantity Required | 1 |
| DL6B, DL6TB Battery Requirements | |
| BCI Group Size | 31 |
| Reserve Capacity | 130 |
| Cold Cranking Amperes (at 0°F/-18°C) | 625 |
| Battery Voltage | 12 |
| Quantity Required | 1 |
| Cooling System Capacity (Engine and Radiator) | |
| DL4B | 12.2 Qt. (11.5 L) |
| DL6B | 17.8 Qt. (16.8 L) |
| DL6TB | 21.8 Qt. (20.6 L) |
| Engine Oil Capacity | |
| DL4B | 6 Qt (5.7 L) |
| DL6B | 9 Qt (8.5 L) |
| DL6TB | 11.4 Qt (10.8 L) |

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 any components. The complete installation must comply with all local and state building codes, fire ordinances and other regulations that may apply.

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.
- Accessibility for operation and servicing.
- Noise levels.
- Vibration Isolation

LOCATION

Generator set location is decided mainly by 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. See Figure 1.

Plan for access 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.

MOUNTING

Mount 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.

Generator sets are mounted on a steel skid which provides proper support. The engine-generator assembly is isolated from the skid frame by rubber mounts which provide adequate vibration isolation for normal installations. For critical installations, however, you can install vibration isolators between skid base and foundation. Onan has two types of vibration isolators available. One is a cork and

rubber pad type which performs satisfactorily for most installations. The other is an adjustable spring-type which can be used for critical locations.

Use anchored mounting bolts to secure the generator set skid to the floor to prevent movement. Refer to set outline drawing for proper spacing of mounting bolts and set mounting dimensions.

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

For indoor installations, locate vents so 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 the vents and ducts so they are large enough to allow the required flow rate of air. The "free area" of ducts must be as large as the exposed area of the radiator. Refer to the appropriate Product Data Sheet for the airflow requirements.

Wind will restrict free airflow if it blows directly into the air outlet vent. Locate the outlet vent so the effects of wind are eliminated.

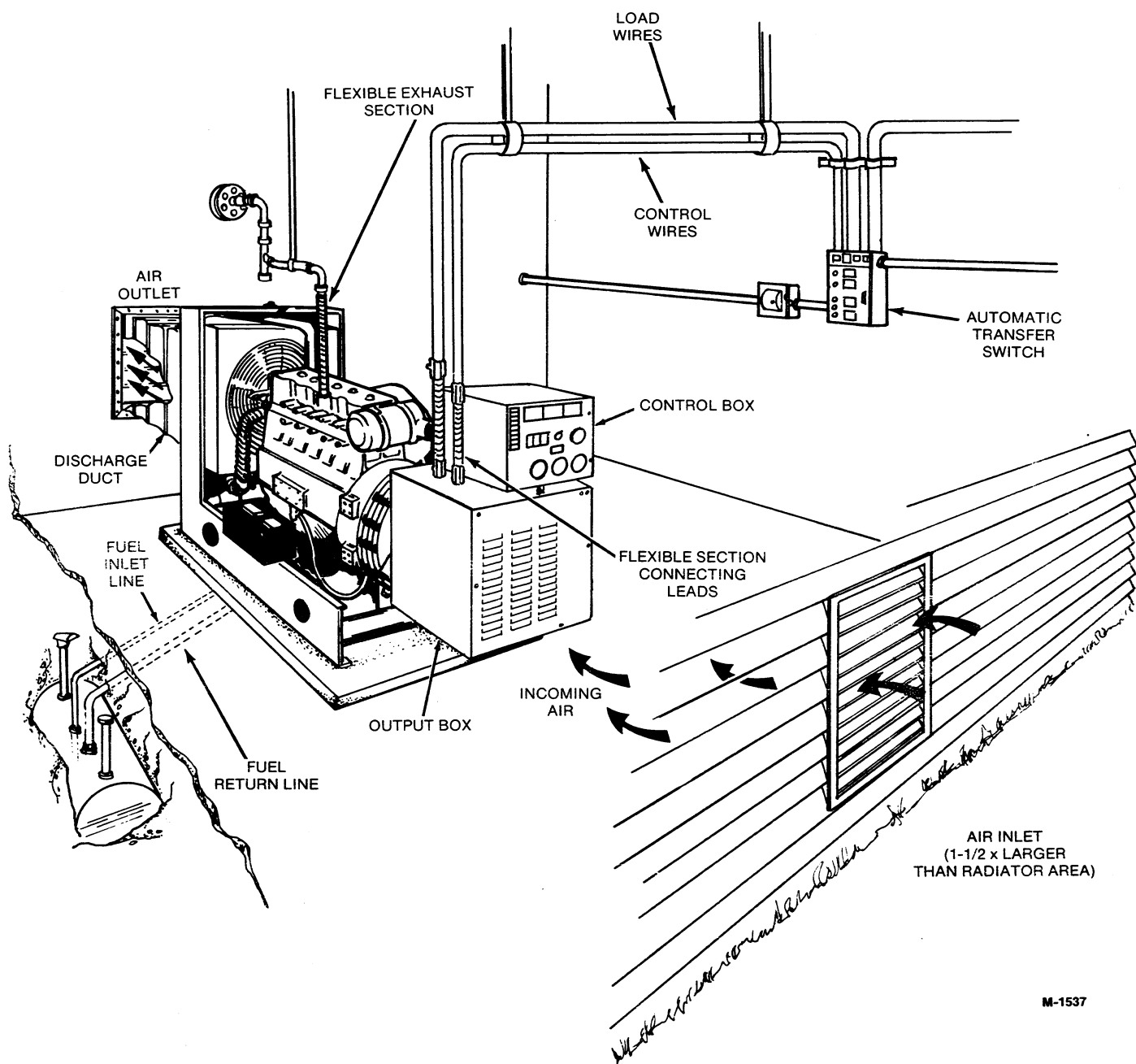
Dampers

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. Refer to Onan Technical Bulletin T-030 for more detailed information.

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 the set. Make the inlet vent opening 1-1/2 times larger than the radiator area.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow. Use a duct of canvas or sheet metal between the radiator and the air outlet opening. The duct prevents recirculation of heated air. Remove the radiator core guard prior to installing the duct.



M-1537

FIGURE 1. TYPICAL INSTALLATION

COOLING SYSTEM

The standard radiator cooled set does not require any external connections except as discussed under Ventilation. Allow clearance around the set for access to service the radiator and fan belt.

Water Jacket Heater (Optional)

A water jacket heater can be used to keep engine coolant warm when the engine is shutdown. It heats and circulates the coolant within the engine. This reduces start-up time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

CAUTION *The water jacket heater will be damaged if it is operated while the cooling system is empty. Fill the cooling system before connecting the water jacket heater.*

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 and phase is correct for the heater element rating.

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. Regularly inspect the exhaust system both visually and audibly to ensure that the entire system remains fume tight and safe for operation.

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 (Figure 2) where exhaust pipes pass through wall or partitions. Refer to NFPA 37, Section 6-3, "Stationary Combustion Engines and Gas Turbines" for accepted design practices. Build according to the code requirements in effect at the installation site.

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 3).

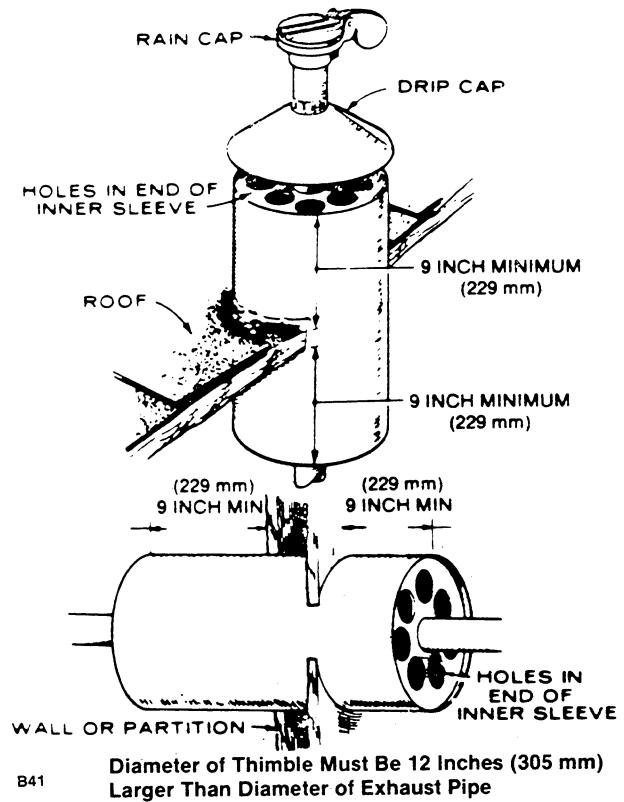


FIGURE 2. EXHAUST THIMBLE

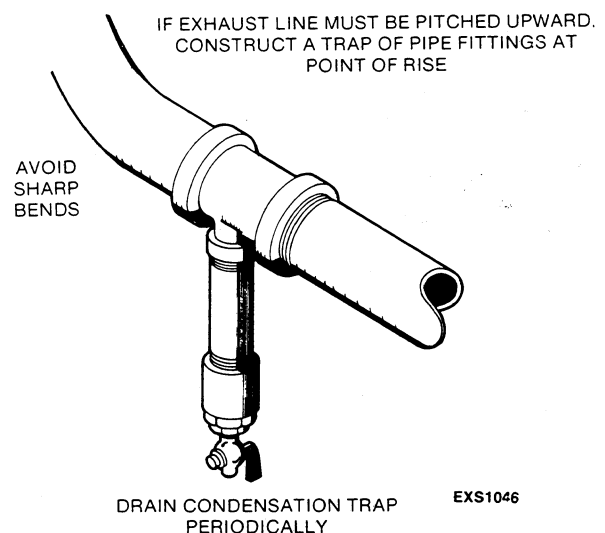


FIGURE 3. EXHAUST CONDENSATION TRAP

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for mufflers and tailpipe. 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 or insulate 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.

Table 1 shows the maximum equivalent exhaust pipe length for exhaust systems using 2 inch through 5 inch diameter pipe. Also shown are the equivalent lengths of various pipe fittings that may be used in the system. To determine the total exhaust pipe equivalent length, add the length of the straight sections of pipe to the equivalent length of the fittings used. Do NOT include the length of the muffler. The TOTAL exhaust pipe equivalent length must NOT exceed the length shown in Table 1 for the size of pipe used.

As the exhaust pipe length and number of bends increases, larger pipe will be required to avoid excessive exhaust restriction and back pressure. Exceeding the maximum equivalent length will increase back pressure beyond the level recommended for satisfactory engine performance. The maximum allowable back pressure on naturally aspirated engines (measured at exhaust manifold) and on turbocharged engines (measured at turbo outlet) is 41 inches (1041 mm) H₂O.

TABLE 1. EXHAUST LENGTH

DL4B - MAXIMUM EQUIVALENT EXHAUST PIPE LENGTH

(ALLOWANCE MADE FOR ONE MUFFLER)

| PIPE SIZE (IN.) | 2.0 | 2.5 | 3.0 | 3.5 | 4.0 |
|--------------------------|--------|---------|---------|----------|----------|
| MAX. PIPE LENGTH IN FEET | 18 | 69 | 153 | 401 | 782 |
| Metres in () | (5.48) | (21.03) | (46.63) | (122.22) | (238.35) |

DL6B - MAXIMUM EQUIVALENT EXHAUST PIPE LENGTH

(ALLOWANCE MADE FOR ONE MUFFLER)

| PIPE SIZE (IN.) | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 |
|--------------------------|---------|---------|---------|----------|----------|
| MAX. PIPE LENGTH IN FEET | 49 | 125 | 261 | 522 | 1590 |
| Metres in () | (14.93) | (38.10) | (79.55) | (159.10) | (484.63) |

DL6TB - MAXIMUM EQUIVALENT EXHAUST PIPE LENGTH

(ALLOWANCE MADE FOR ONE MUFFLER)

| PIPE SIZE (IN.) | 2.5 | 3.0 | 3.5 | 4.0 | 5.0 |
|--------------------------|--------|---------|---------|---------|----------|
| MAX. PIPE LENGTH IN FEET | 22 | 56 | 123 | 245 | 690 |
| Metres in () | (6.70) | (17.06) | (37.49) | (74.67) | (210.31) |

EQUIVALENT LENGTHS OF PIPE FITTINGS

| TYPE OF FITTING (INCHES) | 2 | 2.5 | 3 | 3.5 | 4 | 5 |
|--------------------------|--------|--------|--------|--------|--------|--------|
| STD. ELBOW | 5.3 | 6.4 | 8.1 | 9.6 | 11 | 14 |
| Feet (Metres) | (1.62) | (1.95) | (2.47) | (2.93) | (3.35) | (4.27) |
| LONG RAD ELBOW | 3.5 | 4.2 | 5.2 | 6 | 7 | 9 |
| Feet (Metres) | (1.07) | (1.28) | (1.58) | (1.83) | (2.13) | (2.74) |
| MED RAD ELBOW | 4.6 | 5.4 | 6.8 | 8 | 9 | 12 |
| Feet (Metres) | (1.40) | (1.64) | (2.07) | (2.44) | (2.74) | (3.66) |
| STD. TEE | 13 | 14 | 17 | 19 | 22 | 27 |
| Feet (Metres) | (3.96) | (4.27) | (5.18) | (5.79) | (6.70) | (8.23) |

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. If water in the fuel is a problem despite all precautions to prevent entrance of moisture, a water separator is recommended.

Use a flexible section of tubing between the engine and the stationary fuel supply line to withstand vibration. Use only compatible metal fuel lines when installing stationary fuel supply lines underground to avoid electrolysis. Onan can supply copper fuel lines with brass fittings if required.

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 a 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 recommended for all installations and required for indoor automatic or remote starting installations. Connect the solenoid wires 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 6 foot (1.8 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 liters) in capacity.

WARNING

Due to the potential hazard of fire and explosion with any fuel, carefully design and install the fuel system observing applicable codes. The tank and fuel lines must not be installed near exhaust pipes.

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.

WARNING

Spilled fuel creates a hazardous fire condition which might result in severe personal injury or death. An overflow pipe must be installed between the day tank and main fuel tank.

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 day tank overflow line to the supply tank in case the float switch fails to shut off the fuel transfer pump.

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.

Include a shutoff solenoid in the fuel line between the fuel supply tank and the day tank. It stops fuel flow when the run circuit is de-energized.

Engine Fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections by the factory. Flexi-

ble 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 SYSTEM

Installing the generator set electrical system includes connecting the load, installing the control wiring, and connecting the batteries. The batteries should always be connected last to avoid accidental starting of the unit during installation.

Most location 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.

WARNING

Improper wiring might result in fire and severe personal injury or death. Do not connect electrical wiring to the fuel line.

If the installation is for standby service, a transfer switch is required for switching the load from the normal power source to the generator set. 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. Onan can supply transfer switches to match the generator rating if required.

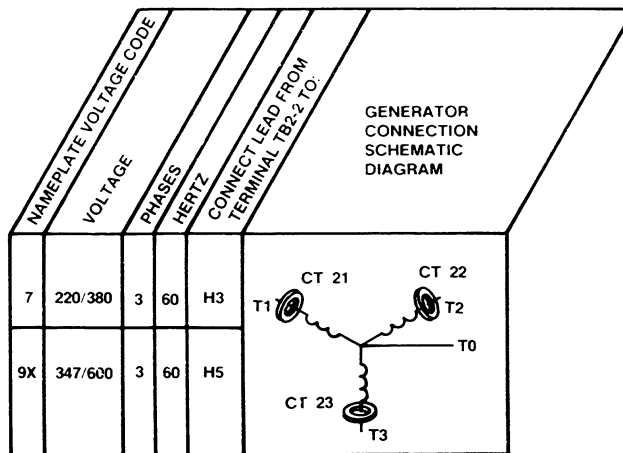
Generator Voltage Connections

The generator output voltage(s) and maximum current rating(s) are 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.

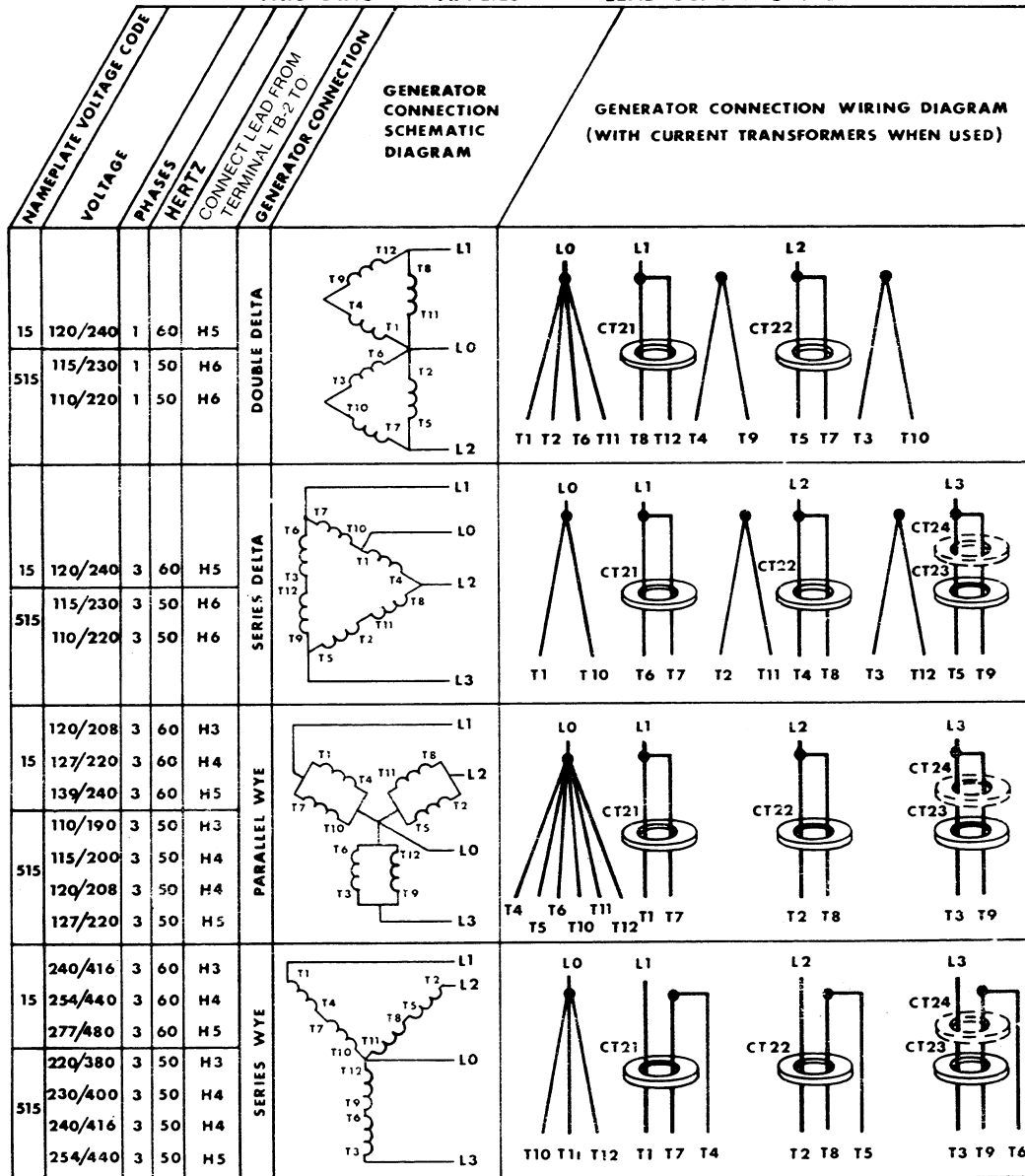
Non-Reconnectible Generators (Voltage Codes 7 or 9X): These generators are wired at the factory for a specific voltage and are not intended for reconnection. The voltage and corresponding current rating (amperes) are shown on the nameplate.

Reconnectible Generators (Voltage Codes 15 and 515): Generators with codes 15 (for 60 Hertz) and 515 (for 50 Hertz) are three phase generators that can be reconnected for any of the voltages shown in Figure 4. Refer to the set nameplate for the corresponding current rating (amperes).

Reconnection lead W12 (on TB2) is used to supply single phase generator voltage to the appropriate tap on the voltage reference transformer. One end of this lead is connected to terminal 2 on TB2. Connect the other end to terminal H3, H4, H5, or H6 (see Figure 5) depending on the voltage option required. Refer to Figure 4 for voltages available and correct hook-up.



THIS DIAGRAM APPLIES TO 12 LEAD GENERATORS ONLY



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FIGURE 4. GENERATOR VOLTAGE CONNECTIONS

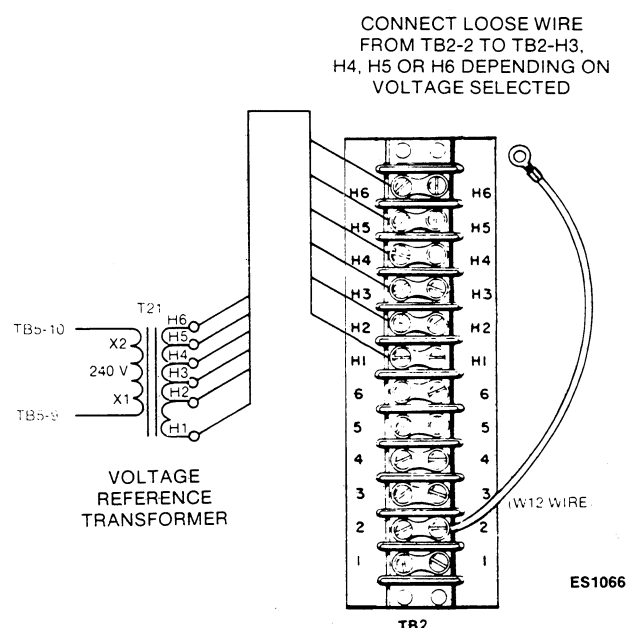


FIGURE 5. VOLTAGE REFERENCE TRANSFORMER LEAD

Load Connections

The load is connected to the generator set by bolting the load wires to the appropriate generator lead wires in the output box. The generator lead wires are marked T1, T2, etc. for identification. On sets with the optional output terminal block, connect the generator lead wires and load lead wires to the appropriate studs (marked L1, L2, etc.). Use a section of flexible conduit at the output box to permit movement.

When installing sets with the optional AC ammeter, the generator output leads must be routed through the current transformers for proper meter operation. The current transformers are identified as CT21, CT22, and CT23 (3 phase only) on the wiring diagrams and electrical schematics. Refer to the appropriate generator connection diagram (see Figure 5) to identify the output leads that must be routed through each current transformer.

On the DL4B, pass the output leads through each current transformer **two times** (two primary turns) as shown in Figure 6. On the DL6B and DL6TB, pass the output leads through each current transformer **one time** (one primary turn) as shown in Figure 6. On sets not equipped with the optional transformer mounting block, use a cable tie to secure the loose current transformers to the output leads.

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 and three phase loads are connected. Any combination of single 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. During testing, check the current flow from each line terminal 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 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 electrical 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.*

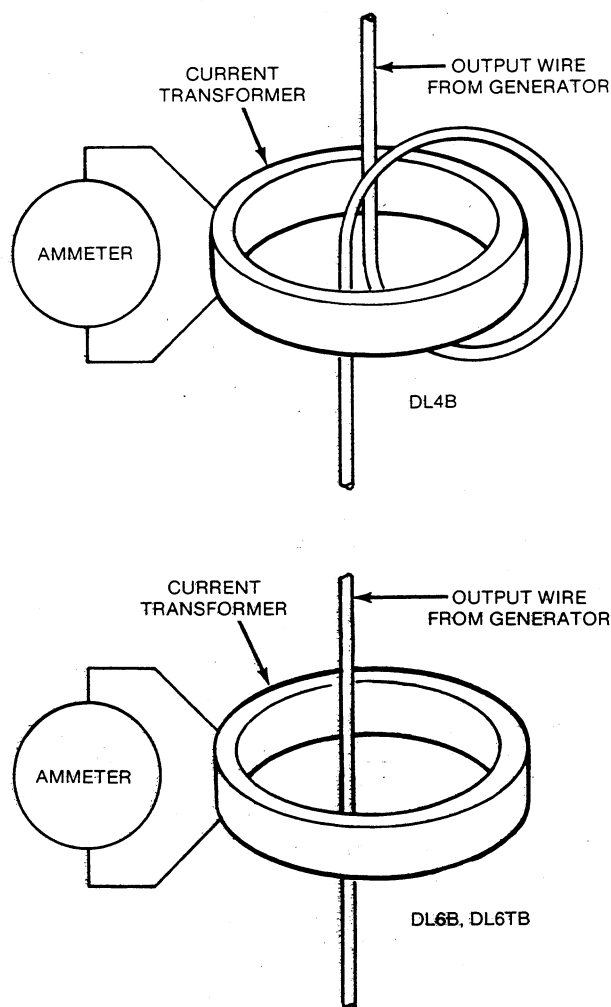


FIGURE 6. CURRENT TRANSFORMERS

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

Remote Control Connections

Provision is made inside the control box for addition of optional remote starting and alarms. Connections are made on a 16 place terminal block on the engine control circuit board (see Figure 7).

Use 18 gauge stranded copper wire if the distance between the set and remote station is less than 1000 feet (305 m). Always run control circuit wiring in a separate conduit from the AC power cables to avoid inducing currents that could cause problems within the control.

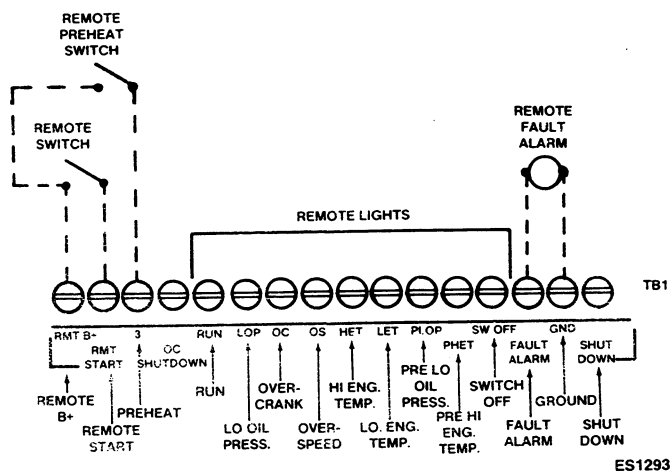


FIGURE 7. TERMINAL BOARD CONNECTIONS

PREPARING GENERATOR SET FOR OPERATION

Before attempting the initial start of the generator set, be sure it is serviced and ready for operation. Refer to the Maintenance section of the manual for the recommended procedures for adding oil, coolant, or fuel.

Lubrication

Engine oil is drained prior to shipment. Before starting, fill the crankcase with the recommended oil.

Coolant

Engine coolant is drained prior to shipment. Before starting, fill the cooling system with the recommended coolant.

Fuel

Fill the fuel tanks with the recommended fuel and prime the fuel system. All manual shutoff valves should be turned open.

Ventilation

Verify that all air vents and ducts are open and free of any obstructions. If dampers are used, verify that they operate properly.

Exhaust System

Check the exhaust system for proper installation. Verify that there is at least 12 inches (305 mm) clearance between exhaust pipes and any combustible materials.

Electrical System

Verify that all electrical connections are secure and all wiring is complete. Replace and secure any access panels that may have been removed during installation.

Mechanical

Check the generator set for loose or damaged components and repair or replace as required.

Battery Connections

Use one 12 volt battery for a normal installation (see Specifications). Connect battery as shown in Figure 8. Battery cables are included on the unit. Connect battery positive before connecting battery negative to prevent arcing.

Service the battery as necessary. Infrequent set use (as in emergency standby service) may allow the battery to self-discharge to the point where it cannot start the set. If an automatic transfer switch is installed that has no built-in charge circuit, connect a separate trickle charger.

WARNING

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

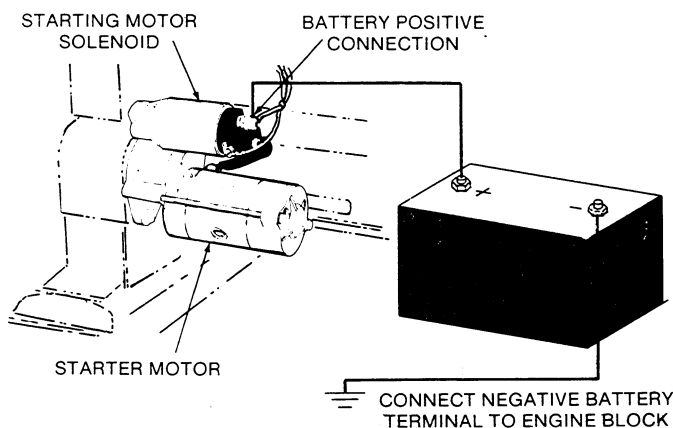
If the battery is installed outside the skid base, use battery cables that are of sufficient size to handle high current loads during cranking. Refer to Table 1 for recommended cable dimensions.

WARNING

Sparks might ignite battery gases and result in an explosion and severe personal injury. Do not disconnect battery cables from battery while generator set is cranking or running.

TABLE 2. CABLE SIZE

| MM | 6.5 | 7.3 | 8.3 | 9.3 | 10.5 | 11.6 |
|-----------|-----------------|-----------------|-----------------|-----------------|------------------|------------------|
| INCH | 0.258 | 0.289 | 0.325 | 0.365 | 0.410 | 0.460 |
| WIRE SIZE | 2 | 1 | 0 | 00 | 000 | 0000 |
| LOOP | 4 ft. 1.24 m | 5 ft. 1.55 m | 7 ft. 2.17 m | 9 ft. 2.79 m | 11 ft. 3.41 m | 14 ft. 4.34 m |



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FIGURE 8. BATTERY CONNECTIONS

INITIAL STARTING AND CHECKS

Before putting the generator set under load, verify that the engine, generator and control function properly.

To start the generator set, refer to the Operation section of this manual for the recommended starting procedures. To stop the generator set, move the START/STOP/REMOTE switch on the generator set control panel to STOP.

1. With the generator set operating at no load, monitor the control panel and note the oil pressure, coolant temperature, and battery charge rate. With the engine at operating temperature, all readings should stay within the range specified in the Maintenance section of this manual.

2. Check the generator set for fuel, oil or coolant leaks. Stop the generator set if any leaks are found. Have the leak repaired before performing the rest of the checks.
3. Check the exhaust system for leaks, visually and audibly. Note the security of the exhaust system supports. If any leaks are found, stop the set and repair before performing the rest of the checks.

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.

4. Monitor the AC instruments (if equipped) on the generator set control panel. The frequency meter and the voltmeter should indicate the rated nameplate frequency and voltage. Use the phase selector switch to reach each of the line-to-line voltages. Minor adjustments to the voltage can be made by turning the control panel voltage adjust rheostat.
5. Hold the Reset/Lamp Test switch in the Test position. All indicator lamps should light.
6. Stop the generator set and check for loose belts, leaking gaskets, loose fittings and clamps, or any signs of damage. If any problems are found, repair as required.

Operation

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

Remove the radiator pressure cap slowly after the engine has cooled. The sudden release of pressure from a heated cooling system might result in loss of coolant and possible personal injury from the hot coolant.

Fuel

Make sure the fuel tanks are full and the fuel system is primed for 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.

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 9.

Gauges Meters and Switches

Oil Pressure Gauge: Indicates engine lubricating oil pressure. The gauge has a range of 0 to 100 psi (0 to 700 kPa).

Water Temperature Gauge: Indicates engine coolant temperature. The gauge is wired to a sensor unit on the engine and has a range of 100° to 250°F (40° to 121°C).

Battery Charge Rate DC Ammeter: Indicates battery charging current. Meter range is ± 30 amperes.

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

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

Tachometer (Optional): Indicates engine speed in r/min. The gauge has a range of 0 to 5000 r/min.

Oil Temperature Gauge (Optional): Indicates engine oil temperature. The gauge has a range of 150° to 300°F (66° to 149°C).

AC Voltmeter (Optional): Dual range instrument indicating AC generator voltage.

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

Start-Stop-Remote Switch: Starts and stops the unit locally, or from a remote location wired to the control panel.

Preheat Switch: Provides manual control for glow plugs for cold engine starting.

Reset Switch: Resets engine monitor circuits after an emergency shutdown. On the optional control panel the switch is also utilized to verify that the nine lamps are functioning properly.

Phase Selector Switch (Optional): Selects phase of generator to be measured by AC voltmeter and ammeter.

Voltage Adjustment (Optional): Provides plus or minus 5 percent adjustment of the rated voltage.

Circuit Breakers

Field Breaker: A 5 ampere breaker provides generator protection from overheating during certain voltage regulator failures.

Control Breaker: A 7 ampere breaker provides protection to the control box wiring from a short circuit or overload.

Remote Breaker: A 7 ampere breaker protects accessory remote controls and wiring from a short circuit or overload.

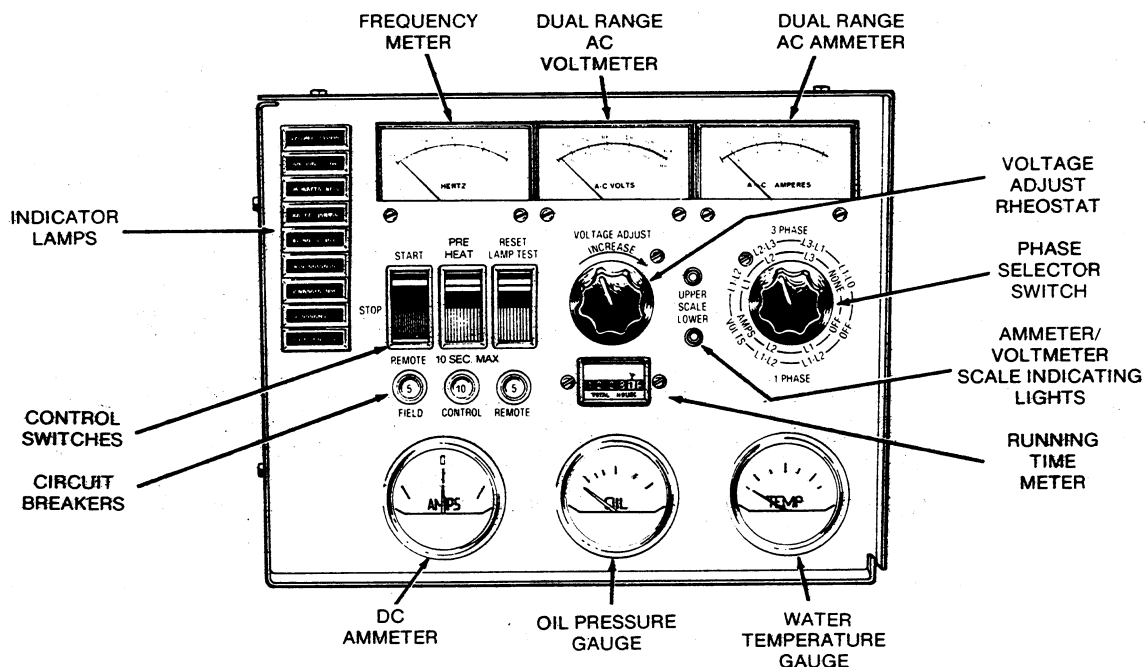


FIGURE 9. OPTIONAL NINE LIGHT PANEL

SC-1302

Indicator Lights

The standard control panel has two monitor system indicator lights.

- Run (green)
- Fault (red)

The green Run light comes on as soon as the starter circuit is opened after unit starting. The red light comes on if an emergency shutdown of the generator set occurs.

The optional control panel has nine monitor system indicator lights.

- Run (green)
- Pre Hi Eng Temp (amber)
- Pre Low Oil Pres (amber)
- Lo Eng Temp (red)
- Hi Eng Temp (red)
- Overcrank (red)
- Overspeed (red)
- Lo Oil Pres (red)
- Switch Off (flashing red)

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

High and Low Indicator Lights indicate which scale to use on the AC voltmeter and ammeter.

STARTING PROCEDURE

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

Manual Starting at Control Panel

The following steps outline the correct procedures for starting the generator set at the generator control panel.

1. If the ambient temperature is below 32°F (0°C), depress and hold the Preheat switch for 10 seconds. (Preheating is not necessary if the ambient temperature is above 32°F.)

CAUTION *Do not exceed the 10 second preheat period prior to cranking. Longer preheating time prior to cranking the engine can ruin the glow plugs.*

2. Place the Start/Stop/Remote switch in the start position and release the Preheat switch.
3. If the engine does not start after 30 seconds of cranking, place the Start/Stop/Remote switch in the Stop position. Wait two minutes and then repeat steps 1 and 2.

Control will disengage starter and signal a fault condition if engine does not start after 45 to 75 seconds of continuous cranking.

CAUTION *Excessive cranking periods might overheat and damage the starter. Do not engage starter for periods longer than 30 seconds without allowing two minutes for starter to cool.*

4. If engine does not start after second starting attempt, check fuel supply. Absence of blue/white exhaust smoke during cranking indicates no fuel delivery.

WARNING *Do not use ether as a cold weather starting aid. The heat from the glow plugs may cause a sudden ignition of the ether vapor. This might result in personal injury and damage to the engine.*

CAUTION *Do not apply overvoltage to the starting circuit at any time. Overvoltage will destroy the glow plugs in 2 to 3 seconds. If it becomes necessary to use an additional source of power to start the engine, use a 12 volt battery connected in parallel.*

Manual Remote Starting

The following steps outline the correct procedures for starting the generator set at a remote start panel.

1. Place the Start/Stop/Remote switch on the generator set control panel in the Remote position.
2. If the ambient temperature is below 32°F (0°C), depress and hold the Preheat switch on the remote control panel for 10 seconds. (Preheating is not necessary if the ambient temperature is above 32°F/ 0°C.)
3. Place the Start/Stop switch on the remote control panel in the Start position and release the Preheat switch.
4. If the engine does not start, the generator control will disengage the starter motor after about 45 to 75 seconds and signal a fault condition. Reset the generator control before trying a second start. Refer to the Troubleshooting section for the correct procedures.

Automatic Transfer Switch Starting

Place the Start/Stop/Remote switch on the generator control panel in the Remote position. This allows the automatic transfer switch to start the generator set if a power outage occurs and stop it when the power returns.

STOPPING

Run the generator set at no load for three to five minutes before stopping to allow for engine cooling. To manually stop the generator set, move the Start/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 usually done using a transfer switch. Refer to the transfer switch Operators Manual for information on how the switch operates.

Break-In

Drain and replace the crankcase oil and reset the valve lash 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

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.

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.

Low Operating Temperatures

Use a water jacket heater if a separate source of power is available. The optional heater available from Onan will assure reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.

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 #2 diesel fuel and operating at an altitude of 300 feet (92 m) with an ambient temperature of 77°F (25°C). For a rating relative to other applications, altitudes, cooling systems, ambient temperatures, or fuels, contact an authorized Onan Distributor or the factory.

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 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 two light control has a single green light to indicate Run and a single fault light to indicate malfunctions. The optional nine light control has a single green Run light, two amber pre-fault lights, and six red fault lights. Both controls also have a terminal connection for an external alarm which will sound when a fault occurs.

When a fault light comes on during operation, follow the procedures in Table 3 to locate and correct the problem. If a major problem is indicated, contact an Onan Dealer or Distributor for service.

Resetting the Control

The external alarm and fault lamp can be deactivated by placing the Start/Stop/Remote switch in the Stop position and pressing the Reset/Lamp Test switch. Locate the problem and make the necessary corrections before restarting the generator set.

Line Circuit Breaker (Optional)

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

TABLE 3. TROUBLESHOOTING

Use Steps 1, 3, 5, 6, 7, 9, 10, 11, 12, and 14 to troubleshoot two lamp control panels.

| SYMPTOM | CORRECTIVE ACTION |
|---|---|
| 1. Green RUN lamp lights following engine start-up. | 1. Indicates all engine systems are normal. No corrective action required. |
| 2. PRE HI ENG TEMP lamp lights. Engine continues to operate. | 2. Indicates engine has begun to overheat and engine temperature has risen to approximately 215°F (102°C). If engine can be stopped, follow procedures in step 3. Use the following procedures if generator is powering critical loads and cannot be shutdown. <ol style="list-style-type: none"> Check air inlets and outlets and remove any obstructions to airflow. Open doors or windows in generator area to increase ventilation. Reduce load if possible by turning off non-critical loads. |
| 3. HI ENG TEMP lamp lights. Engine shuts down. | 3. Indicates engine has overheated (engine temperature has risen above 220°F/104°C) or coolant level is low (sets with coolant level sensor). Allow engine to cool down completely before proceeding with the following checks: <ol style="list-style-type: none"> Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary. Check for obstructions to cooling airflow and correct as necessary. Check for a slipping fan belt and tighten if loose. Reset control and restart after locating and correcting problem. Contact an Onan Dealer or Distributor 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 engine can be stopped, follow procedures in step 5. If generator is powering critical loads and cannot be shut down, wait until next shutdown period and then follow step 5 procedure. |
| 5. LO OIL PRES lamp lights. Engine shuts down NOTE: See also step 6. | 5. Indicates engine oil pressure has dropped to 14 psi (97 kPa). Check oil level and replenish if low. Reset control and restart. Contact an Onan Dealer or Distributor if oil pressure is not in the range of 30 to 55 psi (207 to 380 kPa). |

TABLE 3. TROUBLESHOOTING CON'T

| | |
|--|---|
| <p>6. OVERCRANK lamp lights and engine stops cranking after 45 to 75 seconds.</p> <p>or</p> <p>Engine runs, shuts down, and LO OIL PRES lamp lights.</p> | <p>6. Indicates possible fuel system problem. When the engine has cooled, make the following checks:</p> <ul style="list-style-type: none"> a. Check for empty fuel tank, fuel leaks, or plugged fuel lines and correct as required. b. Check for dirty fuel filter and replace if necessary (see MAINTENANCE section). c. Check for dirty or plugged air filter and replace if necessary (see MAINTENANCE section). d. Reset the control and restart after correcting the problem. Contact an Onan Dealer or Distributor for service if none of the above. |
| <p>7. Engine runs and then shuts down. OVERSPEED lamp lights.</p> | <p>7. Indicates engine has exceeded normal operating speed. Contact an Onan Dealer or Distributor for service.</p> |
| <p>8. SWITCH OFF lamp flashes.</p> | <p>8. Indicates Start/Stop/Remote switch is in the Stop position which will prevent automatic starting if an automatic transfer switch is used. Move the Start/Stop/Remote switch to the Remote position for automatic starting</p> |
| <p>9. Fault lamp lights but no fault exists. Engine gauges show oil pressure, engine temperature, and frequency (speed) are within normal limits.</p> | <p>9. Reset control. If control will not reset, the monitor board or a sensor may be at fault. Contact an Onan Dealer or Distributor for service.</p> |
| <p>10. Engine starts from generator control panel but won't start automatically or from a remote panel (Note: The Start/Stop/Remote switch must be in the Remote position for automatic or remote starting).</p> | <p>10. Remote circuit breaker is tripped. Reset breaker and restart. Contact an Onan Dealer or Distributor if breaker trips after resetting.</p> |
| <p>11. Engine will not crank.</p> | <p>11. Indicates possible fault with control or starting system. Check for the following conditions:</p> <ul style="list-style-type: none"> a. Fault lamp on. Correct fault and reset control. b. Control circuit breaker is tripped. Reset breaker and restart. Contact an Onan Dealer or Distributor if breaker trips again after resetting. c. Poor battery cable connections. Clean the battery terminals and tighten all connections. d. Discharged or defective battery. Recharge or replace the battery. |
| <p>12. No AC output voltage.</p> | <p>12. Field breaker is tripped. Reset breaker. Contact an Onan Dealer or Distributor if voltage build up causes breaker to trip.</p> |
| <p>13. LO ENG TEMP lamp lights. Generator set is in Standby mode or was just started.</p> | <p>13. Indicates engine block temperature has dropped below 70°F (21°C). Lamp will go out when block temperature rises.</p> |
| <p>14. Green RUN lamp does not light following engine start-up.</p> | <p>14. Indicates possible DC Start/Disconnect failure. Stop engine and check for burned out bulb. If bulb is good, contact an Onan Dealer or Distributor for assistance.</p> |

Maintenance

Establish and follow 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:

- 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.

WARNING *Accidental starting of the set might cause severe personal injury or death. Disconnect the negative battery cable when repairs are made to the engine, controls, or generator.*

PERIODIC MAINTENANCE SCHEDULE

| SERVICE THESE ITEMS | AFTER EACH CYCLE OF INDICATED HOURS | | | | |
|--------------------------------------|-------------------------------------|----------------|------------------|-----|------------------|
| | 8 | 50 | 100 | 200 | 400 |
| Inspect Generator Set | x ¹ | | | | |
| Check Oil Level | x | | | | |
| Check Fan Belt | x | | | | |
| Check Coolant Level | x | | | | |
| Check Air Cleaner | | x ² | | | |
| Drain Exhaust Condensate Trap | | | x | | |
| Check Fuel Level | | | x | | |
| Change Crankcase Oil and Filter | | See Note 3 | x ^{2,3} | | |
| Check Battery Condition | | | | x | |
| Clean Generator Assembly | | | | x | |
| Change Air Cleaner Element | | | | | x |
| Change Fuel Filter | | | | | x ^{2,4} |
| Check Valve Lash Clearance | | See Note 3,5 | | | x ^{3,5} |
| Clean Crankcase Breather Cap (DL6TB) | | | | | X |

- 1 - With engine running, visually and audibly check exhaust system for leaks. Refer to Generator Set Inspection section of this manual for complete inspection procedures.
- 2 - Perform more often under extremely dusty or dirty conditions.
- 3 - Perform after first 50 hours of operation on new sets.
- 4 - Perform every 400 hours or 12 months, whichever comes first.
- 5 - Refer to L-Series Engine Service Manual for service procedures or contact an Onan Distributor for service.

GENERATOR 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.

Engine Gauges

Check the following while the generator set is operating.

Oil Pressure Gauge: The oil pressure should be in the range of 30 to 55 psi (207 to 380 kPa) when the engine is at operating temperature.

Water Temperature Gauge: The water temperature should be in the range of 165° to 195°F (74° to 91°C) depending on the load and ambient temperature.

DC Ammeter: The maximum charge rate for the set mounted battery charging alternator is 35 amperes. Charge rate should taper to zero following start-up as battery becomes charged.

AC Meters (If Equipped)

Check the following while the generator set is operating.

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

AC Voltmeter: Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2 on single phase sets; L1-L2, L2-L3, and L3-L1 on three phase sets). 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(s) should be the same as the set nameplate rating.

AC Ammeter: Turn the phase selector switch to each phase selection shown on the Amps scale (L1 and L2 on single phase sets; L1, L2, and L3 on three phase sets). 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 roughly the same and no line current should exceed the set nameplate rating.

Engine Monitor Indicator Lights

Hold the Reset/Lamp Test switch in the Test position. All indicator lamps (except Run) should light. Verify that all of the bulbs are on and then release the switch. Replace any bulbs that are burned out.

Exhaust System

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler, and exhaust pipe. Visually and audibly 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. Inspect exhaust system audibly and visually for leaks daily. Repair any leaks immediately.

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.

WARNING

Leaking fuel will create a fire hazard which might result in severe personal injury or death if ignited by a spark. If any leaks are detected, have them corrected immediately.

DC Electrical System

With the generator set off, 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

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.

LUBRICATION SYSTEM

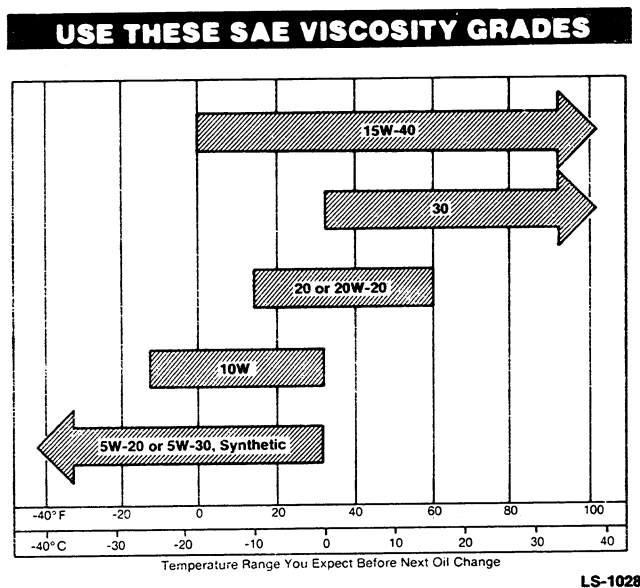
The engine oil was drained from the crankcase prior to shipment. Before the initial start, the lubrication system must be filled with oil of the recommended classification and viscosity. Refer to the Specifications section for the lubricating oil capacity.

Oil Recommendations

Refer to Table 4 for the recommended oil viscosity grades at various ambient temperatures. Oils with viscosity grades 15W-40, 30W, 20, 20W-20, and 10W must meet the American Petroleum Institute (API) classification CD/SF, CD/SE, or Military Specification MIL-L-2104C. Oils with viscosity grades 5W-20 or 5W-30 must be **synthetic** oils that meet Military Specification MIL-L-46167, MIL-L-2104C, or MIL-L-46152B. A mineral base 5W-20 or 5W-30 grade oil is **not** recommended under any conditions.

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.

TABLE 4.



Engine Oil Level

Check the engine oil level during engine shut-down periods at the intervals specified in the Maintenance Table. The oil dipstick and oil fill are located on the side of the engine (see Figure 10). The dipstick is stamped with FULL and ADD 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.

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

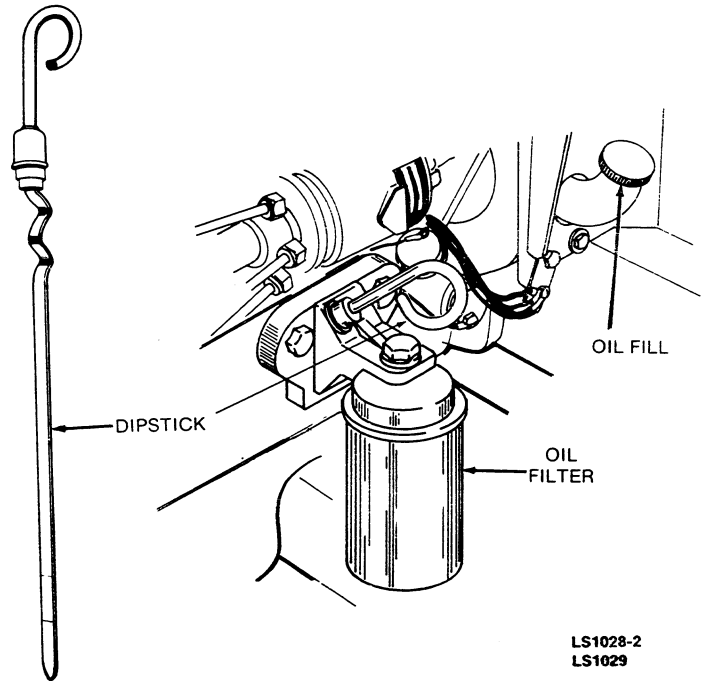


FIGURE 10. ENGINE OIL

Oil and Filter Change

Change the oil and filter at the intervals recommended in the maintenance table. Use oil that meets the API classification and viscosity requirements as indicated in the previous section.

Engine Oil Change: Run engine until thoroughly warm before draining oil. Stop the engine, place a pan under the drain outlet and remove the oil drain plug or open the drain valve. After the oil is completely drained, replace the drain plug or close the drain valve. Refill with oil of the correct API classification and appropriate SAE viscosity grade for the temperature conditions.

WARNING 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.

Oil Filter Change: Spin off oil filter and discard it. Thoroughly clean filter mounting surface. Apply a thin film of oil to filter gasket and install new element. Spin element on by hand until gasket just touches mounting pad and then turn an additional 1/4 to 1/2 turn. Do not overtighten.

With oil in crankcase, start engine and check for leaks around filter element. Retighten only as much as necessary to eliminate leaks, but do not overtighten.

COOLING SYSTEM

The cooling system on each set is drained prior to shipping and must be refilled before being operated. The cooling system capacity of the standard unit with set mounted radiator is shown in the Specifications section.

Coolant Requirements

A satisfactory engine coolant inhibits corrosion and protects against freezing. A solution of ethylene glycol anti-freeze (permanent type) and water is recommended for normal operation and storage periods. Choose only a reliable brand of anti-freeze that contains a rust and corrosion inhibitor but does not contain a stop-leak additive.

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. Use soft water whenever available. Well water often contains lime and other minerals which eventually may clog the radiator core and reduce the cooling efficiency.

Be sure the anti-freeze solution will protect the cooling system during the coldest winter weather. However, use at least a 50/50 mixture of anti-freeze and clean water to provide adequate corrosion protection.

Filling the Cooling System

Verify that all drain cocks are closed and all hose clamps secure. Remove the cooling system pressure cap and slowly fill the cooling system with the recommended coolant. Limit the fill rate to 3 gallons/minute to allow the engine block to fill completely with coolant.

CAUTION *Exceeding the recommended fill rate may cause incomplete filling of the engine block which can result in possible engine damage during warm-up. Always follow the recommended fill procedure.*

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.

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.

WARNING *Remove the radiator pressure cap slowly after the engine has cooled. The sudden release of pressure from a heated cooling system might result in loss of coolant and possible personal injury from the hot coolant.*

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, thereby causing severe damage to the engine. Maintain adequate engine coolant levels to ensure operational integrity of cooling system and engine coolant overheat shutdown protection.*

Flushing and Cleaning

For efficient operation, the cooling system should be drained, flushed, and refilled once a year.

To drain the system completely, the radiator drain and the cylinder block drain located on the right side of engine must be opened.

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 radiator cleaning compound in accordance with instructions furnished by the supplier.

Flushing: After cleaning or before filling the system with new coolant, drain the block and radiator and fill with clean water. Operate the set for 10 minutes and then drain the system completely. Refill with the recommended coolant.

CAUTION *Never pour hot water into a cold engine or cold water into a hot engine. Doing so might crack the head or the cylinder block. Do not operate the unit without water for even a few minutes.*

FUEL SYSTEM

Use only a good quality fuel obtained from a reputable supplier. The quality of fuel used is important in obtaining dependable performance and satisfactory engine life. Fuels must be clean, completely distilled, well refined, and non-corrosive to fuel system parts.

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.*

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) and during long periods of light engine load.

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

Use low sulfur content fuel having a cloud point of 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.

CAUTION *Due to the precise tolerances of diesel injection systems, dirt or water in the fuel might 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 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.

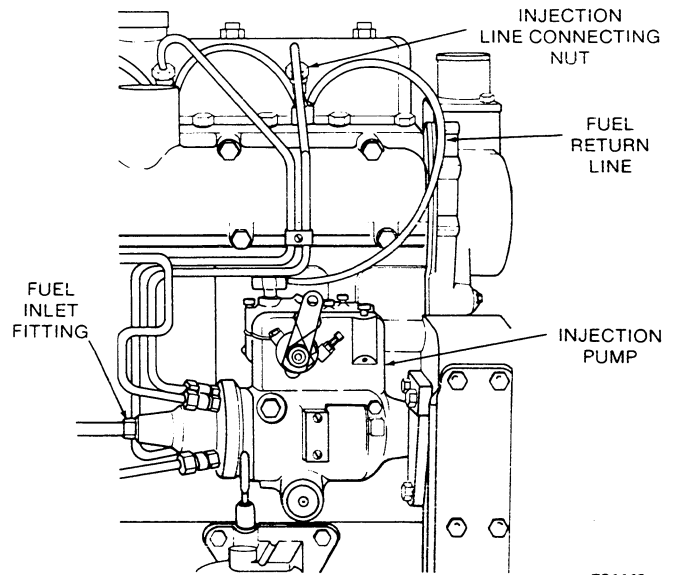
Priming the Fuel System

The fuel system must be primed prior to initial start up or after engine has run out of fuel.

Low Pressure Fuel System: The transfer pump, fuel filter and injection pump housing comprise the low pressure fuel system. Use the following procedure to remove the trapped air from the system.

1. Check fuel level in fuel tank and open shut off valve.

2. Loosen the fuel filter to injection pump line at the injection pump fuel inlet fitting (Figure 11).



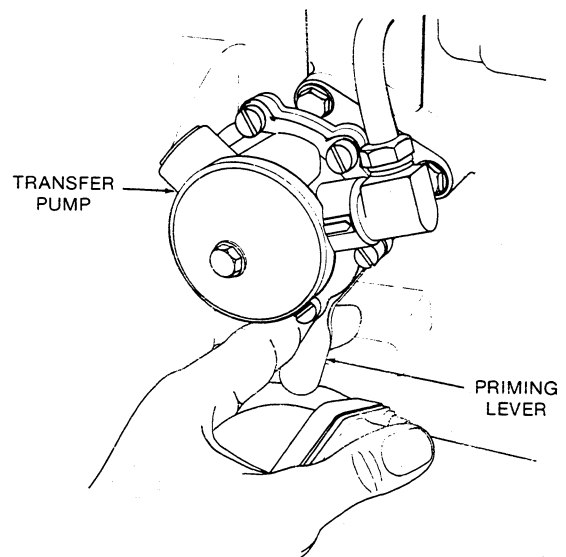
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FIGURE 11. INJECTION PUMP

3. Actuate the priming lever (Figure 12) on the side of the transfer pump until fuel flows from the fitting.

If the camshaft transfer pump lobe is up, turn engine one revolution to permit hand priming.

4. Tighten fuel line at the injection pump inlet.



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FIGURE 12. FUEL TRANSFER PUMP

High Pressure Fuel System: The injection pump, fuel injection lines and fuel injectors comprise the high pressure fuel system. This part of the system is usually self-priming since any trapped air is usually forced out through the injection nozzles. However, if the engine has run out of fuel, been shut down for an extended period of time or has had the injection lines removed, it may be necessary to prime. Use the following procedures:

1. Loosen fuel injection line connecting nut (Figure 11) attaching each line to corresponding nozzle holder.
2. Energize the starting motor by placing the Start/Stop/Remote switch in the Run position.
3. After 30 seconds, place the Start/Stop/Remote switch in the Stop position and pause for two minutes to permit the starter motor to cool.
4. Discontinue priming when fuel flows from the end of all high pressure fuel injection lines. Tighten connection nuts to 18 ft-lbs (24 N•m) torque.

WARNING *Keep hands away from spray. The discharge pressure can penetrate the skin and might cause blood poisoning or a serious skin infection.*

Fuel Filter

The combination primary and secondary fuel filter is a disposable type. Any dirt that passes through the primary section is trapped by the secondary section. This prevents dirt from entering fuel injection pump.

The filter replacement interval will vary according to the fuel quality and cleanliness. Using the wrong fuel or dirty fuel will shorten the service life of the filter.

Refer to the Periodic Maintenance Schedule for the recommended filter change interval. However, if the engine shows signs of fuel starvation (reduced power or surging), change the fuel filter. Use the following procedures to replace.

1. Close fuel tank shut off valve.
2. Clean all dirt from around filter, filter base and surrounding area.
3. Remove filter retaining clip or clips from fuel filter (see Figure 13).

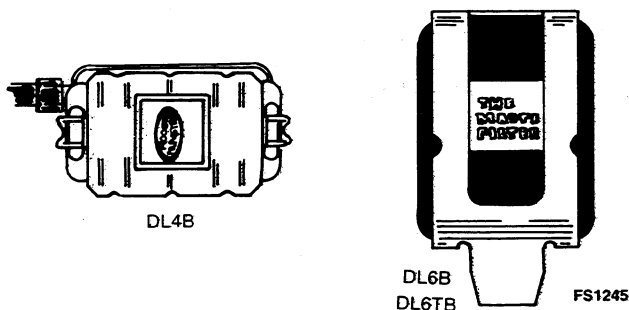


FIGURE 13. FUEL FILTERS

4. Remove old filter and dispose of it properly.

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

5. Install new fuel filter and prime fuel system.

AIR CLEANER

A set-mounted air cleaner with a single replaceable paper filter element is standard on all generator sets. Inspect the filter element at recommended intervals and clean or replace the filter as necessary. Refer to the following sections for inspection and service procedures.

Air Cleaner Inspection

An air restriction gauge (see Figure 14) is used on DL4B and DL6B generator sets to indicate when the filter element requires servicing. If the red indicator is locked into position, the filter element requires cleaning or replacement. After service is complete, reset the restriction gauge by pressing the release button on top of the gauge.

The filter element on DL6TB generator sets must be removed and visually inspected to determine if service is necessary. Remove the filter by following the procedures in the service section. Replace or clean the filter element if there is an excessive build-up of dirt or soot.



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FIGURE 14. AIR RESTRICTION GAUGE

inspect all components of the air filtering system including all ducts and hoses. Verify that all connections and clamps are tight and inspect each component for cracks, dents, or other damage. Repair or service as required.

Air Cleaner Service

Use the following procedures to remove and service the air cleaner element:

1. Loosen the clamp (see Figure 15) and remove the dust cup assembly.
2. Remove the wing nut from the dust cup assembly and lift out the baffle. Clean out all dust and debris from the dust cup.
3. Remove the air filter element wing nut and carefully lift out the element.
4. Clean the element by directing dry, clean, low pressure air (35 psi/241 kPa) up and down the pleats on the inside of the element. If the element is extremely dirty, it can be washed by soaking in a special detergent cleaner such as Donaldson D-1400. Soak for 15 minutes and then rinse thoroughly with clean water.

CAUTION *High pressure water cleaning might damage the filter element. When rinsing the element, make sure the water pressure does not exceed 40 psi (276 kPa).*

5. Air dry the element for a minimum of 24 hours. Do not dry with compressed air or at temperatures greater than 150°F (66°C).
6. Reassemble making certain the dust cap "TOP" is facing up.

CAUTION *Do not reuse the element after it has been cleaned twice. Replace element if it has even the slightest hole to prevent engine damage from dirt.*

VALVE CLEARANCE

Correct valve clearance is very important in diesel engine performance because of the high compression developed in the cylinders. Incorrect valve clearance will cause loss of compression, misfiring, noise and may eventually lead to damaged engine components. Always perform valve clearance adjustments with the piston near the top dead center on its compression stroke and intake and exhaust valves closed. For detailed valve clearance adjustment procedures refer to the L ENGINE SERVICE MANUAL (934-0750) or contact your authorized Onan Distributor.

BATTERY

Check the condition of the starting battery at the interval specified in the Periodic Maintenance Schedule. 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 type battery.

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

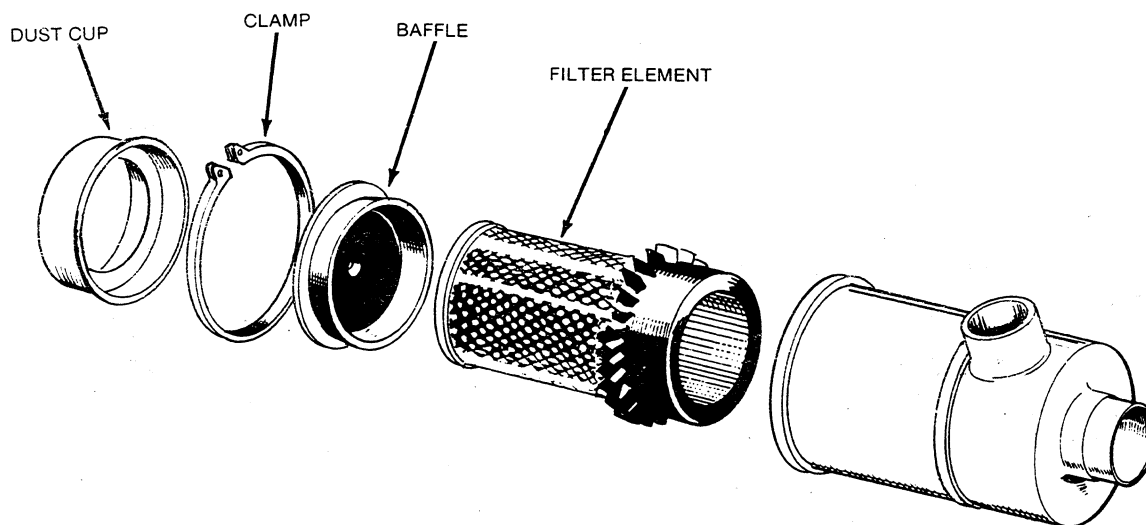


FIGURE 15. AIR CLEANER

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 (100 g/Litre) 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 five degrees the electrolyte temperature is above 80°F (27°C) or subtracting four gravity points for every five degrees below 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

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.

CAUTION 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. Incomplete mixing may allow the electrolyte to freeze and cause battery damage.

FAN BELT

To adjust, loosen alternator bolt that passes through elongated slot in mounting bracket. Slide alternator until a fan belt tension of 60 lbs (267 N) is obtained. Tighten alternator mounting bolt to lock alternator in place. Check tension and repeat if necessary. See Figure 16. A belt adjustment tool is available from Onan for checking belt tension.

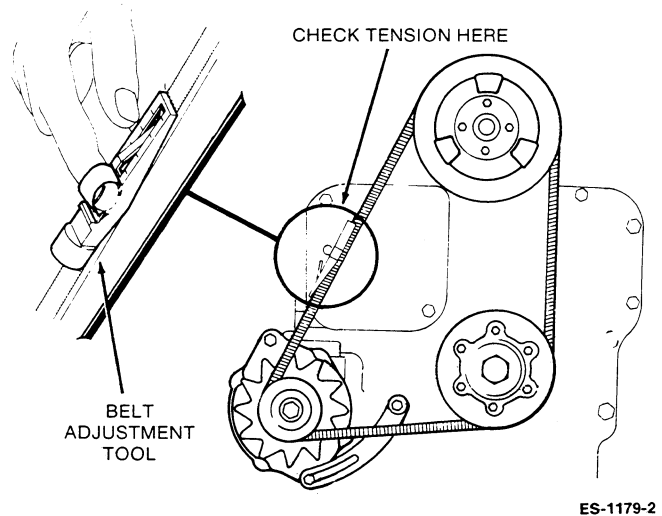


FIGURE 16. FAN BELT ADJUSTMENT

CRANKCASE BREATHER

(Turbocharged Engines)

Clean crankcase breather each time valve clearance adjustments are made. Refer to the *Periodic Maintenance Schedule* for the recommended cleaning interval. Use the following procedure when cleaning crankcase breather.

1. Remove breather cap and lift out the breather element (Figure 17).
2. Clean breather cap and element in cleaning solvent. Dry thoroughly with low pressure (under 35 psi/241 kPa) compressed air.
3. Install a clean or new breather element in the valve cover. Do not pack element in valve cover.
4. Install clamp, breather cap, and connect breather tube.

CAUTION Overtightening of the clamp will tear breather cap.

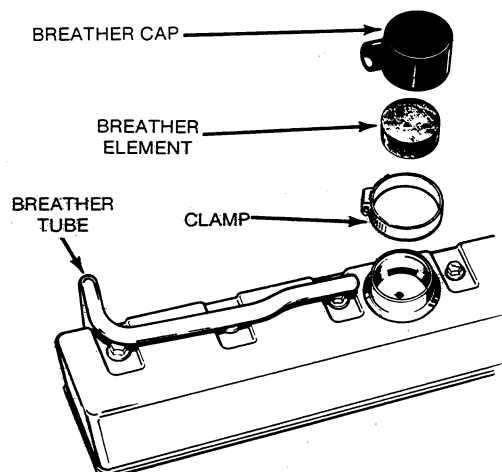


FIGURE 17. CRANKCASE BREATHER

AC GENERATOR

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 generator output box cover and inspect the rotating rectifier assembly to make sure the diodes (see Figure 18) 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.

CAUTION *Excessive foreign matter on diodes and heat sinks will cause overheating and possible failure.*

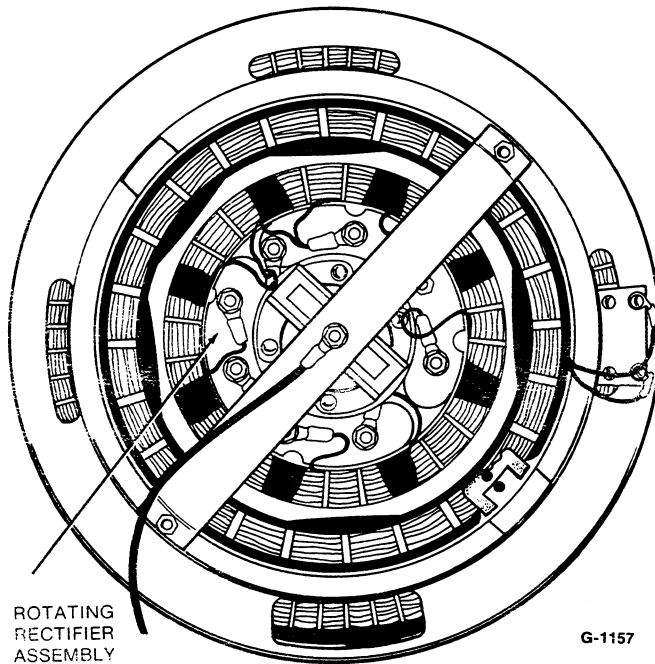


FIGURE 18. GENERATOR END VIEW

Generator Bearing

Inspect the generator bearing for signs of outer case rotation every 500 hours. Have the bearing replaced every five years. Deterioration of the bearing grease due to oxidation makes replacement necessary. If the generator requires major repair or servicing, contact an Onan Distributor for service.

OUT-OF-SERVICE PROTECTION

The inherent lubricating qualities of No. 2 diesel fuel 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 engine.
3. Disconnect battery and store in a cool dry place. Connect battery to a charger every 30 days to maintain it at full charge.
4. Drain the engine oil while still warm. Refill and attach a warning tag indicating viscosity of oil used.
5. Service air cleaner.
6. Check the coolant level and add more coolant if the level is low.
7. Plug exhaust outlets to prevent entrance of moisture, bugs, dirt, etc.
8. Clean and wipe entire unit. Coat parts susceptible to rust with a light coat of grease or oil.
9. Provide a suitable cover for the entire unit after unit has cooled down.

Returning a Unit to Service

1. Remove cover and all protective wrapping. Remove plug from exhaust outlet.
2. Check warning tag on oil base and verify that oil viscosity is still correct for existing ambient temperature.
3. Drain and flush the cooling system and refill with the recommended coolant.
4. Prime the fuel system.
5. Clean and check battery. Measure specific gravity (1.260 at 80° F [27° C] and verify level to be at split ring. If specific gravity is low, charge until correct value is obtained. If level is low, add distilled water and charge until specific gravity is correct. DO NOT OVERCHARGE.

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

6. Connect starting battery (ground terminal last).
7. Remove all loads before starting the engine.
8. After start, apply load to at least 50 percent of rated capacity.
9. Check all gauges for normal readings. Set is ready for service.



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