

Onan

Installation Manual

*DB BA has a
supplement to this
manual that
covers it.*

DGCA

DGCB

DGDA

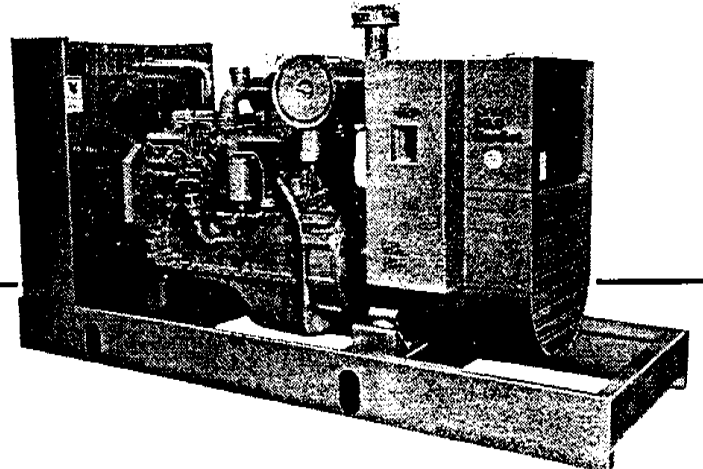
DGDB

DGEA

DGFA

GenSets

50-150 kW



960-0605
12-87
Printed in U.S.A.

 **Power
Generation**

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Safety Precautions

Before operating the generator set, read the Operator's Manual and become familiar with it and your 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 SMOKE OR ALLOW AN OPEN FLAME near the generator set or fuel tank. Internal combustion engine fuels are highly flammable.
- 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 work harden and become brittle.
- Be sure all fuel supplies have a positive shutoff valve.
- 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 DEADLY

- 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.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- 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.

- Keep your hands away from moving parts.
- Before starting work on the generator set, disconnect batteries. 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 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 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 surfaces to be damp when handling electrical equipment.
- Use extreme caution when working on electrical components. High voltages cause injury or death. DO NOT tamper with interlocks.
- Follow all 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

- 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 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 your generator set and the surrounding area clean and free from obstructions. Remove any debris from 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 installation instructions for the DG Series generator sets. This includes the following information:

- Mounting — Recommendations for fastening generator set to base and space requirements for normal operation and service.
- Mechanical Connections — Location of connection points for fuel, exhaust, ventilation, and cooling.
- Electrical Connections — Location of electrical connection points for the control, generator, and starting system.
- Prestart — Checklist of items or procedures needed to prepare generator set for operation.
- Initial Startup — Test complete system to ensure proper installation, satisfactory performance, and safe operation. Refer to Operators Manual for troubleshooting information.

This manual DOES NOT provide application information for selecting a generator set or designing the complete installation. If it is necessary to design the various integrated systems (fuel, exhaust, cooling, etc.), review standard installation practices, or specify system materials, additional information is required. For engineering data specific to the generator set, refer to the DG Series specification and product data sheets. For generator application information about generator set installation, refer to the following Onan Technical Bulletins.

T-009/T-017 — Selecting Onan Generator Sets
T-030 — Installation Information for
Liquid-Cooled GenSets

Bulletin T-030 is a particularly useful installation reference and is shipped with this manual. Bulletin T-009/T-017 is included in the Onan Power Systems Manual or may be obtained separately on request from an authorized Onan distributor.

INSTALLATION OVERVIEW

These installation recommendations apply to typical generator set installations with standard model generator sets. Whenever possible, these recommendations also cover factory designed options or modifications. However, because of the many variables in any installation, it is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact an Onan distributor for assistance.

Application and Installation

A standby power system must be carefully planned and correctly installed for proper operation. This involves two essential elements: application and installation.

Application (as it applies to generator set installations) refers to the design of the complete standby power system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, and cooling, exhaust, and fuel systems. Each component must be correctly designed so the complete system will function as intended. Application and design is an engineering function generally done by specifying engineers or other trained specialists. Specifying engineers are responsible for the design of the complete standby system and for selecting the materials and products required.

Installation refers to the actual set-up and assembly of the standby power system. The installers set-up and connect the various components of the system as specified in the system design plan. The complexity of the standby system normally requires the special skills of qualified electricians, plumbers, sheetmetal workers, etc. to complete the various segments of the installation. This is necessary so all components are assembled using standard methods and practices. Figure 1 shows a typical installation and Table 1 lists the equipment installation specifications.

Safety Considerations

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

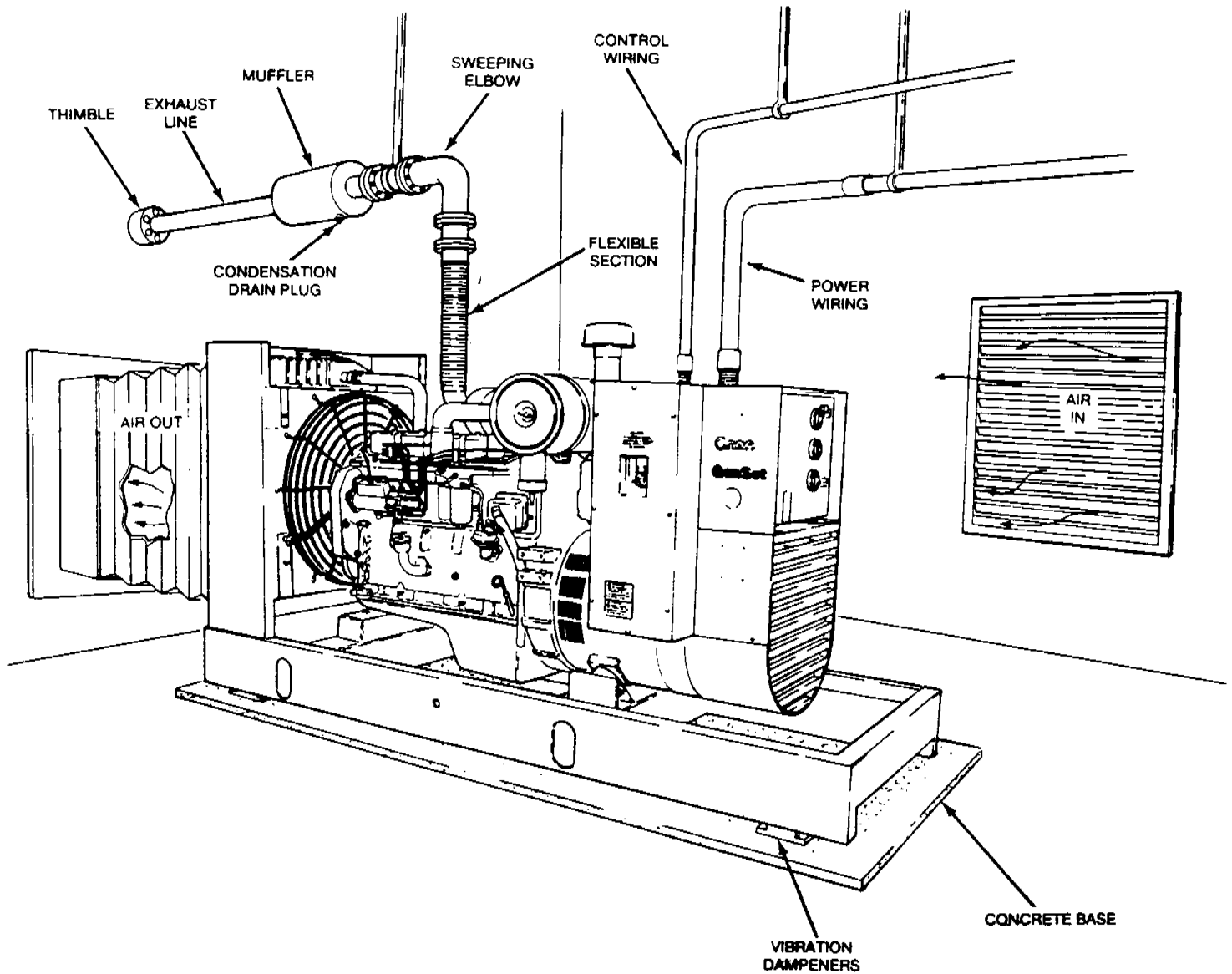
Specifications

TABLE 1. EQUIPMENT INSTALLATION SPECIFICATIONS

SYSTEMS	DGCA	DGCB	DGDA	DGDB	DGEA	DGFA
Fuel System Inlet Fitting Size Return Fitting Size Fuel Pump (Lifting Capacity)	1/4-18 0.18 O.D. Tube 5 feet (1.525 m)	1/4-18 0.18 O.D. Tube 5 feet (1.525 m)	1/4-18 0.18 O.D. Tube 5 feet (1.525 m)	1/4-18 0.18 O.D. Tube 5 feet (1.525 m)	1/4-18 0.31 O.D. Tube 4 feet (1.22 m)	1/4-18 0.31 O.D. Tube 4 feet (1.22 m)
Exhaust System Exhaust Connection (in. pipe thread) Exhaust Backpressure (Maximum Allowable)	3 inch O.D. 41 inches H ₂ O	3 inch O.D. 41 inches H ₂ O	3 inch O.D. 41 inches H ₂ O	3 inch O.D. 41 inches H ₂ O	4 inch O.D. 41 inches H ₂ O	4 inch O.D. 41 inches H ₂ O
Electrical System Starting Voltage Battery Cold Cranking Amps	24 Volts DC Two, 12-Volt 625	24 Volts DC Two, 12-Volt 625	24 Volts DC Two, 12-Volt 800	24 Volts DC Two, 12-Volt 800	24 Volts DC Two, 12-Volt 900	24 Volts DC Two, 12-Volt 900

⚠ WARNING

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



IMPORTANT!

COOLING AIR INLET MUST BE AT
 AT LEAST 1-1/2 TIMES LARGER THAN
 RADIATOR DUCT OUTLET AREA ON
 RADIATOR COOLED MODELS.

FLOW OF COOLING AIR AND
 HEATED AIR MAY BE CONTROLLED
 BY AUTOMATICALLY OPERATED
 LOUVERS.

M-1696

FIGURE 1. TYPICAL INSTALLATION

Mounting the Generator Set

GENERAL

Most generator set installations must be engineered so 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 applicable regulations. Refer to Onan Technical Bulletin, T-030, for further 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
- 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. The set should be located as near as possible to the main power fuse box.

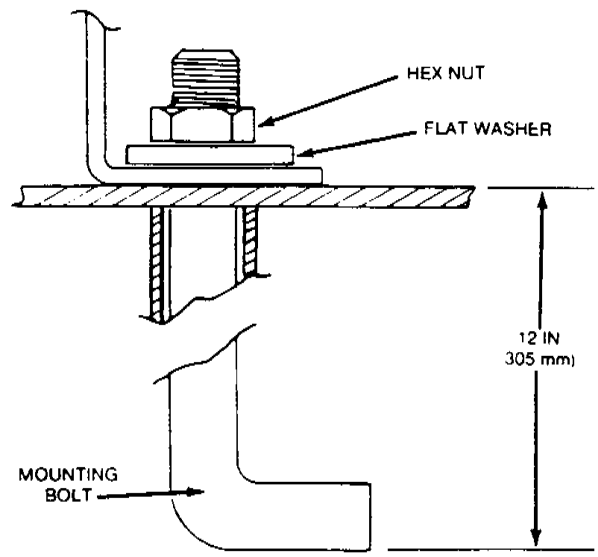
Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions. An optional housing is available for outside operation.

MOUNTING

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

Mount the generator set on a substantial and level base such as a concrete pad. For proper spacing of mounting bolts and set mounting dimensions, see specific generator set specification sheet.

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



M-1627

FIGURE 2. BOLT DIAGRAM

ACCESS TO SET

Plan for access to the generator set for servicing and provide adequate lighting around the unit. For convenience in general servicing such as the radiator, fan belt, and changing the crankcase oil; the surface of the mounting base should be at least 6 inches (152 mm) above the floor.

Mechanical Connections

The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation and cooling systems. Before starting any type of fuel installation, Onan recommends all pertinent state and local codes be complied with and the installation must be inspected before the unit is put in service.

FUEL SYSTEM

Cummins engines used on the DG series generator sets normally use ASTM No. 2 Diesel fuel. They will, however, operate on diesel fuels within the specifications delineated in the Cummins engine manual.

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. 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 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 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. Underground fuel tanks must meet local, state, and EPA requirements.

WARNING *Fuel leaks create fire and explosion hazards which can 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 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 3.

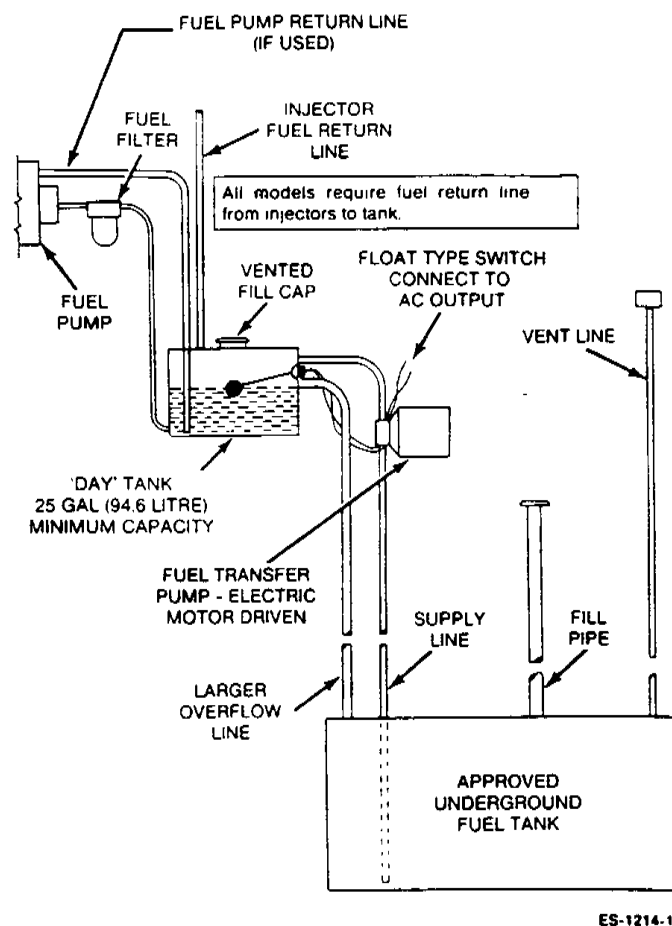


FIGURE 3. DAY TANK (TYPICAL)

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.

⚠ WARNING *Spilled fuel presents the hazard of fire or explosion which can result in severe personal injury or death. Provide an overflow line to the supply tank from the day tank.*

Supply Tank Higher Than 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 Table 1, SPECIFICATIONS for the fitting sizes.

EXHAUST SYSTEM

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlet away from air inlets to prevent exhaust gases from re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, and light loads. Regularly inspect the exhaust system both visually and audibly so the entire system remains fume tight and safe for operation.

⚠ WARNING *Inhalation of exhaust gases can result in severe personal injury or death. Use extreme care during installation to provide a tight exhaust system.*

Use an approved thimble (Figure 4) where exhaust pipes pass through walls 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 *Hot exhaust pipes can cause a fire and severe personal injury or death if improperly routed through walls. Use an approved thimble where exhaust pipes pass through walls or partitions.*

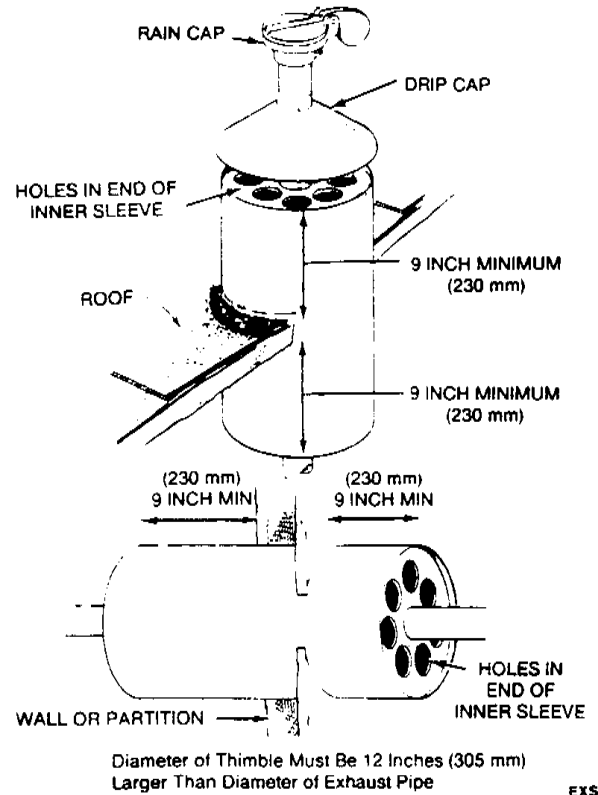


FIGURE 4. EXHAUST THIMBLE (TYPICAL)

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

Onan has rain caps available for the discharge end of vertical exhaust pipes. The rain cap clamps onto the end of the pipe and opens due to exhaust discharge force from the generator set. When the generator set is stopped, the rain cap automatically closes, protecting the exhaust system from rain, snow, etc.

⚠ CAUTION *Weight applied to the engine manifold can result in manifold damage. Support the muffler and exhaust piping so no weight or stress is applied to the engine exhaust manifold.*

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for mufflers, and tailpipe. 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 5).

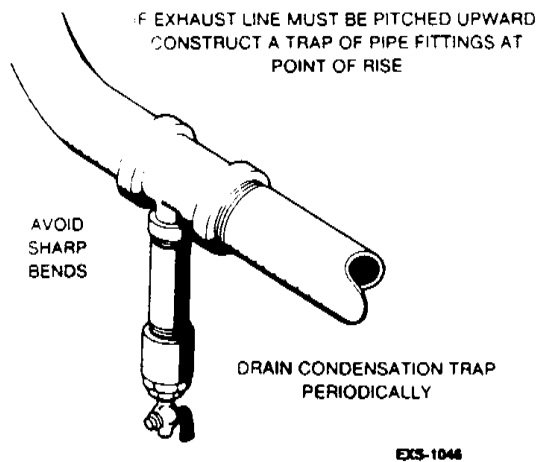


FIGURE 5. EXHAUST CONDENSATION TRAP (TYPICAL)

Shield or insulate exhaust lines if there is a danger of personal contact. Allow at least 12 inches (305 mm) of clearance if the pipes pass close to a combustible wall or partition.

VENTILATION SYSTEM

Generator sets create considerable heat that 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. Refer to Onan Technical Bulletin, T-030, for additional application information.

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.

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 DG series Product Data Sheets 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.

For operation outside a building, a shelter housing with electrically operated louvers is recommended. Transformers connected across the generator output supply current to the motors.

When the generator is operating, current in the transformers actuate the motors and open the louvers. The louvers are held open for the duration of the set operation, then are closed by return springs when the set is shut down.

Dampers

Dampers are 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.

Radiator Set

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.

Heat Exchanger

Heat exchanger cooled sets do not use a conventional radiator. Instead, a constantly changing water flow cools the heat exchanger which in turn cools the engine coolant. Sufficient air movement and fresh air must be available to disperse heat radiated from the heat exchanger.

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 and heat exchanger cooling.

The following sections briefly cover the installation requirements for each system. Refer to Technical Bulletin T-030 for more detailed information.

Standard Radiator Cooling

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 radiators can be located a horizontal or a vertical distance, from an engine. The horizontal distance is limited by the capability of the engine driven water pump and the maximum external Friction Head pressure. The vertical distance is limited to the maximum Static Head pressure which can be imposed on coolant system gaskets and seals without leakage of coolant from coolant system components. The Friction and Static Head pressures of each GenSet are included in their Product Data Sheet.

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 6). 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.

Heat Exchanger (Optional)

This cooling system uses a shell and tube type heat exchanger instead of the standard radiator and fan (see Figure 7). Engine jacket coolant circulates through the shell side of the heat exchanger, while the cooling water is pumped through the tubes. Engine coolant and raw water do not mix. This type of cooling separation is necessary when the raw water contains scale forming lime, or other impurities.

This system can reduce set enclosure airflow requirements and noise levels. Proper operation depends on a constant supply of raw water for heat removal. Adjust the flow to maintain water temperature between 165° and 195°F (74° and 91°C) while viewing the water temperature gauge. The engine coolant side of the system can be protected from freezing; the raw water side cannot be protected.

All heat exchanger 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. If an automatic flow valve is used, the engine thermostat must be removed.

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 or remote mounted radiator.

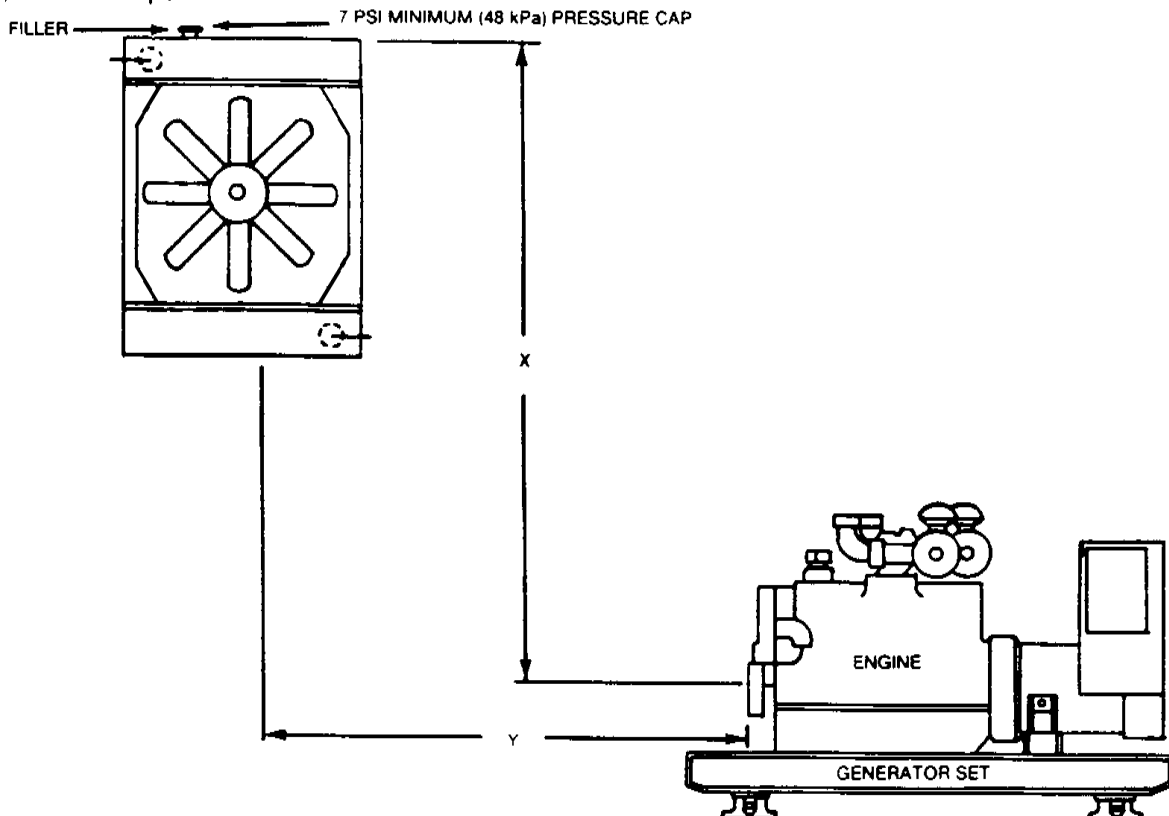


FIGURE 6. REMOTE RADIATOR INSTALLATION

CS-1130

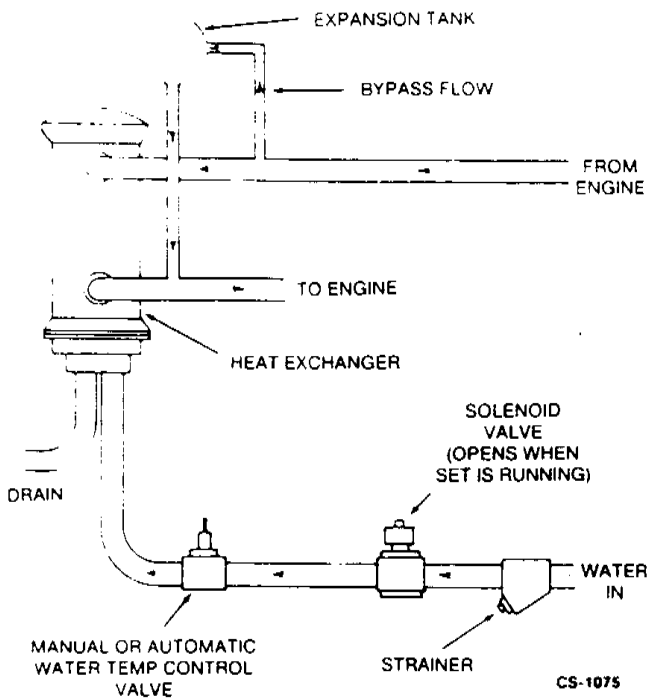


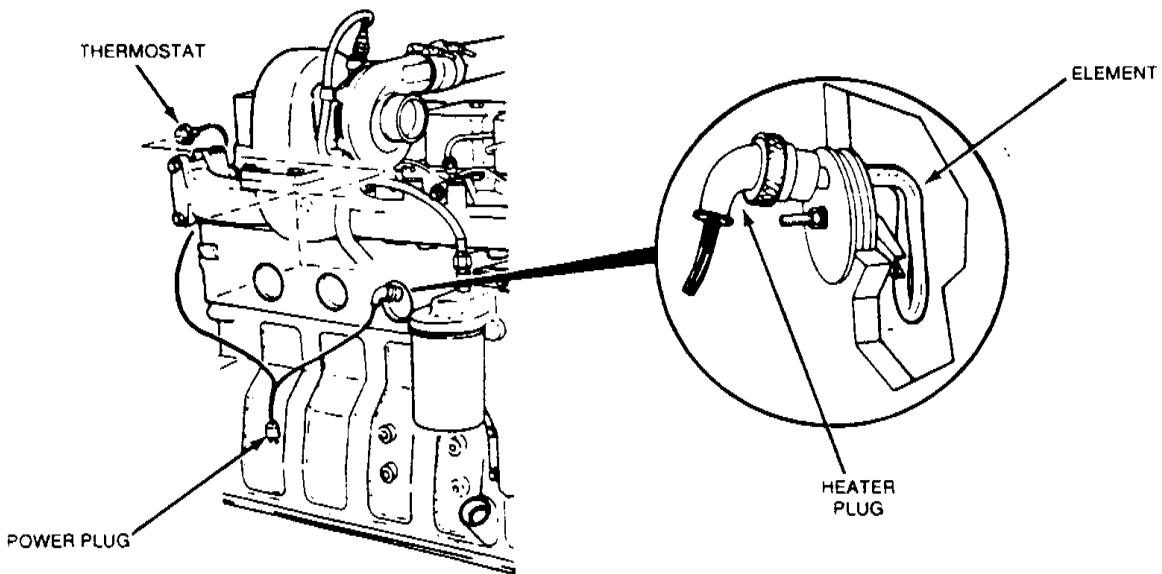
FIGURE 7. TYPICAL HEAT EXCHANGER

Coolant Heater (Optional)

A coolant heater is used to keep engine coolant warm when the engine is shut down. It heats 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 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 8 shows the the heater. Connect the heater to a source of power that will be on during the time the engine is not running.



CS-1320

FIGURE 8. TYPICAL COOLANT HEATER

Electrical Connections

GENERAL

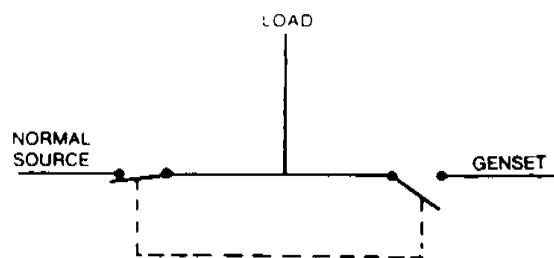
The generator set electrical system installation includes connecting the load, installing the control wiring, and connecting the batteries. The batteries should be connected last to avoid accidental starting of the unit during installation.

Most local regulations require wiring connections be made by a licensed electrician and the installation must 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 can result in fire or electrocution and severe personal injury or death.*

TRANSFER SWITCH

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 (see Figure 9). 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 supplied transfer switches match the generator rating.



SC-1181

FIGURE 9. LOAD TRANSFER SWITCH
(TYPICAL FUNCTION)

AC WIRING

Generator Voltage Connections

The generator output voltages 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 voltage code.

Non-Reconnectible Generators (Voltage Codes E, F and H): 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.

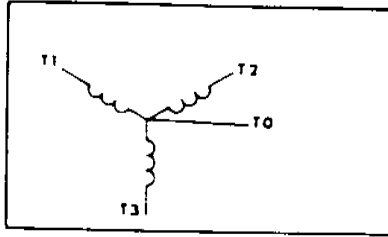
Reconnectible Generators (Voltage Codes L and Z): Generators with codes L (for 60 Hertz) and Z (for 50 Hertz) are three phase generators that can be reconnected for any of the voltages shown in Figure 10. Refer to the set nameplate for the corresponding current rating (amperes).

Load Connections

The 12 lead generators with load connection wires ARE NOT connected together in the output box when shipped from the factory. These 12 wires are labeled T1 through T12 and must be brought together before making load connections. Proceed as follows:

1. Remove the right or left panel from output box.
2. Bolt the load wires to the appropriate generator lead wires in the output box according to Figure 10 for required voltage.
3. Insulate the connections.

220/380 VOLT, 3 PHASE, 60 HERTZ (CODE F)
 347/600 VOLT, 3 PHASE, 60 HERTZ (CODE H)

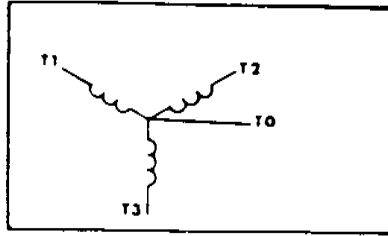


NAMEPLATE VOLTAGE CODE		PHASES	HERTZ	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM (WITH CURRENT TRANSFORMERS WHEN USED)							
VOLTAGE													
L	120/240	1	60	DOUBLE DELTA									
	Z						115/230 110/220						
E	240/480	3	60	SERIES DELTA									
	L						120/240						
	Z						115/230 110/220						
L	120/208	3	60	PARALLEL WYE									
	Z						110/190 115/200 120/208 127/220						
	L						240/416	3	60	SERIES WYE			
							Z						230/400 240/416 254/440
													220/380

98C2193

FIGURE 10. GENERATOR VOLTAGE CONNECTIONS 50-100 kW

220/380 VOLT, 3 PHASE, 60 HERTZ (CODE F)
 347/600 VOLT, 3 PHASE, 60 HERTZ (CODE H)

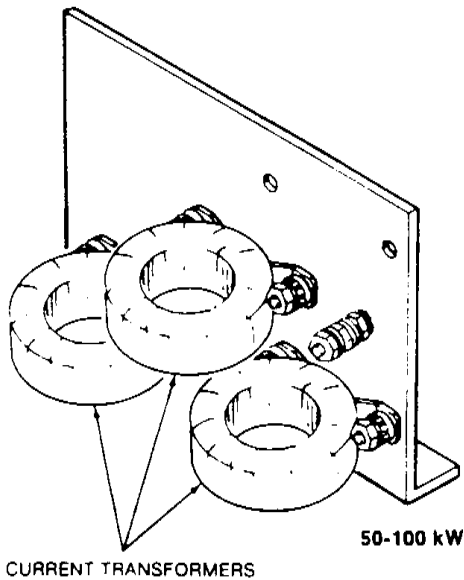


NAMEPLATE VOLTAGE CODE				PHASES	HERTZ	CURRENT TRANSFORMER SECONDARY CONNECTION	GENERATOR CONNECTION	GENERATOR CONNECTION SCHEMATIC DIAGRAM	GENERATOR CONNECTION WIRING DIAGRAM (WITH CURRENT TRANSFORMERS WHEN USED)
VOLTAGE									
L	120/240	1	60	1-3	DOUBLE DELTA	L1 L2			
	Z	115/230 110/220	1 1	50 50					1-3 1-3
E	240/480	3	60	1-2	SERIES DELTA	L1 L2 L3			
L	120/240	3	60	1-3					
Z	115/230 110/220	3 3	50 50	1-3 1-3					
L	120/208	3	60	1-3	PARALLEL WYE	L1 L2 L3			
	127/220	3	60	1-3					
	138/240	3	60	1-3					
	Z	110/190 115/200 120/208 127/220	3 3 3 3	50 50 50 50					1-3 1-3 1-3 1-3
L	240/416	3	60	1-2	SERIES WYE	L1 L2 L3			
	254/440	3	60	1-2					
	277/480	3	60	1-2					
	Z	220/380 230/400 240/416 254/440	3 3 3 3	50 50 50 50					1-2 1-2 1-2 1-2

98C2193

FIGURE 10A. GENERATOR VOLTAGE CONNECTIONS 125-150 kW

When installing sets with the optional AC ammeter, the generator output leads must be routed through a current transformer for proper meter operation (See Figure 11). The transformers are identified CT21, CT22, and CT23 (three phase only) on the wiring diagram and electrical schematics. Refer to Figure 10 to identify the output leads that must be routed through each transformer. Use a cable tie to secure the loose transformer to the generator output leads.



Load Balancing

When connecting loads to the generator set, balance the loads so 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 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 by observing the control panel ammeter.

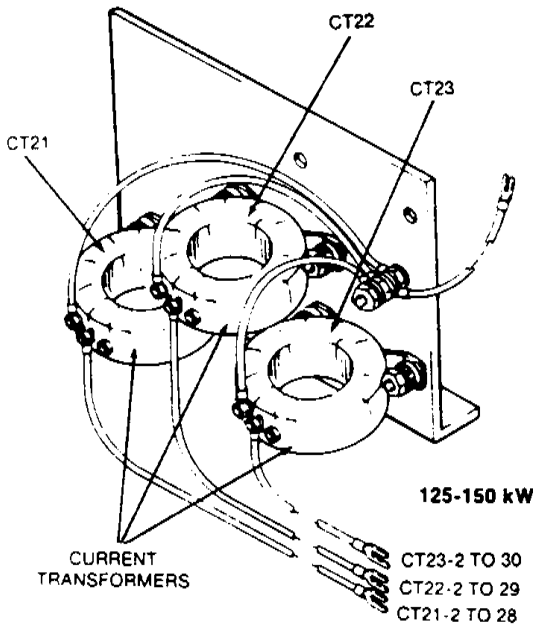
Grounding

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

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

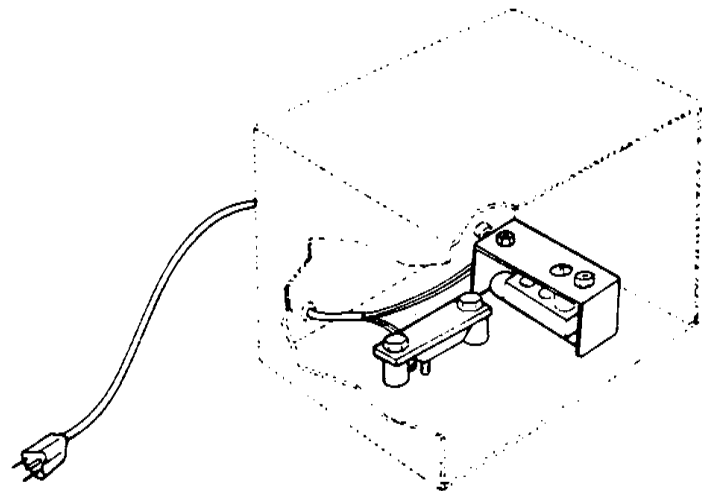
Control Heater (Optional)

A control heater provides a means of humidity/temperature control of the control box interior to protect the components and ensure their effectiveness when the generator set is subjected to varying ambient air conditions during extended periods of non-use (see Figure 12). The element is controlled by an adjustable thermostat.



CURRENT TRANSFORMER SECONDARY MUST BE MANUALLY SELECTED HIGH VOLTAGE (ABOVE 300 VOLTS) - USE TERMINALS 1 AND 2 LOW VOLTAGE (BELOW 300 VOLTS) - USE TERMINALS 1 AND 3 TERMINAL 1 IS COMMON AND CONNECTED TO GND

ES-1702-1



ES-1563-3

FIGURE 11. CURRENT TRANSFORMERS

FIGURE 12. CONTROL HEATER

DC WIRING

Remote Control Connections

Provisions are made inside the control box for addition of optional remote starting and alarms. Connections are made on the terminal block (TB1) located on the engine monitor circuit board (A11). Connect one or more remote switches across remote terminal and B+ terminal (see Figure 13).

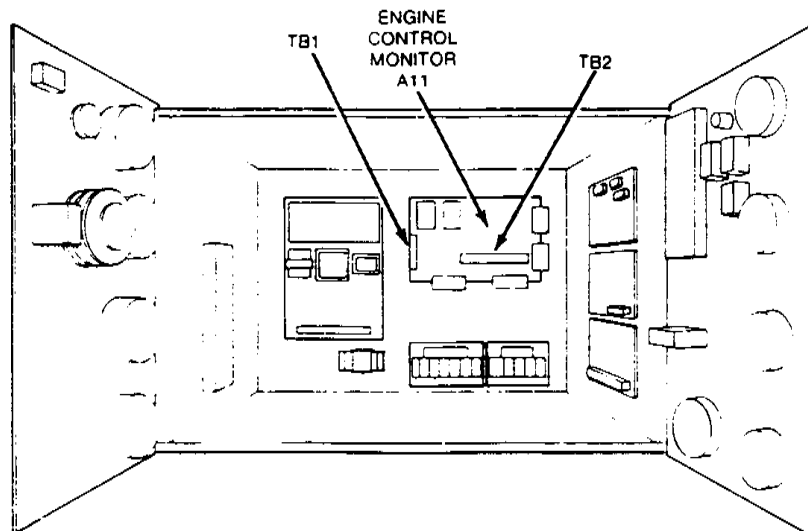
If the distance between the generator set and remote stations is less than 1000 feet (305 m), use 18 gauge stranded copper wire. If the distance is 1000 to 2000 feet (305 to 610 m), use 16 gauge stranded copper wire. Always run control circuit wiring in a separate conduit from the AC power cables to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

Remote Monitor Connections

Provisions are made inside the control box for addition of optional remote monitoring on these generator sets employing optional Detector 12 Control (12 light panel). Connections are made on the terminal block (TB2) located on the engine monitor circuit board (A11).

CAUTION Do Not install DC control wiring in the same conduit as the AC power. AC voltage induced currents can create operational problems with electronic solid-state devices.

TB1		TB2	
7	B+ (DC POWER)	1	FAULT 2 - INPUT } NON-TIMED
6	RMT (REMOTE START)	2	FAULT 2 - OUTPUT } SHUTDOWN
5	GND (GROUND)	3	FAULT 1 - INPUT } TIMED
4	ALM (COMMON ALARM)	4	FAULT 1 - OUTPUT } SHUTDOWN
		5	LAMP TEST/RESET
		6	OVERCRANK
		7	OVERSPEED
		8	HIGH ENGINE TEMPERATURE
		9	LOW OIL PRESSURE
		10	PRE-HIGH ENGINE TEMPERATURE
		11	PRE-LOW OIL PRESSURE
		12	SWITCH OFF
		13	LOW ENGINE TEMPERATURE
		14	LOW FUEL - INPUT
		15	LOW FUEL - OUTPUT
		16	SHUT-DOWN



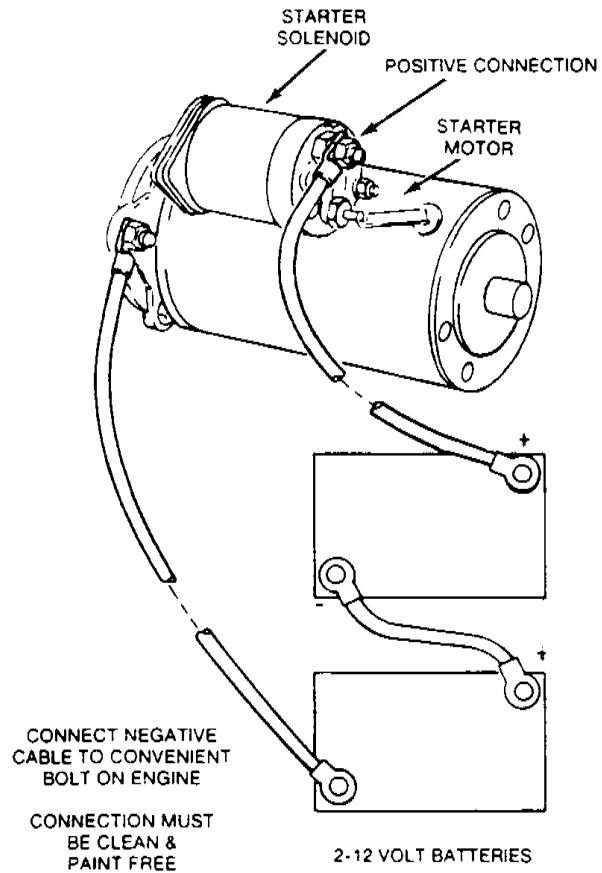
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FIGURE 13. REMOTE CONTROL AND REMOTE MONITOR CONNECTIONS

Battery Connections

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 shown in Figure 14. Normal installation battery cables are included. Increase the cable size if batteries are located remotely from generator set. 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 can cause severe personal injury. Do not smoke while servicing batteries.*



ES-1693

FIGURE 14. BATTERY CONNECTIONS

Prestart Preparations

Before attempting the initial starting of the generator set, be sure it is serviced and ready for operation. Fill the coolant, lubrication and fuel systems and prime the lubrication and fuel systems.

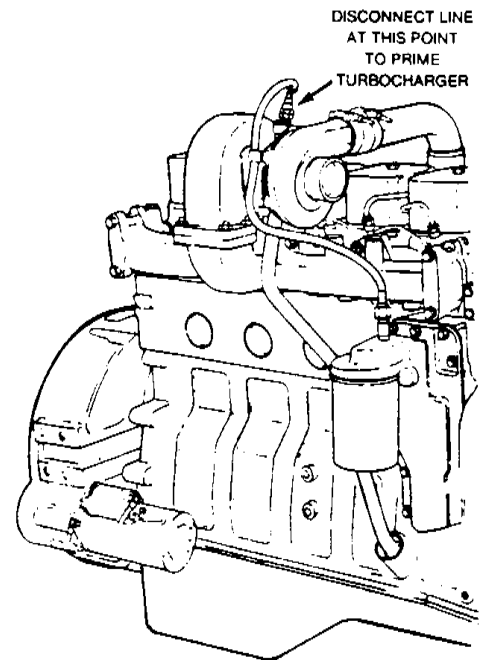
COOLANT

Engine coolant is drained prior to shipment. Before starting, fill the coolant system with the recommended coolant per the Operator's Manual *MAINTENANCE* section, Coolant instructions.

LUBRICATION

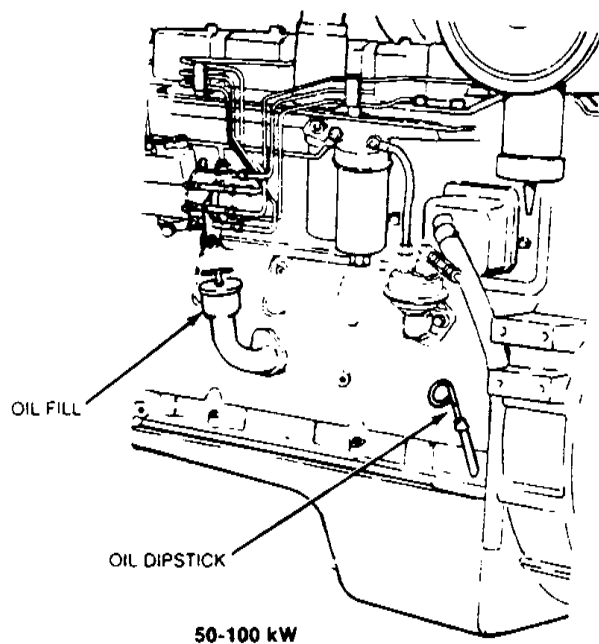
Engine lubrication is drained prior to shipment. Before starting, fill and prime the lubrication system with oil as follows:

1. Remove oil inlet line from turbo-charger housing (Figure 15), fill bearing housing with clean engine lubricating oil; replace line, secure.
2. Fill crankcase to "L" (low) mark on dipstick (Figure 16).
3. Disconnect wire from fuel solenoid valve, close throttle and crank engine for approximately 20 seconds to prime engine.
4. Reconnect wire to fuel shut-off valve.
5. Complete oil fill to "H" (high) mark on dipstick.

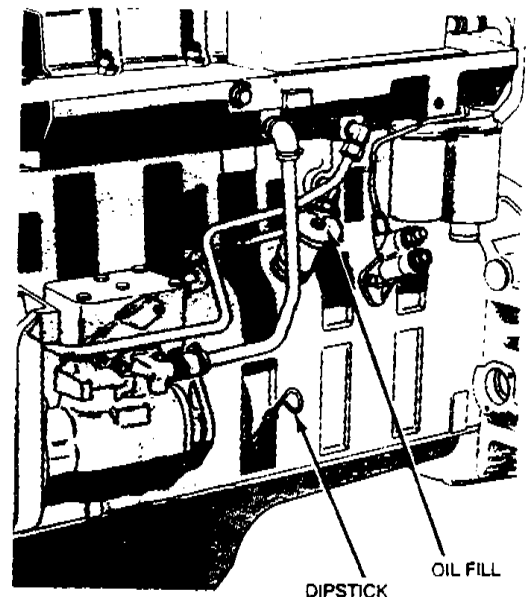


LS-1167

FIGURE 15. PRIMING TURBOCHARGER



LS-1168



FS-1764-1

FIGURE 16. OIL FILL AND DIPSTICK LOCATIONS

FUEL SYSTEM

Engine fuel may not be primed at the fuel filters after shipment. To verify and reprime the fuel system perform the following procedure:

1. Remove each fuel filter (Figure 17) and fill with clean fuel.
2. Put a light coat of fuel on the sealing gasket.
3. Install and tighten by hand until the gasket just touches the filter head.
4. Tighten the filter an additional one-half to three-fourths of a turn.
5. Bleed the Fuel System. Refer to Cummins Operation Manual.

⚠ WARNING *Fuels can ignite causing severe personal injury or death. Do not allow any spark, flame, cigarette, pilot light, etc. when working with fuel system.*

VENTILATION

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

EXHAUST SYSTEM

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

ELECTRICAL SYSTEM

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

Battery Connections

Use two 12-volt batteries for a normal installation. Connect positive battery cable before connecting negative battery cable to prevent arcing.

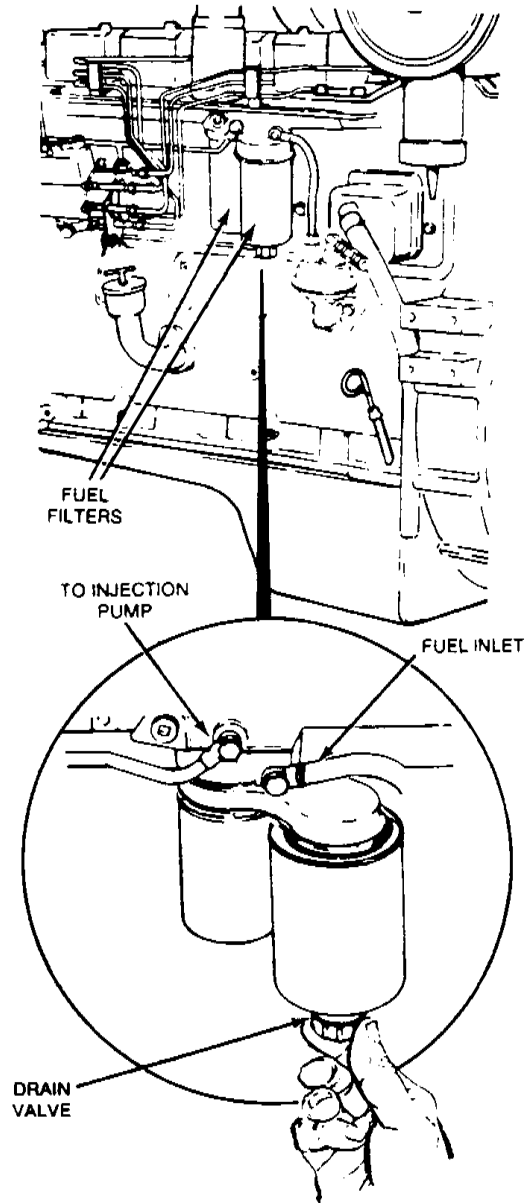
Service the battery as necessary. If an automatic transfer is not used or is installed without a built-in charge circuit, connect a special float charger to the battery.

Load Connections

Check that load cables from generator set are properly connected to either a transfer switch or circuit breaker panel.

MECHANICAL CHECK

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



FS-1698

FIGURE 17. FUEL FILTERS

Initial Start and Checks

Before putting the generator set under load conditions, verify the generator set will perform correctly by checking the following areas.

STARTING

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. If after a few seconds of cranking the engine fails to start or starts, runs, and then stops and the fault lamp lights, refer to the Troubleshooting chart in the Operator's Manual.

ENGINE GAUGES

Check the following while the generator set is operating.

Oil Pressure Gauge

The oil pressure should be in the range of 35 to 55 psi (241 to 379 kPa) when the engine is at operating temperature.

Water Temperature Gauge

The water temperature should be in the range of 170° to 230° F (77° to 111°C) depending on the load and ambient temperature.

DC Ammeter/DC Voltmeter

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.

A DC ammeter is used on 50-100 kW models. A DC voltmeter is used on 125-150 kW models.

AC METERS (IF EQUIPPED)

Note the AC instruments on the control panel. The frequency meter and voltmeter should indicate rated nameplate frequency and voltage. Turn the control panel Voltage Adjust control (if equipped) for nameplate voltage. Use the Phase Selector Switch to read each of the line-to-line voltages.

If unit does not have control instruments or a Voltage Adjust control on the front panel, proceed to Generator Voltage Checks section of this manual.

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 should be the same as the set nameplate rating.

AC Ammeter

Turn the phase selector switch to each phase selection shown on the amperes 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 approximately the same and no line current should exceed the set nameplate rating.

ENGINE MONITOR INDICATOR LAMPS

Move the Run/Stop/Remote switch on the engine panel to the stop position. Hold the Reset/Lamp Test switch in the Test position. All indicator lamps should light. Verify all of the lamps are on and then release the switch. Contact an Onan distributor if any lamps require replacement.

GENERATOR VOLTAGE CHECKS

Generator voltage checks consist of two possible procedures dependent on generator set meters (Detector AC Option).

The generator voltage may be adjusted within 5% of the rated nameplate voltage through external control panel mounted or internal voltage regulator mounted potentiometers. The internal potentiometer also adjusts the range of the external potentiometer.

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

Generator Voltage Adjust (Detector AC Option)

This procedure pertains to generator sets equipped with Detector AC option only. The AC option consists of meters, switches and a voltage adjusting R21 potentiometer on the control front panel.

1. Operate Phase Selector switch to read generator output current and voltage and perform the following steps:
 - A. Insert a screwdriver into the Voltage Adjust R21 potentiometer located on the front of the generator set control and using a wrench carefully loosen the locking nut.

- B. While observing the voltmeter, slowly turn the screwdriver clockwise to increase voltage or counterclockwise to decrease voltage, and adjust to the rated nameplate voltage.

If correct voltage cannot be attained through this adjustment, proceed to Voltage Regulator Adjustment procedure.

- C. After setting correct voltage, retighten locking nut being careful not to change the adjustment.

2. Operate Phase Selector switch to the Off position.

Voltage Regulator Adjustment

This procedure pertains to generator sets equipped with Detector AC option only. The procedure performs the adjustment range centering of voltage adjust R21 potentiometer located on the control front panel.

1. Operate Phase Selector switch to read generator output current and voltage and perform the following steps:
 - A. Insert a screwdriver into the Voltage Adjust R21 potentiometer located on the front of the generator set control and using a wrench carefully loosen the locking nut.
 - B. Turn screwdriver to set adjustment screw to the mid-position and retighten locking nut being careful not to change the adjustment.

⚠WARNING *High voltages in the control present an electrical shock hazard which can cause severe personal injury or death. Refer to Safety Precautions page.*

- C. Open control panel doors, locate VRAS-2 (upper left), and refer to Figure 18 to locate R32 potentiometer.

- D. While observing the voltmeter, insert a screwdriver into R32 potentiometer and slowly turn to increase or decrease voltage until adjusted to the rated nameplate voltage.

2. Close control panel doors and operate Phase Selector switch to the Off position.

Generator Voltage Adjust (Without Detector AC Option)

This procedure pertains to the voltage adjustments of a generator set that does not have the Detector AC option. It applies to any voltage (shown in Figure 10) except series Wye connections.

⚠WARNING *High voltages in the control present an electrical shock hazard which can cause severe personal injury or death. Refer to Safety Precautions page.*

1. Open control panel doors, locate VRAS-2 (upper left), and refer to Figure 18 to locate terminal board TB1 and R32 potentiometer.
2. Connect an accurate 2% voltmeter to VRAS-2 terminal board TB1-2 and TB1-3 terminals (Figure 18).
3. While observing the voltmeter, insert a screwdriver into R32 potentiometer and slowly turn to increase or decrease voltage until adjusted to the rated nameplate voltage.
4. Disconnect voltmeter from TB1 and close control panel doors.

GENERATOR FREQUENCY CHECK

The generator frequency is a result of engine speed, which is automatically controlled. If generator frequency is below specification contact an Onan distributor.

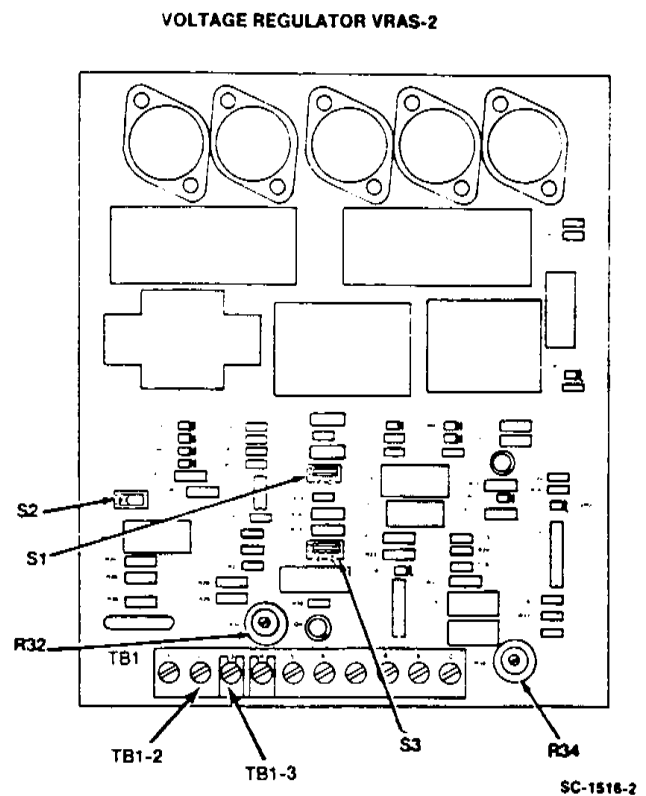
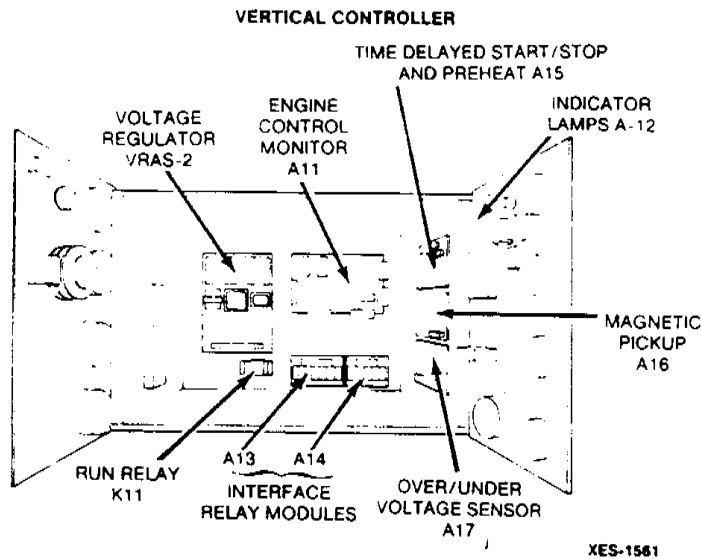


FIGURE 18. VRAS-2 VOLTAGE REGULATOR ASSEMBLY

TABLE 2. VRAS-2 SWITCH SETTINGS

GENSET kW	STABILITY RANGE		REGULATION MODE											
			TMB: 60 HZ TORQUE-MATCHING			TMB: 50 HZ TORQUE-MATCHING			TMC: NON- TORQUE-MATCHING			TMA: NON- TORQUE-MATCHING		
RATING	S1-1	S1-2	S2	S3-1	S3-2	S2	S3-1	S3-2	S2	S3-1	S3-2	S2	S3-1	S3-2
36-50	OFF	ON	POS 2	OFF	ON	POS 2	ON	ON	POS 2	OFF	OFF	POS 1	OFF	OFF
51-100	ON	OFF	POS 2	OFF	ON	POS 2	ON	ON	POS 2	OFF	OFF	POS 1	OFF	OFF
101-150	ON	ON	POS 2	OFF	ON	POS 2	ON	ON	POS 2	OFF	OFF	POS 1	OFF	OFF

- Switch S1 - Selects the overall range of operation for the regulator. Refer to Table 2.
- Switches S2 and S3 - Determine the mode of regulation (Torque-Matched, or Non-Torque-Matched). Refer to Table 2.
- Potentiometer R32 - Provides adjustability to increase or decrease generator voltage to achieve proper setting.
- Potentiometer R34 - Is adjusted at the factory to set the frequency breakpoint, and does not require further adjustment.

EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system including the exhaust manifold, muffler, turbocharger and exhaust pipe. Visually and audibly check for leaks at all connections, welds, gaskets, and joints. Make sure exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, have them corrected immediately.

▲WARNING *Inhalation of exhaust gases can result in severe 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, 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 that can 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 that can hinder starting. Clean and reconnect the battery cables if loose. Always connect the negative battery cable last.

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

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.

▲WARNING *Contact with hot coolant can result in severe burns. Allow cooling system to cool before releasing pressure and removing the radiator cap.*

MECHANICAL ADJUSTMENTS

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. Refer to the Operator's Manual for any necessary adjustments.



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