



GenSet Installation Manual

Models:

DNBA

DNCA

DNCB

DNDA

DNDB

DWBA

DWCA

DWCB

DWDA

DWDB

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 become brittle if continuously vibrated or repeatedly bent.
- 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 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 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 applicable 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. Electrocution 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 the following generator set installation instructions:

- Mounting — Recommendations for fastening generator set to base and space requirements for normal operation and service.
- Mechanical Connections — Connection points for fuel, exhaust, ventilation, and cooling.
- Electrical Connections — Location of electrical connection points for the control, generator, and starting systems.
- 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 Operator's 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. For engineering data specific to the generator set, refer to the Specification and Product Data Sheets. For generator application information about generator set installation, contact your distributor.

INSTALLATION OVERVIEW

The recommendations apply to typical installations with standard model generator sets. They cover many factory designed options and modifications. It is not possible to provide specific recommendations for every situation. If there are any questions not answered by this manual, contact your distributor for assistance.

Application and Installation

A standby power system must be carefully planned and correctly installed to ensure 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. The generator set is only one component in an integrated power system that usually includes power distribution equipment, transfer switches, ventilation equipment, mounting pads, and cooling, exhaust, and fuel systems. Each component must be designed so the complete system will function as intended. Application and design is generally done by specifying engineers or other trained specialists. They are responsible for the design of the complete standby system and for selection of materials and products required.

Installation refers to the actual set-up and commissioning of the power system. The installers set-up and connect the various components of the system as specified in the design plan. The complexity of the system normally requires qualified electricians, plumbers and sheetmetal workers to complete the various segments of the installation. 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. 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 as complete and ready for service.

Specifications

TABLE 1. EQUIPMENT INSTALLATION SPECIFICATIONS*

SYSTEMS

Fuel System

Inlet Fitting Size	1/4-18
Return Fitting Size	0.18 O.D. Tube
Fuel pump (Lifting Capacity)	5 feet (1.525 m)

Exhaust System

Exhaust Connection	Pipe Nipple or Flange Type*
Exhaust Backpressure (Maximum Allowable)	41 inches H ₂ O / 3 inches Hg

Electrical System

Starting Voltage	24 Volts DC
Battery	Two, 12-Volt Group 8D

* Refer also to Specification and Product Data sheets.

⚠ WARNING

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

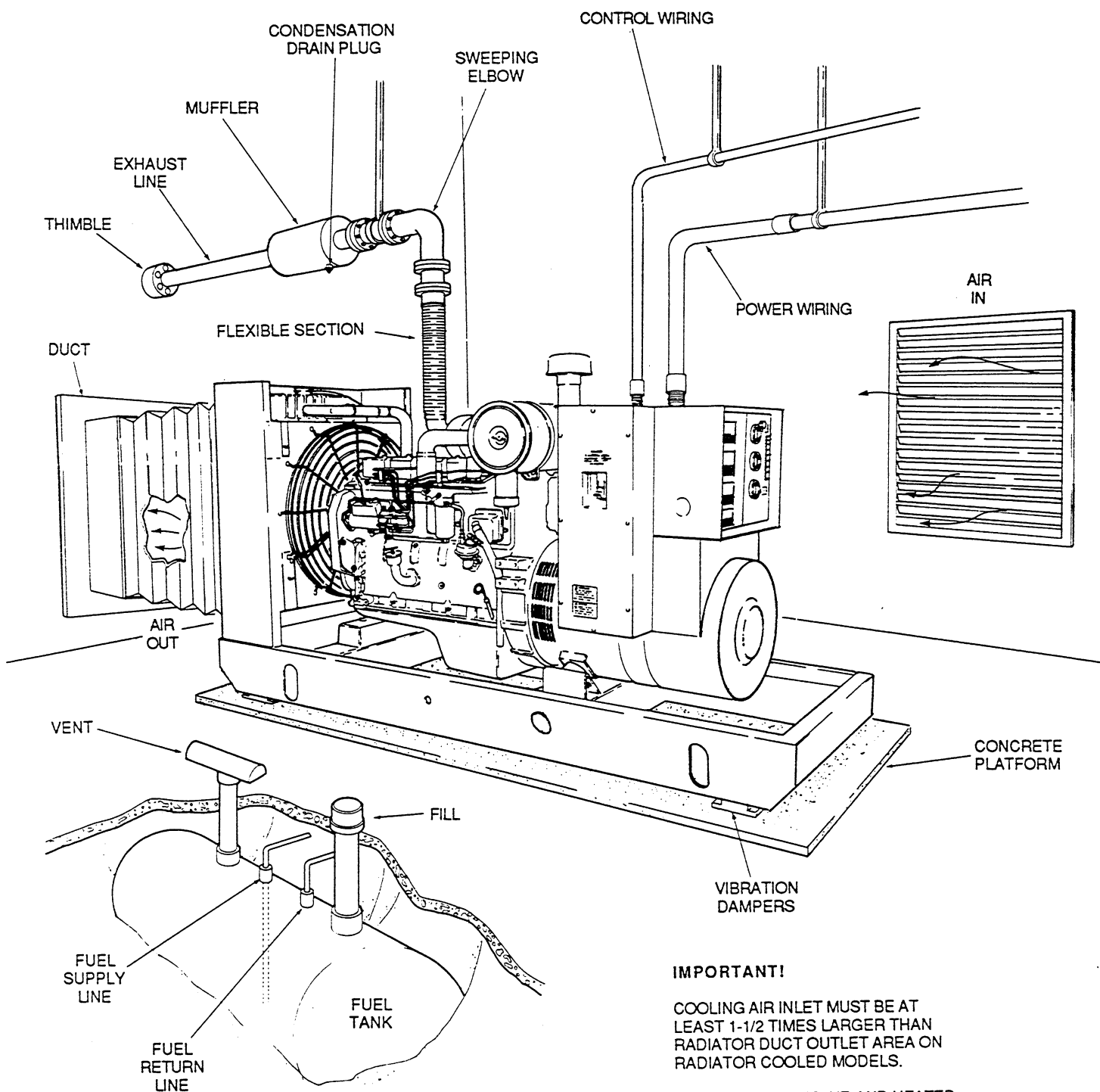


FIGURE 1. TYPICAL INSTALLATION

Mounting the Generator Set

GENERAL

Most installations must be designed to ensure that the generator set will function properly under 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.

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

LOCATION

Optimum generator set location is determined 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. Protect the generator set from adverse weather conditions.

MOUNTING

Generator sets are mounted on a steel skid that provides proper support. For critical installations, additional vibration isolators between the skid base and foundations are available from your distributor.

Mount the generator set on a substantial and level base such as a concrete pad. For spacing of mounting bolts and set mounting dimensions, see your generator set outline drawing.

Typically 3/4-inch diameter, anchored mounting bolts are used 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).

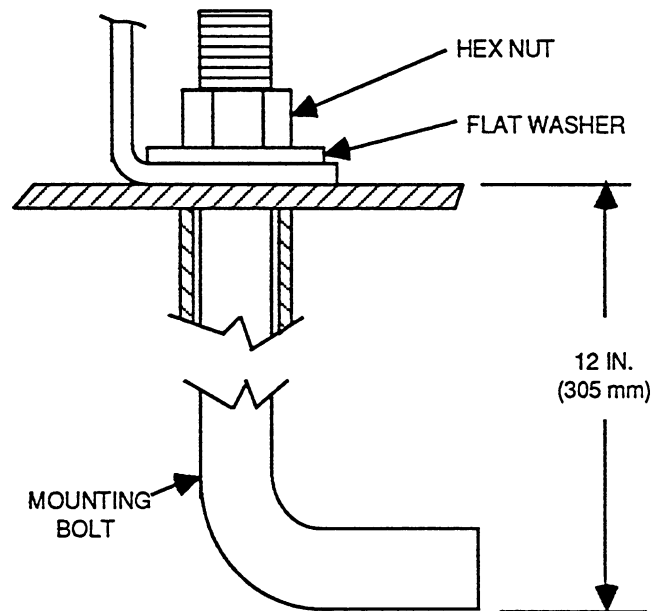


FIGURE 2. BOLT DIAGRAM

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 top of the mounting platform should be at least 6 inches (152 mm) above the floor level.

Mechanical Connections

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

FUEL SYSTEM

Cummins engines used on the generator sets normally use ASTM No. 2 Diesel fuel. They will, however, operate on alternate 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. Use a flexible section of tubing between the engine and fuel supply line to provide vibration isolation.

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

An electric solenoid shutoff valve in the supply line is recommended for all installations and is 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. Install a fuel tank that has sufficient capacity to keep the generator set operating continuously at full load for at least 36 hours.

⚠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 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 transfer 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.

Day Tank (If Used)

Day tanks are fuel transfer tanks which are used when the standard engine fuel pump does not have the capability 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.

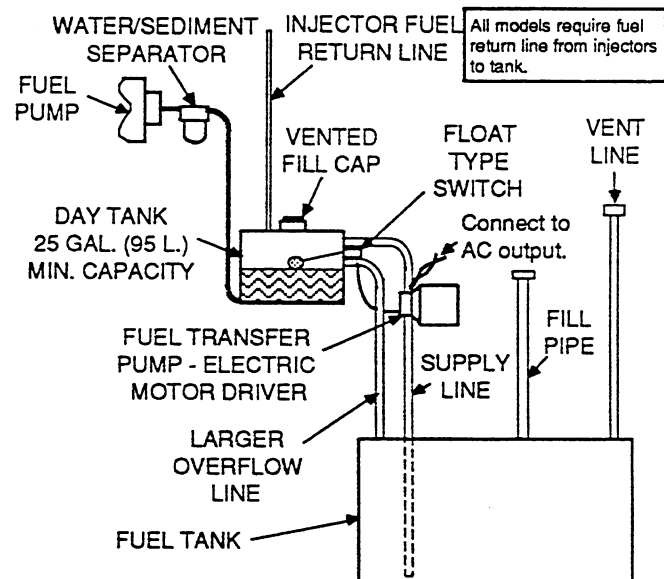


FIGURE 3. DAY TANK (TYPICAL)

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, 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 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, hanging loads, etc. Regularly inspect the exhaust system both visually and audibly to ensure the entire system remains fume tight and safe for operation.

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

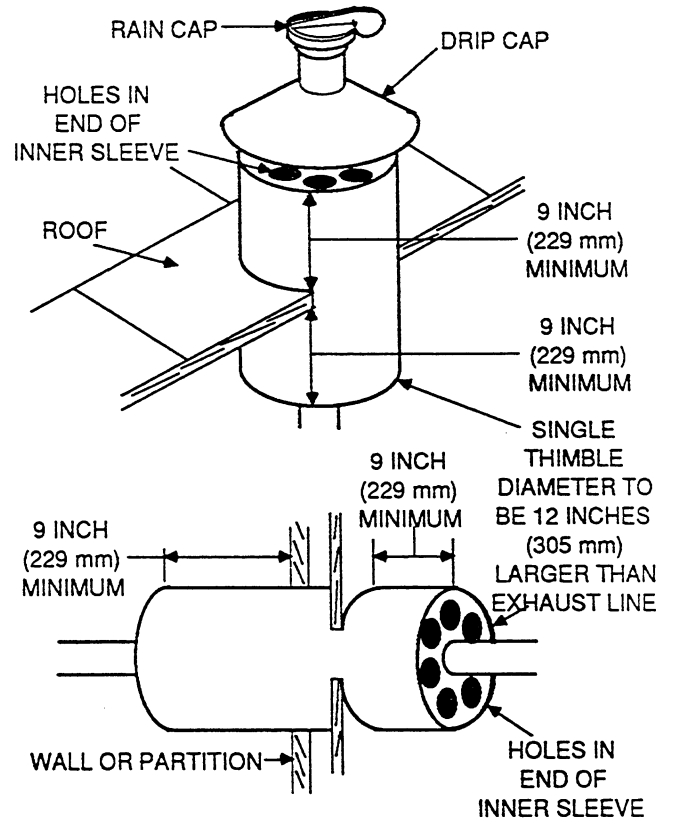


FIGURE 4. EXHAUST THIMBLE (TYPICAL)

Use an approved thimble, or other refractory insulation system, where exhaust pipes pass through walls or partitions, see Figure 4. Build according to all applicable code requirements.

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

Rain caps are 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).

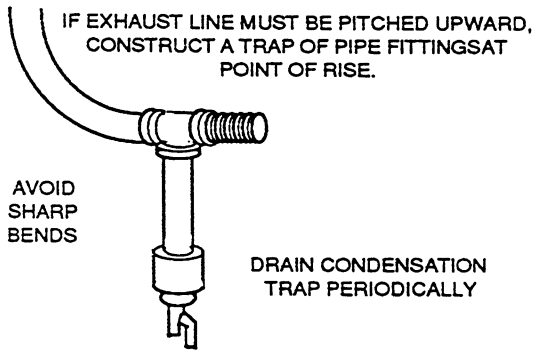


FIGURE 5. EXHAUST CONDENSATION TRAP (TYPICAL)

Shield or insulate exhaust lines if there is 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 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.

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 area. Refer to the 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.

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.

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 air inlet vent opening 1.5 to 2 times larger than the radiator opening.

Locate the air outlet directly in front of the radiator and as close as possible. The effective opening area should 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 to prevent recirculation of heated air and provide for flexible connection. The outlet opening size must be increased proportionate to any added restriction caused by ducting or louvers.

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, engine room 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 SYSTEM

A set mounted radiator with engine driven fan is standard on the generator sets. Optional cooling systems include remote radiator cooling and heat exchanger cooling. The following briefly cover the installation requirements for each system.

Radiator Cooling (Standard)

The standard radiator cooling system 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 sum of the vertical and 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 pressure limits of each generator set are included in the Product Data Sheets.

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. All remote radiator installations must be designed to insure that the system will function properly. Follow the instructions of the consulting engineer when installing a remote radiator system.

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 because the raw water contains scale forming impurities and lacks corrosion inhibitors.

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). The engine coolant side of the system can be protected from freezing; the raw water side cannot.

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.

Before filling the 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.

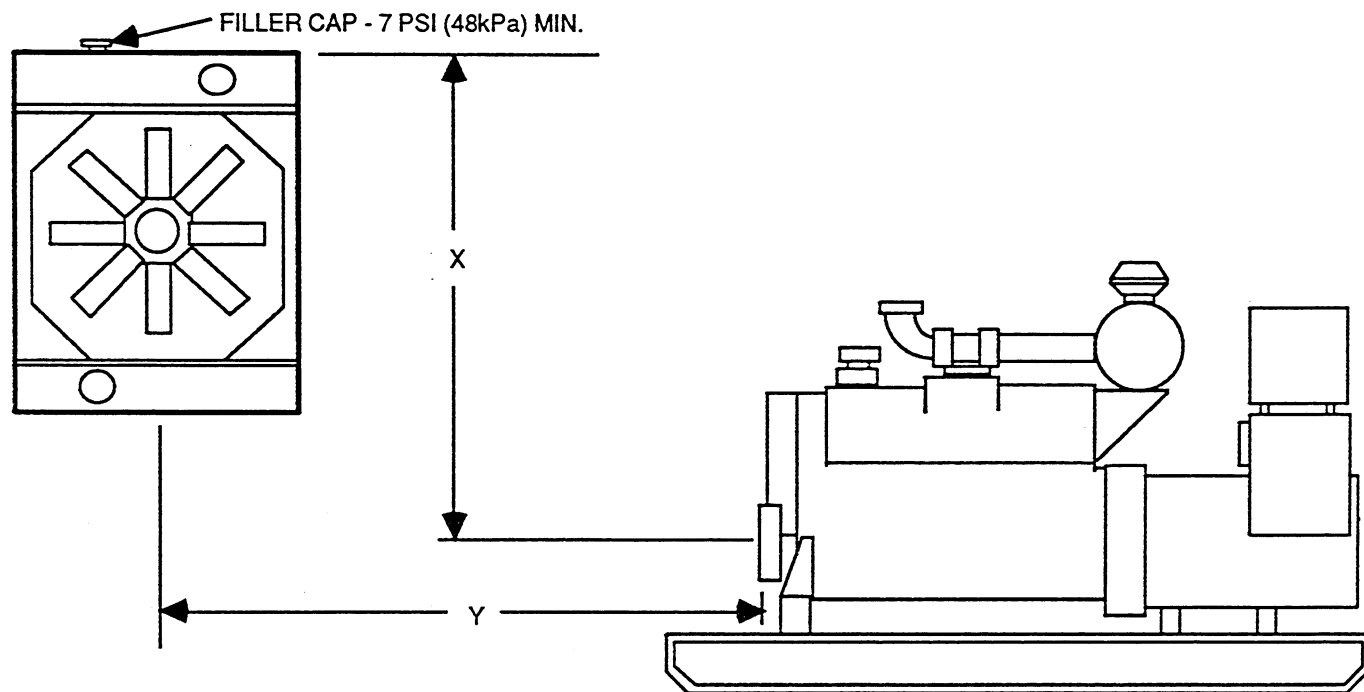


FIGURE 6. REMOTE RADIATOR INSTALLATION

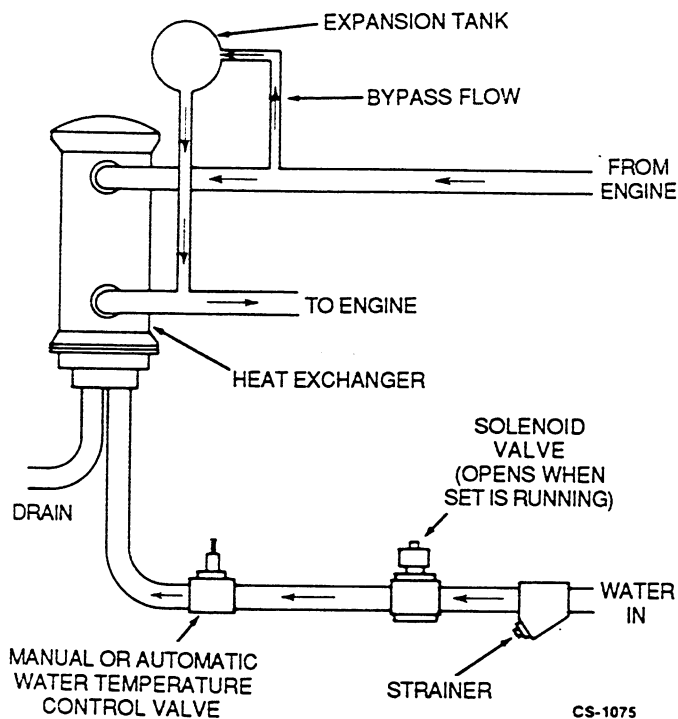


FIGURE 7. TYPICAL HEAT EXCHANGER

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 generator set is operating or damage to the heater will occur.

Figure 8 shows the heater. Connect the heater to a source of power that will be on when the generator set is not operating. Be sure the voltage is correct for the heater element rating.

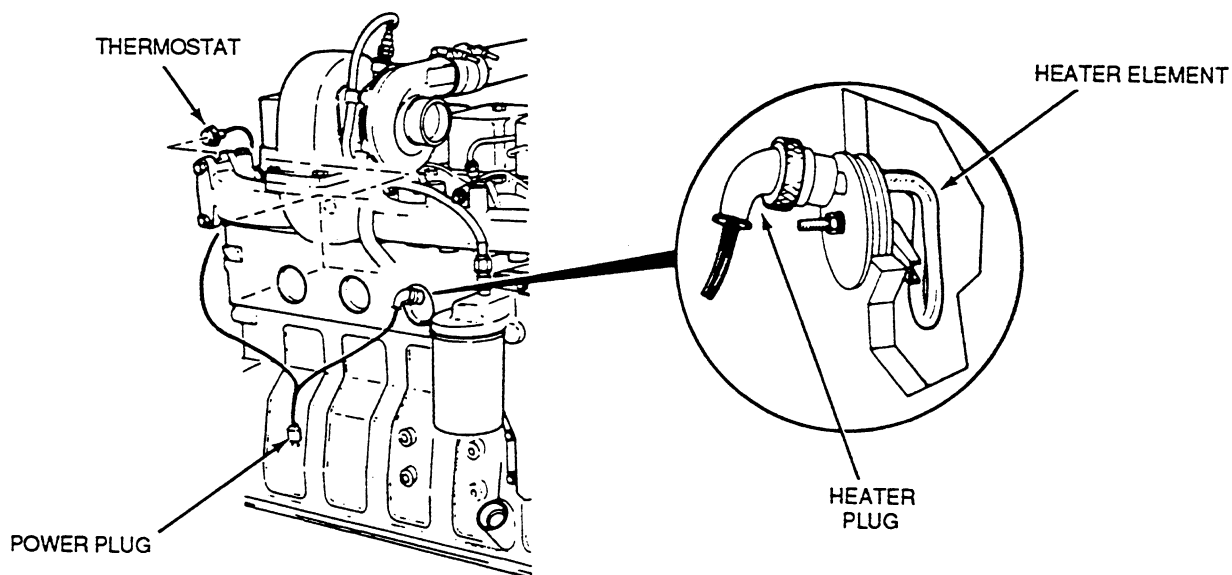


FIGURE 8. TYPICAL COOLANT HEATER

Electrical Connections

GENERAL

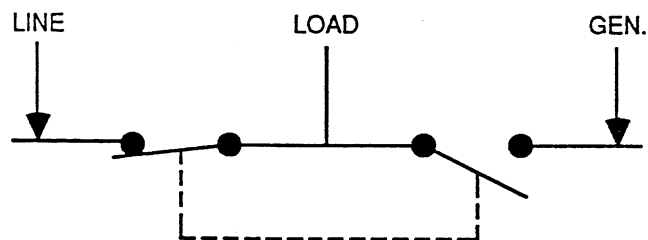
The generator set electrical installation includes connecting the load, installing the control wiring, and connecting the batteries. Batteries should be connected last to avoid accidental starting of the unit during installation.

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

⚠ WARNING *Improper wiring can result in fire and severe personal injury or death.*

TRANSFER SWITCH

If the installation is for standby service, a transfer switch may be used to switch 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. Your distributor can supply transfer switches matched to the generator rating.



NOTE: SHOWN WITH LINE CONNECTED TO LOAD.

FIGURE 9. LOAD TRANSFER SWITCH
(TYPICAL FUNCTION)

AC WIRING

Generator Voltage Connections

The output voltage and maximum current rating are specified on the generator set 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, reconnectable and non-reconnectable. The reconnectable type can be wired to give one of several possible voltages. Non-reconnectable type generators produce only one specific voltage and cannot be re-configured to a different voltage. The following sections explain the connection procedure for each voltage code. Refer to Figure 10 when reviewing the voltage connection information; use the electrical schematic supplied with your generator set when actually performing load connections.

Non-reconnectable Generators: These generators are wired at the factory for a specific voltage and cannot be reconnected. The voltage and corresponding current rating (amperes) are shown on the nameplate. For these generators, proceed to Load Connections.

Reconnectable Generators: These generators may be configured for the voltages shown in Figure 10. Most of these generators must be reconnected by the installer to give the voltage required by the installation. Before shipping, the factory tests the generator set output by connecting the generator to produce a particular test voltage. The installer must always check the stator lead terminal block connections and perform the necessary reconnect to obtain the voltage desired. For complete connection information, refer to the AC wiring diagram enclosed with your generator set literature.

Load Connections

Connecting the Load: All loads are connected to the generator by bolting the load wires to the appropriate terminals on the generator terminal block. The terminals are stamped U, V, W, and N to indicate the line and neutral connections. (Reference: U, V, and W correspond with L1, L2, and L3; and N with L0 respectively.)

VOLTAGE	PHASES	FREQUENCY (Hz)	Generator Connection	Current Transf. Conn.	GENERATOR CONNECTION SCHEMATIC DIAGRAM (Reconnectable Type Only)	GENERATOR CONNECTION WIRING DIAGRAM PHASE SEQUENCE - U.V.W. WHEN ROTATING CLOCKWISE, VIEWED AT THE DRIVE END.
120/240	1	60	DOUBLE DELTA*	1 and 3		
115/230 110/220	1	50				
120/240	3	60				
110/220 115/230	3	50	SERIES DELTA	1 and 2		
120/208 127/220 139/240	3	60	PARALLEL WYE	1 and 3		
110/190 115/200 120/208 127/220	3	50				
220/380 240/416 254/440 277/480	3	60				
200/346 220/380 230/400 240/416 254/440	3	50	SERIES WYE	1 and 2		
**347/600	3	60				

* Single phase, double delta connection will reduce set rating, and may not work with 3-phase meters, etc.

** Not Reconnectable.

FIGURE 10. GENERATOR VOLTAGE CONNECTIONS

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 on the wiring diagram and electrical schematics. Refer to Figure 10 to identify the output leads that must be routed through each transformer. Use cable ties to secure the loose transformers to the generator output leads.

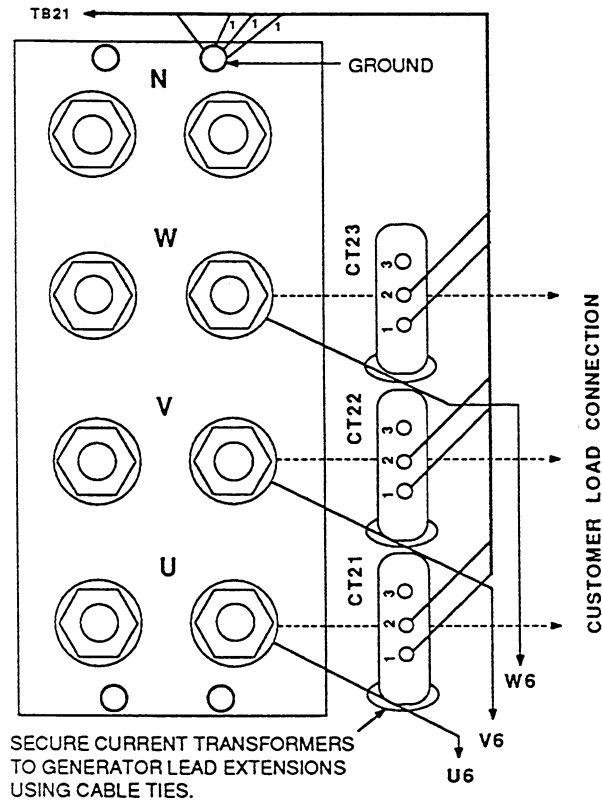


FIGURE 11. CURRENT TRANSFORMERS

Load Balancing

When connecting load to the generator set, balance the load so the current flow from each line terminal (L1, L2, and L3) is about the same. This is especially important if 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 within 10 percent of median value, and no line current exceeds the nameplate rating of the generator.

Grounding

Grounding is 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 multiple transformers, ground fault protection requirements, and physical location of the generator set. Follow the recommendations of the consulting engineer when installing the grounding system.

⚠ WARNING

Contact with electrically "hot" 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 and temperature control of the control box interior. It protects the components and ensures 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. Various voltages are available for the heater power source. Before connecting, be sure you have compatible voltage ratings on the heater and its source of power.

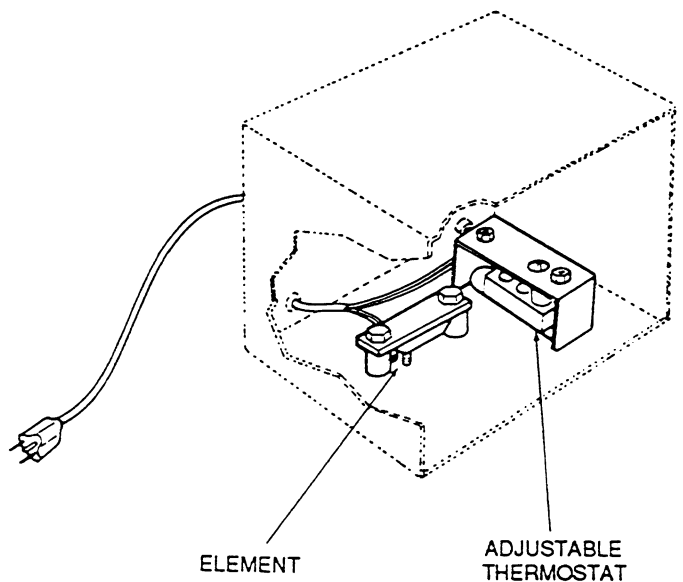


FIGURE 12. CONTROL HEATER

DC WIRING

Battery Connections

Starting the unit requires 24-volt battery current. Use two 12-volt (see *SPECIFICATIONS*) batteries for normal installation. Connect the batteries in series (negative post of first battery to positive post of second) as in Figure 13. Normal installation battery cables are included with the generator set. Connect the battery cables to the starter only at this time, make final connections to the battery when instructed to in *PRESTART PREPARATIONS* section. Increase the cable size if batteries are located remotely from the generator set. Service batteries as necessary. Infrequent unit use (as in emergency standby service) may allow the batteries to discharge so they cannot start the unit. Connect a float charger to the batteries to avoid self-discharge problems.

▲WARNING *Ignition of explosive battery gases can cause severe personal injury. Do not smoke or allow any arc-producing devices around the battery area. Do not disconnect battery cables while the generator set is cranking or running.*

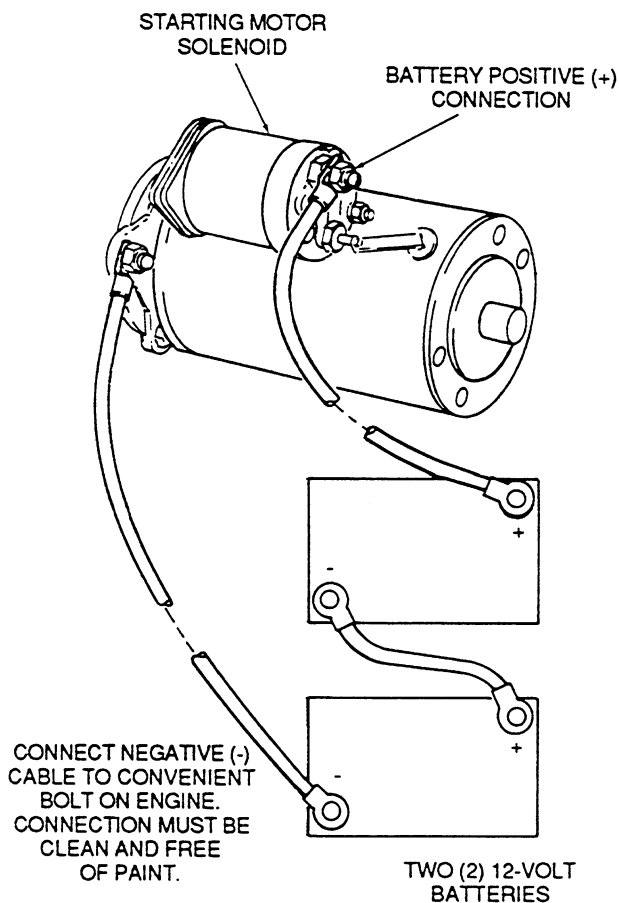


FIGURE 13. BATTERY CONNECTIONS

Remote Control Connections

Provisions are made in the control box for optional remote start and alarms. Connections are made on terminal block TB1 located on the engine monitor circuit board A11. Connect one or more remote switches across RMT and B+ terminal (see Figure 14).

If the distance between the 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 conduit separate from the AC power cables to avoid interference problems with the control.

Remote Monitor Connections

Provisions are made in the control box for optional remote monitoring. The standard control has remote common alarm capability. Those GenSets equipped with the optional twelve-indicator lamp control (12 light panel) may be capable of more extensive remote monitoring. Connections for remote monitoring are located on the engine monitor circuit board A11 on terminal block TB1 and TB2. Refer to Figure 14 and the DC wiring diagram enclosed with the generator set for further information.

▲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.*

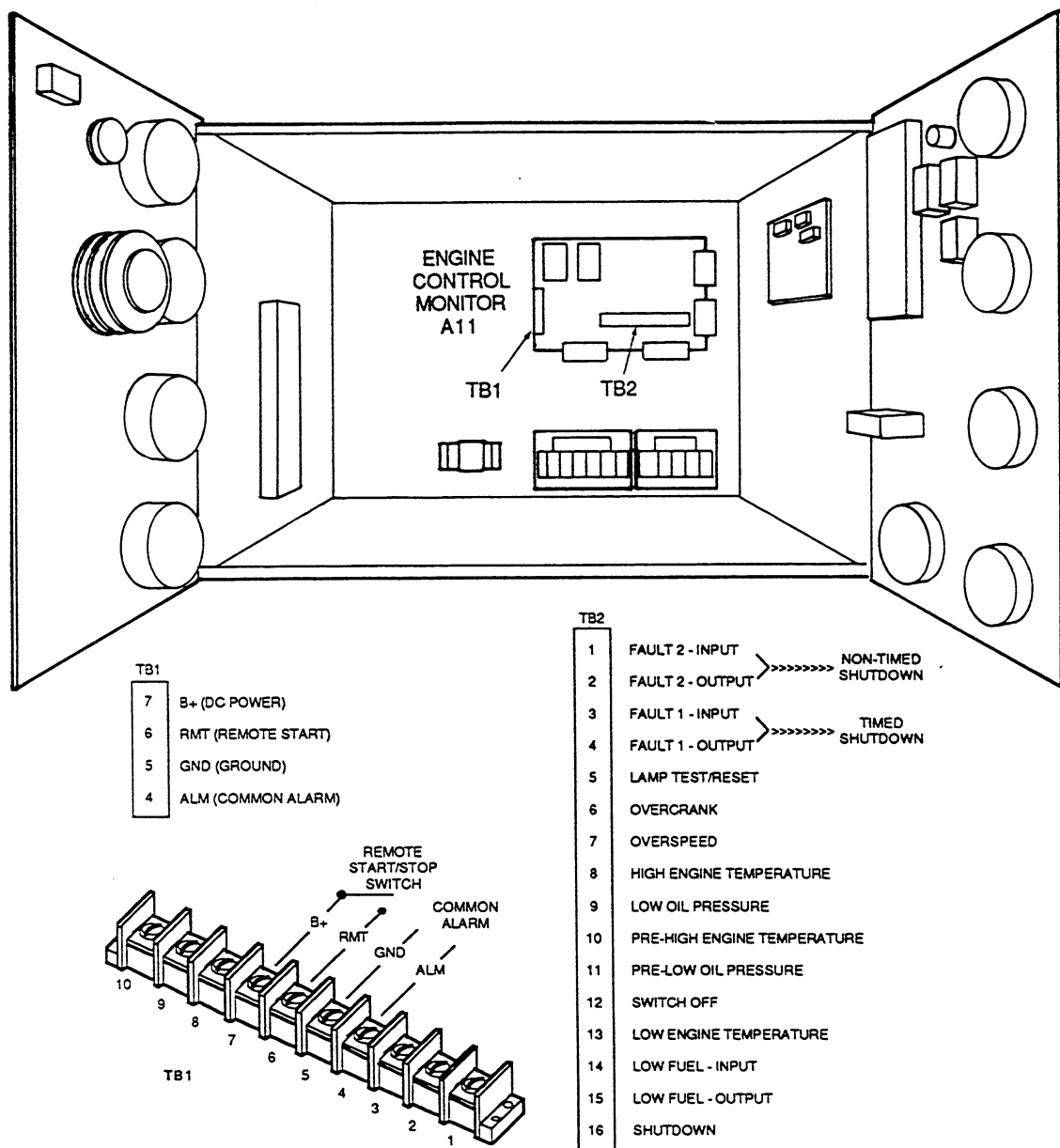


FIGURE 14. REMOTE CONTROL AND REMOTE MONITOR CONNECTIONS

Prestart Preparations

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

COOLANT

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 turbocharger 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. Remove plug from head of oil filter housing (Figure 15) and connect a hand or motor-driven priming pump from a source of clean lubricating oil to the plug hole in filter housing.
4. Prime until a 30 psi (207 kPa) pressure is obtained.
5. Disconnect wire from fuel solenoid valve (Figure 17), close throttle and crank engine while maintaining an external prime pressure of 15 psi (103 kPa), for 15 seconds.
6. Remove external priming equipment, replace plug in filter housing and torque to 15 to 20 ft lb (20 to 27 N•m).
7. Reconnect wire to fuel shutoff valve.
8. Complete oil fill to "H" (high) mark on dipstick.

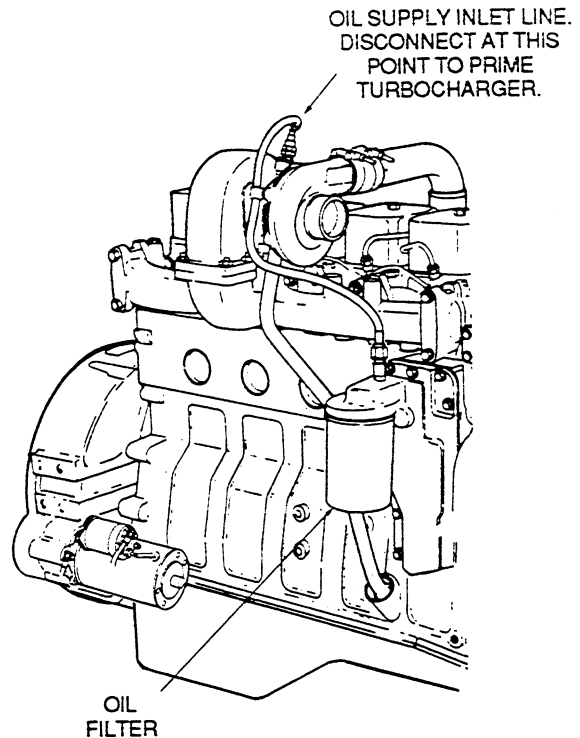


FIGURE 15. PRIMING TURBOCHARGER

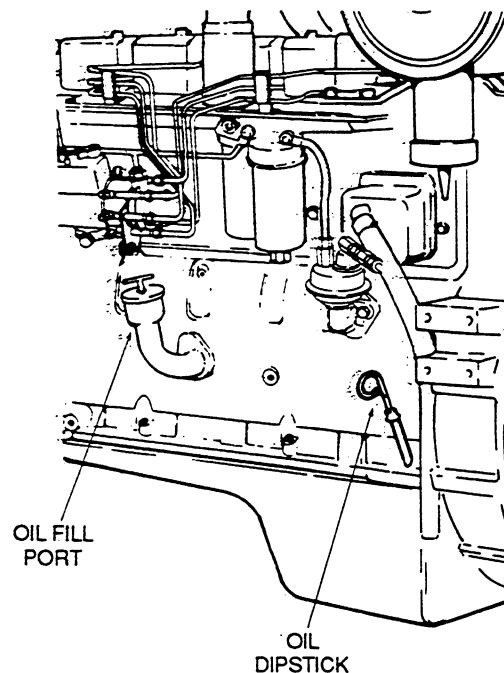


FIGURE 16. OIL FILL AND DIPSTICK LOCATION

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.

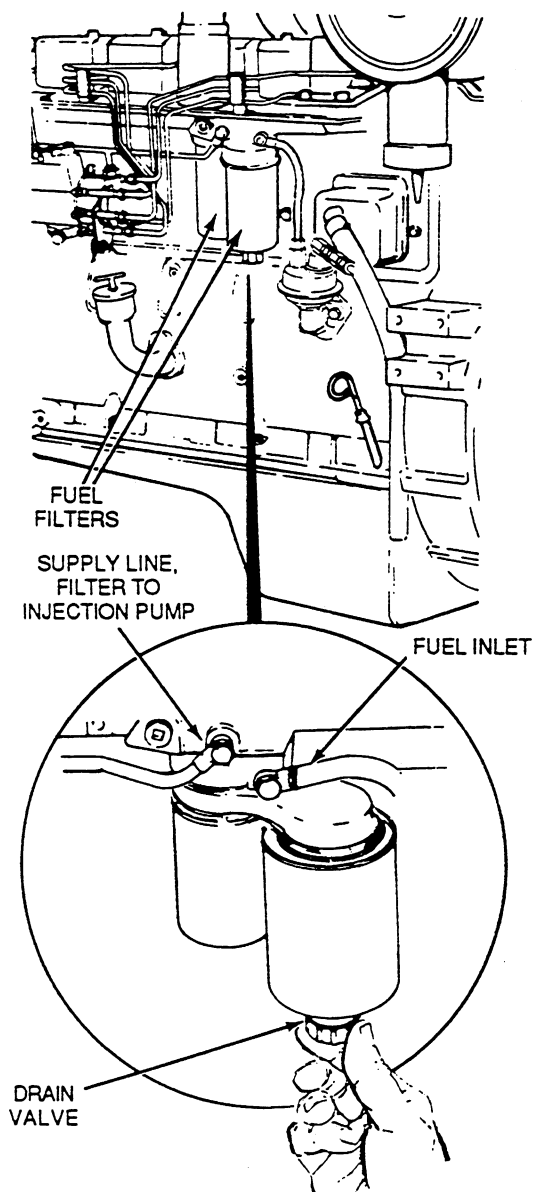


FIGURE 17. FUEL FILTERS

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 connected in series 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 switch is not used or is installed without a built-in charge circuit, connect a separate trickle 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.

Initial Start and Checks

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

Mechanical Adjustment

With the generator set stopped, check for loose belts and fittings, leaking gaskets and hoses, or any sign of mechanical damage. If any problems are found, correct them 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*

ENGINE MONITOR INDICATOR LAMPS

With the Run-Stop-Remote switch on the engine panel in 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. Replace lamps as required.

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.

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.*

ENGINE GAUGES

Check the following while the generator set is operating.

Oil Pressure Gauge

The oil pressure should be in the range of 50 to 70 psi (345 to 483 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.

▲WARNING *High AC voltages produced by the generator set present the hazard of severe personal injury or death. During a no-load test there should be no AC output current readings at generator set.*

AC CHECKS

Frequency Checks

Generator set frequency is related to engine speed, which is automatically controlled. The frequency meter should be stable and the reading should be the same as the nameplate rating (50 or 60 Hz). If the generator frequency is outside of specifications, adjust the frequency adjustment potentiometer on control panel (if equipped), or refer to the *ADJUSTMENTS* section for proper governor adjustment procedure (mechanical governor, or, electric governor option).

AC Ampere Check

Turn the phase selector switch to each phase selection shown on the amperes scale. At no-load, the current reading should be zero. With a load applied, all three phases should be approximately the same, and no line current should exceed the set nameplate rating.

AC Voltage Check

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 voltage scale as indicated by the scale indicator light on the sets so equipped). At full load, the line-to-line voltage should be the same as the set nameplate rating. On generator sets with AC meter package and voltage control rheostat (R21), adjust voltage with R21 as necessary. If voltage cannot be adjusted to rated values, refer to the *ADJUSTMENTS* section for voltage regulator adjustment procedure.

On generator sets without AC meter package, use a remote voltmeter to verify generator set voltages. If voltage is not at rated value, refer to *ADJUSTMENTS* section for voltage regulator adjustment procedure.

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, correct them immediately.

▲WARNING

Inhalation of engine 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 or 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, correct them 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.

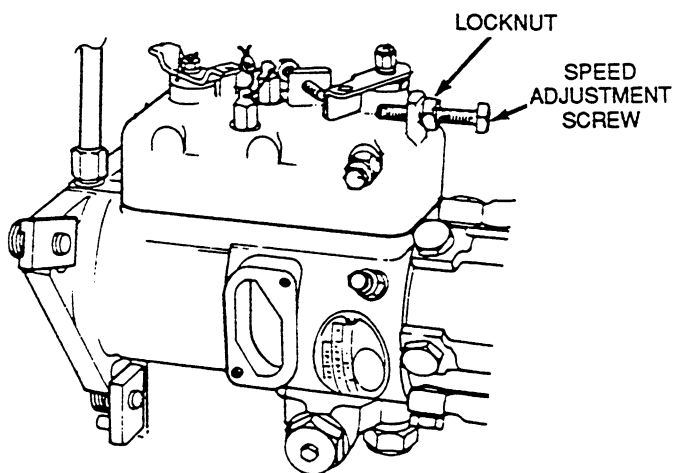
Stop the generator set by moving the Run-Stop-Remote switch to STOP position.

Adjustments

MECHANICAL GOVERNOR (Standard)

For generator sets not equipped with the electric governor, adjust the engine speed as follows:

1. Use the control frequency meter (if equipped) or an accurate tachometer.
2. Loosen the speed adjustment screw locknut. See Figure 18.
3. Start the generator set, allow unit to warm up to proper operating temperature, then apply full rated load.
4. Adjust the speed adjust screw in or out to reach required speed (60 Hz - 1800 r/min, or 50 Hz - 1500 r/min).
5. Hold the speed adjust screw at proper setting and retighten the locknut.
6. Remove and apply loads to check generator set response. Readjust the speed adjust screw if necessary. Contact your service representative if governor response is not satisfactory.



FS-1724

FIGURE 18. MECHANICAL GOVERNOR

ELECTRIC GOVERNOR ADJUSTMENT (Optional)

Generator frequency is in direct ratio to engine speed which is controlled by the governor. The governor control has four potentiometers for making adjustments. See Figure 19. Use a frequency meter or tachometer to monitor the unit during adjustment procedure.

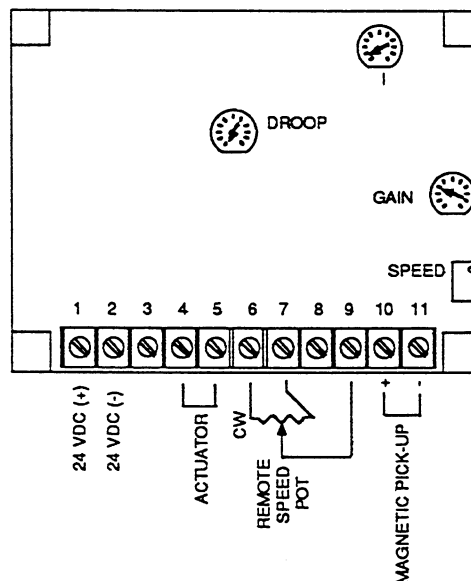


FIGURE 19. ELECTRIC GOVERNOR

Gain and I: The Gain and I controls are one-turn potentiometers used to adjust the sensitivity of the governor. Adjustment of these potentiometers will shorten the response time to load changes.

Droop: The Droop control is a one-turn potentiometer. It is adjustable for zero % (isochronous) to 5% speed droop. Fully counterclockwise rotation will decrease the speed droop.

Speed: The Speed control is a 20-turn potentiometer for setting the desired no-load governed speed. A clockwise rotation will increase the engine speed.

Preliminary Adjustments

1. Frequency Adjust (engine speed) potentiometer on control panel (if equipped).
 - a. Loosen the locking nut.
 - b. With a screwdriver, turn the potentiometer fully counterclockwise, then fully clockwise, then to mid position.
 - c. Hold mid position setting with screwdriver, and tighten locking nut.
2. Speed potentiometer.
 - a. Turn the screw counterclockwise 20 turns.
 - b. Turn the screw clockwise 10 turns.
 - c. This will set the run speed potentiometer to its mid position.
3. I potentiometer.
 - a. Set the I adjustment one division from zero.
4. Gain potentiometer.
 - a. Set the Gain adjustment at the third division from zero.
5. Droop potentiometer.
 - a. Turn the screw fully counterclockwise for isochronous operation.
 - b. Turn the screw to approximately 40 for 3 percent droop.
 - c. Turn the screw to approximately 80 for 5 percent droop.

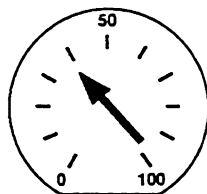


FIGURE 20. GAIN, I, AND DROOP POTENTIOMETERS

Governed Speed Adjustment

Generators which are to operate at 60 Hz full load, must have the engine no-load Speed adjusted to:

- 60.0 Hz (1800 r/min) for isochronous operation
- 61.8 Hz (1854 r/min) for 3% speed droop
- 63.0 Hz (1890 r/min) for 5% speed droop

For generators which are to operate at 50 Hz full load, the engine no-load Speed must be adjusted to:

- 50.0 Hz (1500 r/min) for isochronous operation
- 51.5 Hz (1545 r/min) for 3% speed droop
- 52.5 Hz (1575 r/min) for 5% speed droop

Isochronous Operation Droop Adjustment

For isochronous operation, the droop potentiometer must be turned fully counterclockwise and will not require any further adjustment.

Calibration Checks

1. Start the generator set.
2. With the generator set warmed up to proper operating temperature, adjust the Speed potentiometer until the engine is operating at the desired frequency or r/min.
3. With no load connected to the generator set, finalize the GAIN and I adjustments as follows:
 - a. Turn the GAIN adjustment clockwise slowly until the actuator lever oscillates. Reduce the GAIN adjustment slowly counterclockwise until the lever is stable. Upset the lever by hand. If the lever oscillates 3 to 5 diminishing oscillations and stops, the setting is correct.
 - b. Reduce the GAIN setting counterclockwise one division. Next, turn the I adjustment fully clockwise while observing the actuator lever. If the lever does not become unstable, upset it by hand. When the lever slowly oscillates, turn the I adjustment counterclockwise slowly until the lever is stable. Upset the lever again, it should oscillate 3 to 5 times and then become stable for optimum response.
4. Apply and remove loads to check generator set response. If generator set operation is satisfactory, the governor is now calibrated. If generator set response is not satisfactory, review steps 3a and 3b. If electric governor cannot be properly calibrated, contact your service representative for assistance.

Fine Speed Adjustment

After the GAIN adjustment is made, the full load governed Speed may require a minor adjustment to equal the desired speed (i.e. 60 Hz, 1800 r/min or 50 Hz, 1500 r/min). Use the SPEED ADJUST potentiometer (when supplied) on the engine instrument panel for fine speed adjustments of less than ± 100 r/min.

VOLTAGE REGULATOR ADJUSTMENT

Generator voltage is controlled by the optional voltage control rheostat (R21) located on the control front panel and the solid-state voltage regulator located on the engine side of the generator output box.

The generator voltage may be adjusted within ± 3 percent of the rated nameplate voltage via the optional control-panel mounted voltage control rheostat (R21). If the adjustment cannot be made with R21, or if R21 is not installed, adjust the voltage regulator as follows:

1. Adjust voltage control rheostat R21 (if available) to the mid position.
 - Loosen the locking nut. With a screwdriver, turn rheostat R21 fully counterclockwise, then fully clockwise, then to mid position.
2. Remove the cover from the voltage regulator housing at the engine side of the generator output box.
3. With the generator set operating, and the voltage being monitored (either by meters on the set or with remote metering), adjust voltage regulator board Coarse Voltage Potentiometer (see Figure 21) to the desired generator voltage.

4. Perform fine voltage adjustment (± 3 percent) by rheostat R21 as necessary and retighten locking nut.
5. Stop and restart generator set to confirm proper operation.
6. If adjusting the Coarse Voltage Potentiometer of the voltage regulator board does not allow the generator voltage to come within desired range, refer to wiring diagram included with unit and check for proper connections. Repeat the adjustment procedure. If proper adjustment is still not possible, contact your service representative for assistance.

⚠ WARNING

Do not adjust any other voltage regulator potentiometers or rheostats. They are factory-calibrated for operation with this generator set. Any adjustment of other components could cause generator set voltage instability or overheating. Any other adjustments should only be made by a qualified service representative.

7. Shut down the generator set. Replace cover on voltage regulator housing before returning the generator set to service.

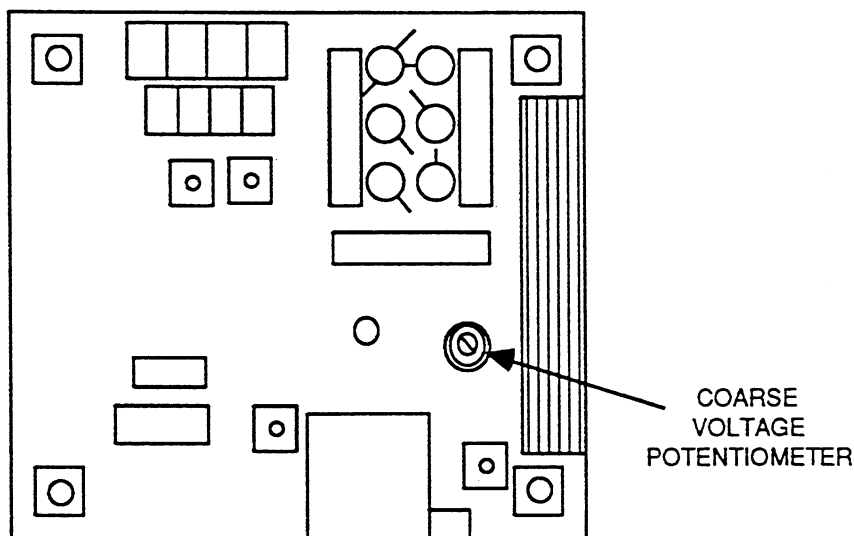


FIGURE 21. VOLTAGE REGULATOR

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