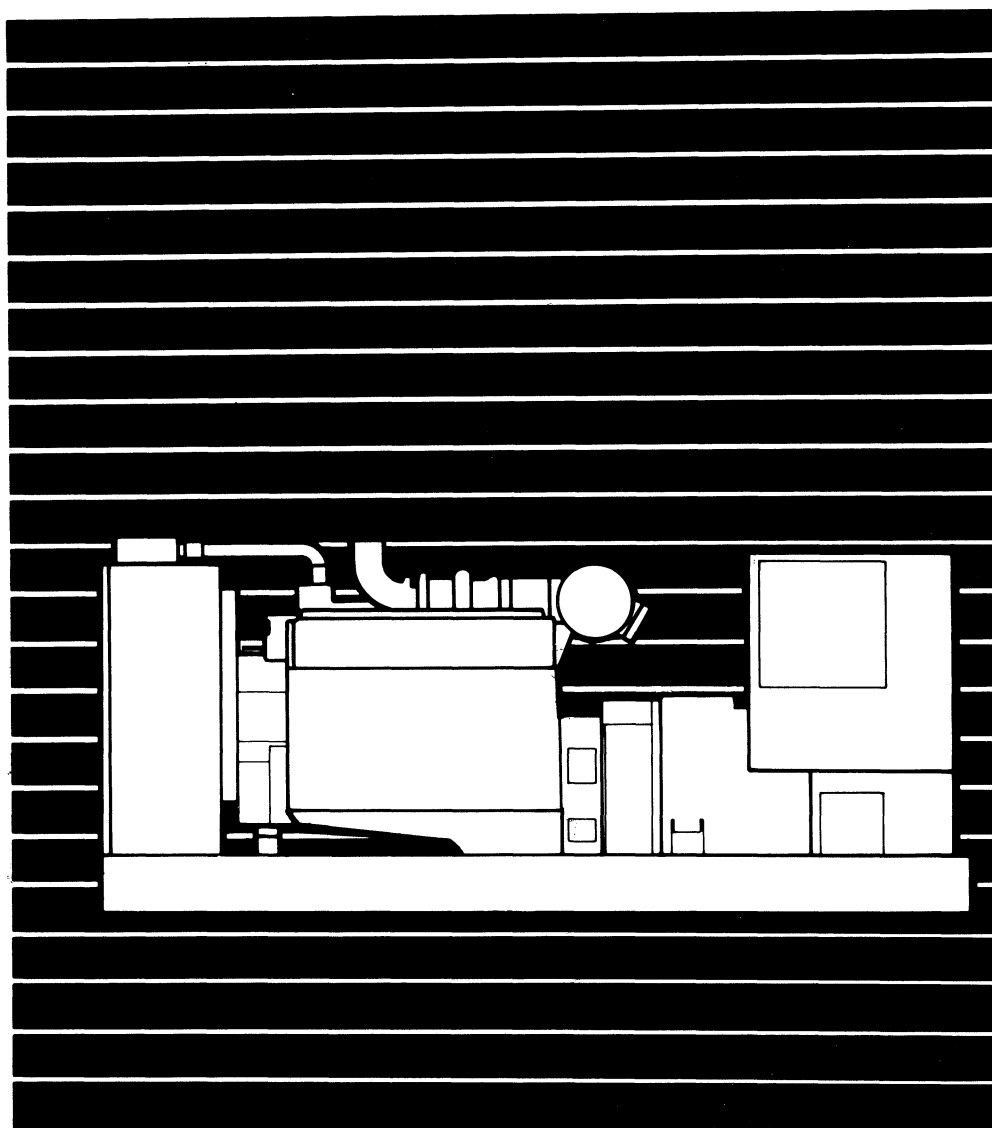




Installation Manual

DFGA
DFGB
DFGC
GENERATOR SETS



Safety Precautions

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

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

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

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

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

FUEL AND FUMES ARE FLAMMABLE. Fire and explosion can result from improper practices.

- DO NOT fill fuel tanks while engine is running, unless tanks are outside the engine compartment. Fuel contact with hot engine or exhaust is a potential fire hazard.
- DO NOT permit any flame, cigarette, pilot light, spark, or other ignition source near the generator set or fuel tank.
- Fuel lines must be adequately secured and free of leaks. Fuel connection at the engine should be made with an approved flexible line. Do not use copper piping on flexible lines as copper will become brittle if continuously vibrated or repeatedly bent.
- Be sure all fuel supplies have a positive shutoff valve.
- Do not smoke while servicing lead acid batteries. Lead acid batteries emit a highly explosive hydrogen gas that can be ignited by electrical arcing or by smoking.

EXHAUST GASES ARE DEADLY

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

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.

- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.
- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

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Section 1. Introduction

GENERAL

This manual provides installation instructions for the DF Series generator sets. This includes the following information:

- Mounting - Recommendations for fastening the generator set to the 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 system.
- Prestart - Checklist of items or procedures needed to prepare generator set for operation.
- Initial Startup - Test complete system for proper installation, satisfactory performance, and safe operation. Refer to *Operator's* manual for troubleshooting information.

INSTALLATION OVERVIEW

The installation recommendations in this section 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. For engineering data specific to the generator set, refer to the specification and product data sheets. For generator application information about generator set installation, or any questions not answered by this manual, contact the distributor for assistance.

APPLICATION AND INSTALLATION

An electrical power system must be carefully planned and correctly installed to provide 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 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 power system and for the selection of the materials and products required.

Installation refers to the actual set-up and commissioning the 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 system requires qualified electricians, plumbers and sheet metal workers to properly complete the various segments of the installation.

SAFETY CONSIDERATIONS

The generator set has been 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.

⚠ WARNING

Incorrect installation, service or replacement parts can result in severe personal injury or death, and/or equipment damage. Service personnel must be qualified to perform electrical and mechanical component installation.

Section 2. Specifications

SYSTEMS	DFGA	DFGB	DFGC
Engine Cummins Model	VTA28-G2	VTA28-G2	VTA28-G3
Coolant Capacity Engine and Radiator	44 gal 167 L	44 gal 167 L	44 gal 167 L
Oil Capacity	89 qts 84 L	89 qts 84 L	89 qts 84 L
Fuel Pump Inlet Thread Size Outlet Thread Size Maximum Lift	1-1/16-14 UNF, 45° 3/4-16 UNF, 45° 6 ft (1.8 m)	1-1/16-14 UNF, 45° 3/4-16 UNF, 45° 6 ft (1.8 m)	1-1/16-14 UNF, 45° 3/4-16 UNF, 45° 6 ft (1.8 m)
Exhaust Outlet Size Maximum Allowable Exhaust Back Pressure	5 in. 41 in H ₂ O (10.2 kPa)	5 in. 41 in H ₂ O (10.2 kPa)	5 in. 41 in H ₂ O (10.2 kPa)
Starting System Voltage DC	24	24	24
Battery Requirements Battery Cold Cranking Amps	Four, 12 Volt 975	Four, 12 Volt 975	Four, 12 Volt 975

Section 3. Mounting the Generator Set

GENERAL

Most generator set installations must be designed so the generator set will function properly under all anticipated operating conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components. 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 (refer to Figure 3-2):

- Level mounting surface
- Adequate cooling air supply
- Adequate fresh induction air
- Discharge of cooling 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, and unauthorized personnel.

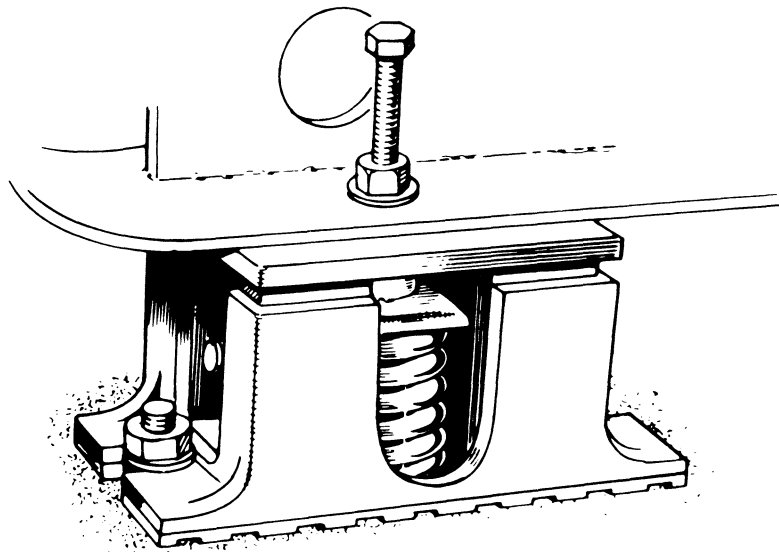
MOUNTING

The generator set has an integral subbase designed for mounting on steel spring vibration isolators (Figure 3-1). Provide a substantial and level base, such as a concrete pad.

For proper spacing of vibration isolators and set mounting dimensions, see the generator set outline drawing. Bolt the vibration isolators to the base as recommended by the manufacturer.

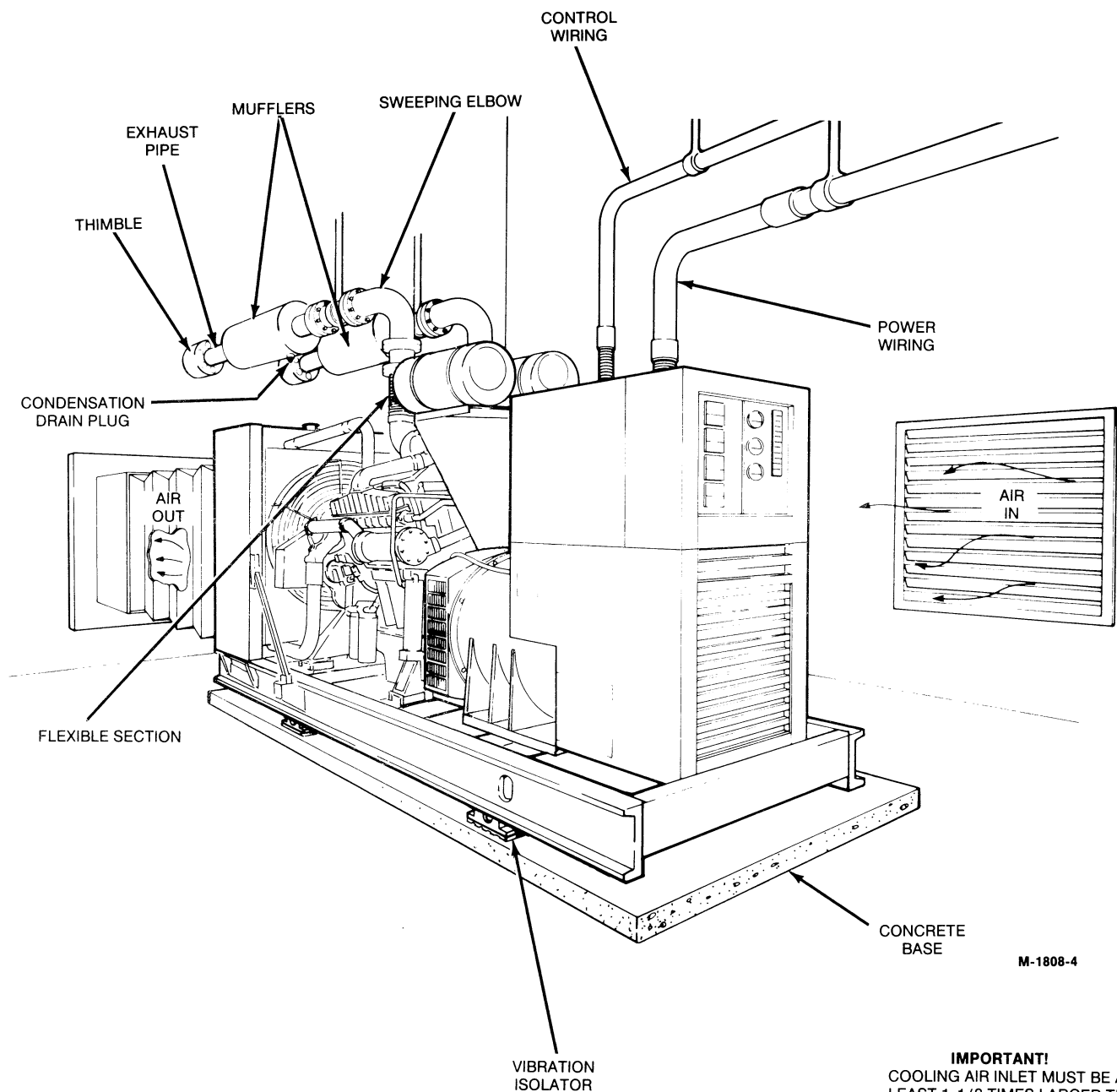
ACCESS TO SET

Plan for access to the generator set for servicing and provide adequate lighting around the set. For easier maintenance and service, such as changing oil, the mounting base should extend at least 6 inches (152 mm) above the floor.



M-1828

FIGURE 3-1. TYPICAL STEEL SPRING VIBRATION ISOLATOR



M-1808-4

IMPORTANT!
COOLING AIR INLET MUST BE 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
DOOVERS.

FIGURE 3-2. TYPICAL INSTALLATION

Section 4. Mechanical Connections

GENERAL

The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation and cooling systems (see Figure 3-2). 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

ASTM No. 2 Diesel fuel is recommended. Check the engine manual for fuel specifications to determine acceptability.

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.

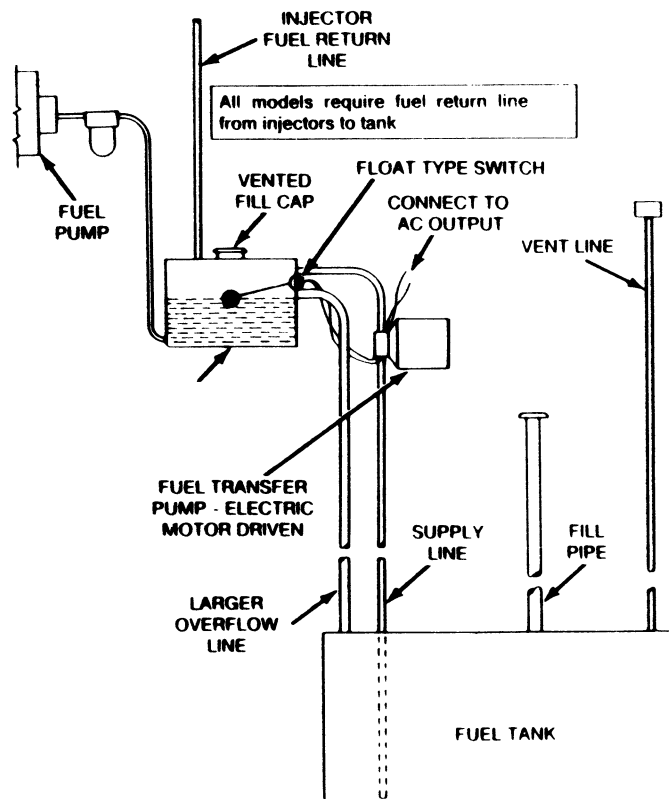
Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Use approved flexible fuel hose at the engine fuel supply and return fittings to isolate vibration. Refer to your generator set outline drawing for sizes and locations.

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

An electric solenoid shutoff valve in the supply line is recommended for all installations and required for indoor automatic or remote starting installations. Connect the solenoid wires to the battery run 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 6 foot (1.8 m) lift capacity of the fuel pump if possible. The fuel tank must have sufficient capacity to keep the generator set operating at full load for the duration specified for the system.



ES-1214-2

FIGURE 4-1. TYPICAL FUEL SUPPLY INSTALLATION

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

If the main fuel tank is installed below the lift capabilities of the standard fuel transfer pump, a transfer tank (referred to as a day tank) and auxiliary pump will also be required. If an overhead main fuel tank is installed, a transfer tank and float valve will be required to prevent fuel head pressures from being placed on the fuel system components. See Day Tank and Figure 4-1.

Day Tank (If Used)

Fuel day tanks 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.

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 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 to stop fuel flow when the generator set is off.

Engine Fuel Connections

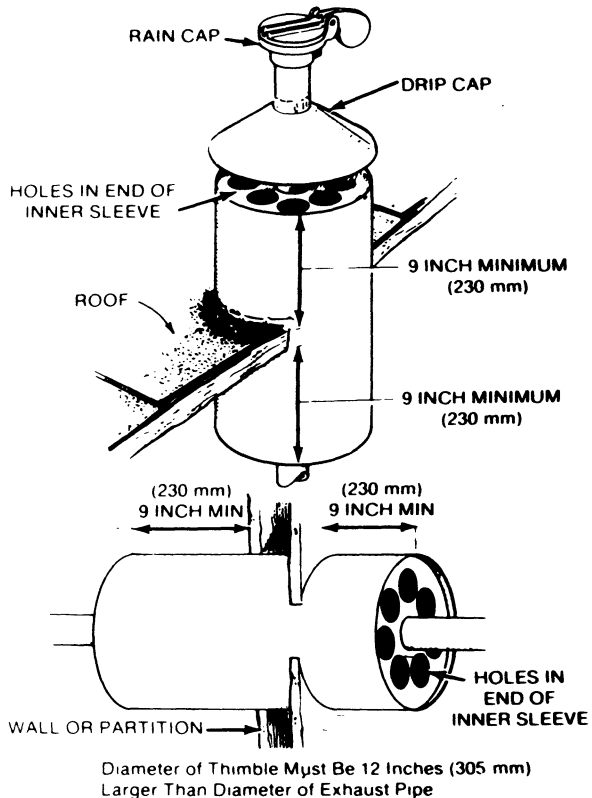
Identification tags are attached to the fuel supply line and fuel return line connections by the factory. Flexible lines for connecting between the engine and the stationary fuel line are supplied as standard equipment.

EXHAUST SYSTEM

Pipe exhaust gases to the out-of-doors. Locate the exhaust outlet away from building air inlets to avoid exhaust gases re-entering the building. 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 to see that 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. Terminate exhaust pipe away from enclosed areas, windows, doors, and vents.*

Use an approved thimble, or a refractory insulation system, where exhaust pipes pass through walls or partitions (see Figure 4-2). Refer to the National Fire Protection Association (NFPA) Standard for Chimneys, Fireplaces and Vents, No. 211, for suggested code requirements. Build according to all applicable code requirements in effect at the installation site.



EXS-1036-1

FIGURE 4-2. MOUNTING EXHAUST THIMBLE THROUGH ROOF OR WALL

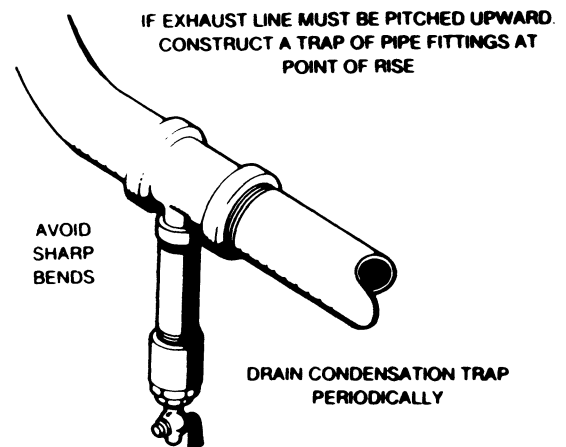
⚠WARNING *Inhalation of exhaust gases can result in severe personal injury or death. Do not use exhaust heat to warm a room, compartment or storage area.*

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.

Use sections of flexible exhaust pipe between engine and exhaust system. The entire weight of the exhaust system must be supported so that no weight rests on the engine exhaust outlets. Use non-combustible hangers and brackets.

⚠CAUTION *The turbochargers will fail if used to support the exhaust system. Use flexible connectors, and support the exhaust pipe and mufflers properly.*

Avoid sharp bends by using sweeping, long radius elbows. 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 4-3).



EXS-1046

FIGURE 4-3. EXHAUST CONDENSATION TRAP

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.

⚠WARNING *Exhaust pipes and mufflers get very hot. They can cause severe burns on contact or a fire if installed too close to combustible construction. Provide shields or insulation if contact cannot be avoided or minimum clearances to combustible construction cannot be maintained.*

VENTILATION SYSTEM

Generator sets dissipate a lot of heat which must be removed by ventilation. Properly sized and positioned vents are required.

Vents and Ducts

For indoor installations (see Figure 3-2), 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 radiator core. 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 minimized.

Dampers

Dampers can be used to block the flow of ventilating air to keep the room warmer when the generator set is not running. Dampers must be open when the set is running.

A thermostatically controlled damper to recirculate a portion of the radiator discharge air can be used to keep the room warmer when the generator set is running.

Radiator Set

Radiator set cooling air is drawn past the rear of the set by a fan which blows air through the radiator. An air duct adapter flange surrounds the radiator grill to allow mounting of the air discharge duct.

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. Provide for flexible connection at front of radiator made of canvas or rubber. The outlet opening size must be increased proportionate to any added restriction caused by ducting louvers. The restriction must not result in a static pressure at the radiator outlet greater than that specified in the generator set Data Sheet.

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 generator set.

To provide sufficient airflow, ventilation fans are required. Size the fans to remove all heat rejected to the room by the generator set, exhaust pipes, and other heat producing equipment. The generator set Data Sheet indicates the heat dissipated to the room by the engine and generator. Maintaining a temperature rise in the room of 20°F to 30°F (11°C 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. Contact the distributor for detailed technical information.

Mounted Radiator

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 is forced through the radiator. An air duct adapter flange surrounds the radiator grill to allow mounting of the air discharge duct. Refer to the *Ventilation* section for location and sizing of ducts and vents.

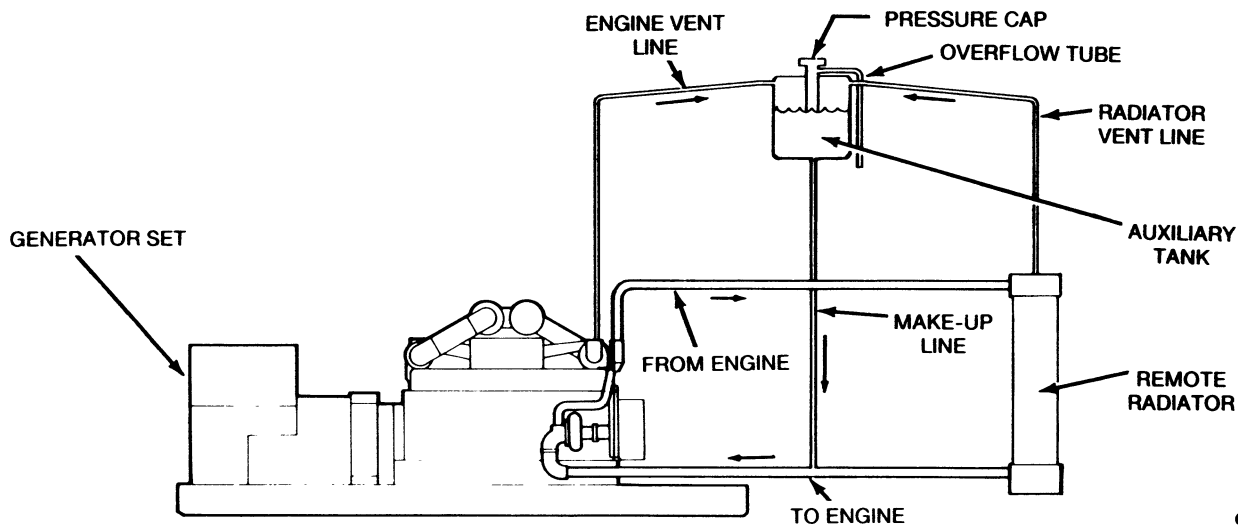
Remote Radiator (Optional)

Installation of a remote radiator requires careful design by a consulting engineer. Figure 4-4 illustrates a typical installation. Important considerations include the following:

- The radiator and fan must be sized so that the coolant temperature does not exceed the radiator inlet temperature specified in the generator set Data Sheet.
- The coolant friction head external to the engine (pipe, fitting and radiator friction) and the coolant static head (height of the radiator top tank above the center line of the engine crankshaft) must not exceed the maximums specified in the generator set Data Sheet. If the radiator has to be located such that excessive friction or static head cannot be avoided, an auxiliary pump or hot well may be necessary.

CAUTION

Excessive static head (pressure) can cause coolant gaskets and pump shaft seals to leak. Excessive friction head (pressure loss) will result in insufficient cooling capacity.



CS-1375

FIGURE 4-4. REMOTE RADIATOR INSTALLATION

- A deaeration type radiator or a radiator and separate auxiliary tank for deaeration is required. The capacity of the radiator top tank or auxiliary tank must be equal to at least 5% of the total coolant volume, to allow for thermal expansion, plus the "drawdown capacity" specified in the engine Data Sheet.

CAUTION *The system must vent so that coolant can be filled at not less than the minimum fill rate specified in the engine Data Sheet.*

Mounted Heat Exchanger (Optional)

This cooling system uses a shell and tube type heat exchanger instead of the standard radiator and fan (see Figure 4-5). 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 are segregated.

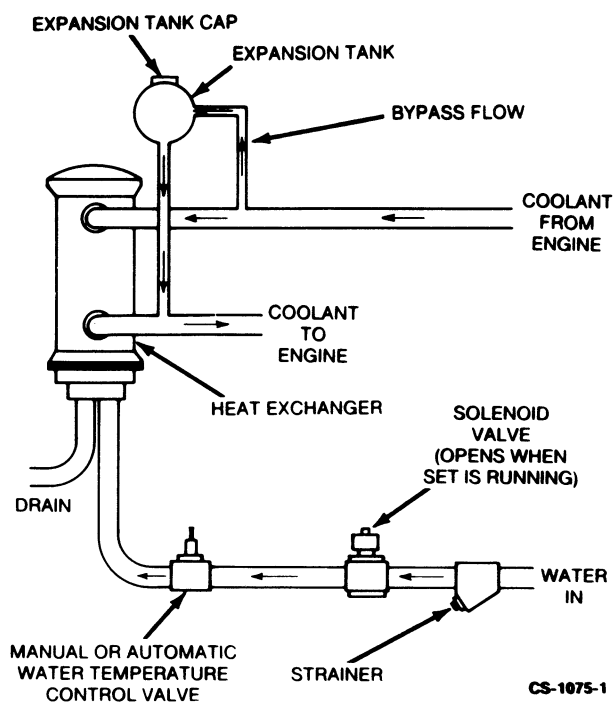
This system can reduce set enclosure noise levels. Proper operation depends on a constant supply of raw water for heat removal. The engine coolant side of the system can be protected from freezing; the raw water side cannot be protected.

All heat exchanger cooled sets must be connected to a pressurized supply of cold water. Use flexible water tubing for raw water connections at the heat exchanger to isolate vibration. On the cold water line, install a solenoid valve to shut off the flow when the set is shut down, and a rate flow valve to control engine temperature. This valve can be either manual or automatic. Actual rate of flow will depend on inlet water temperature.

CAUTION *Never cool an engine directly with raw water. Raw water can cause corrosion and clogging of engine water jackets and does not afford protection from freezing.*

Adjust the flow rate to maintain raw water discharge temperature between 165° F and 195° F (74° C to 91° C) while operating the unit at full load.

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.



CS-1075-1

FIGURE 4-5. TYPICAL HEAT EXCHANGER

Coolant Filter

Spin-on type corrosion filters (Figure 4-6) are standard equipment. These precharged filters are compatible with plain water and all ethylene glycol based permanent antifreeze coolants. Refer to engine manufacturer's manual for instructions if a methoxy propanal base antifreeze is desired. Replace filter periodically as recommended in the *Maintenance* section of the Operator's manual.

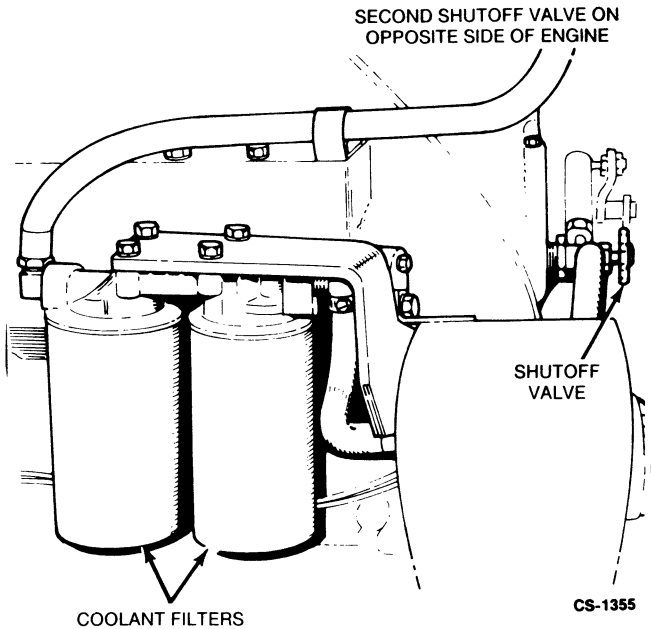


FIGURE 4-6. TYPICAL COOLANT FILTER

Coolant Heater

A coolant heater on each side of the block is used to keep the engine coolant warm when the engine is shut down. It heats and circulates the coolant within the engine. This reduces startup time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

⚠ WARNING *The coolant 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 4-7 shows the heater line connections. Connect the heater to a source of power that will be on during the time the engine is not running. Be sure the voltage rating is correct for the heater element rating.

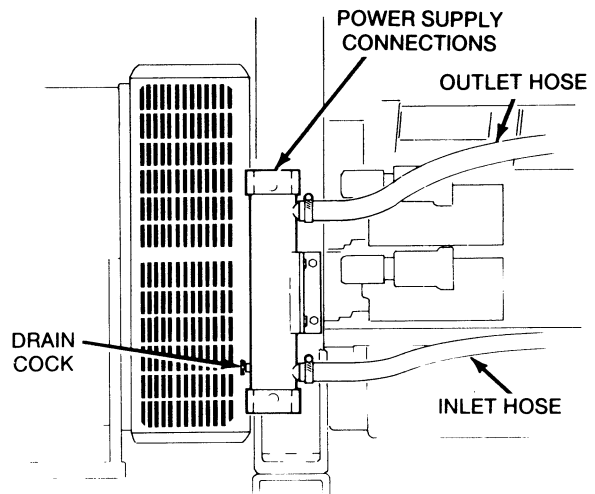


FIGURE 4-7. TYPICAL COOLANT HEATER

Section 5. Electrical Connections

GENERAL

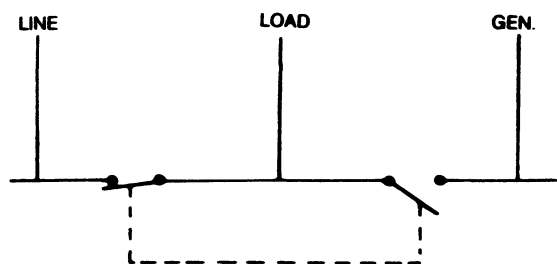
The generator set electrical installation includes connecting the load, installing the control wiring, and connecting the batteries. The batteries should be connected last to avoid accidental starting of the unit during installation. Always connect the negative (-) battery cable last to reduce the risk of arcing.

Most local regulations require that wiring connections be made by a licensed electrician and the installation be 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 presents the hazard of fire or electrical shock which can result in severe personal injury or death, and equipment damage. All electrical connections must be made by qualified personnel and meet all applicable codes.*

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 5-1). Either a manual or automatic transfer switch may be used. Follow the installation instructions provided with the transfer switch when connecting the load and control wiring. The generator set distributor can supply transfer switches matched to the generator rating.



NOTE: SHOWN WITH LINE CONNECTED TO LOAD.

SC-1101-1

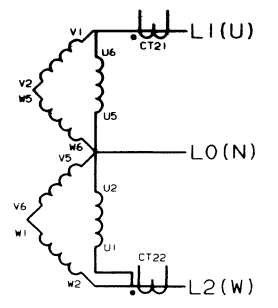
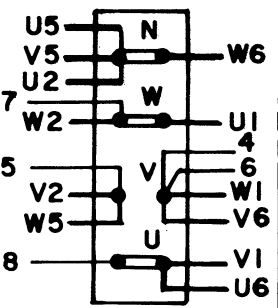
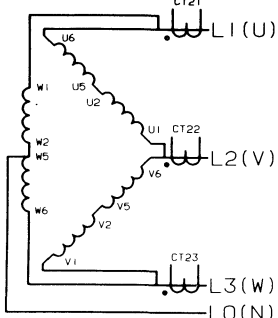
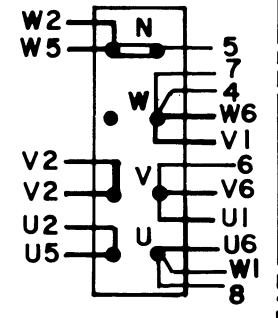
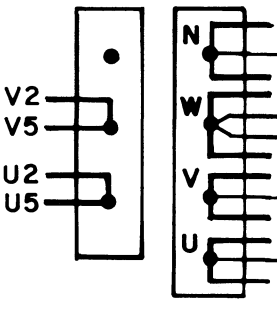
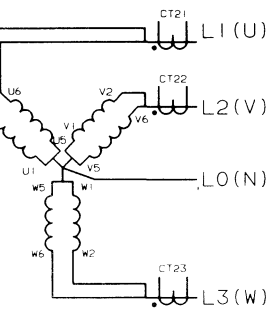
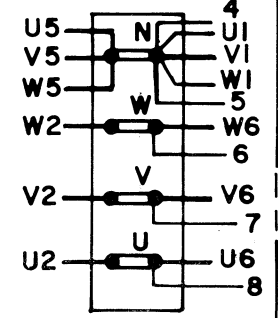
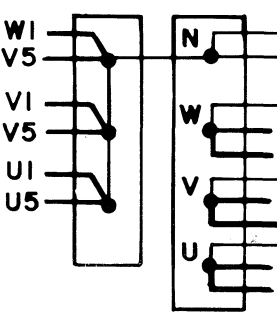
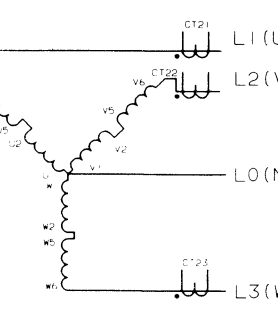
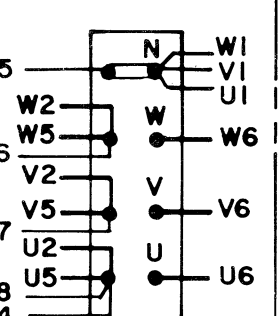
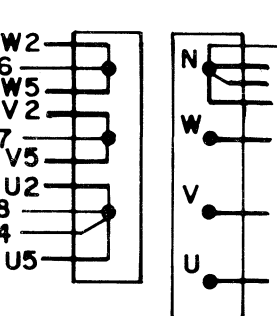
FIGURE 5-1. TYPICAL LOAD TRANSFER SWITCH

AC WIRING

Generator Connections

These are 3 phase generators having load terminals U, V, W and N for connection to the load lines designated L1, L2, L3 and L0, respectively (Figure 5-2). Phase rotation is U-V-W. The rated output (kW), line-to-line/line-to-neutral voltages and maximum allowable phase currents are specified on the generator nameplate.

Use stranded load cables and flexible conduit for connections to the generator to allow for relative movement of the spring mounted set.

CURRENT TRANS. CONN.		VOLTAGE CODE		VOLTAGE		PHASES		HERTZ		GENERATOR CONNECTION		GENERATOR CONNECTION SCHEMATIC DIAGRAM		GENERATOR CONNECTION WIRING DIAGRAM		PHASE SEQUENCE U.V.W. WHEN ROTATING CLOCKWISE VIEWED AT THE DRIVE END														
														HC 4		HC5 - 7														
1 AND 3	L	120/240		I	60		DOUBLE DELTA																							
	Z	115/230 110/220		I	50																									
1 AND 3	L	120/240		3	60		SERIES DELTA																							
	Z	110/220 115/230		3	50																									
1 AND 3	L	120/208		3	60		PARALLEL WYE																							
		127/220		3	60																									
		139/240		3	60																									
	Z	110/190		3	50																									
		115/200		3	50																									
		120/208		3	50																									
1 AND 2	L	220/380		3	60		SERIES WYE																							
		240/416		3	60																									
		254/440		3	60																									
		277/480		3	60																									
	Z	220/380		3	50																									
		230/400		3	50																									
		240/416		3	50																									
		254/440		3	50																									
	H	347/600		3	60																									

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FIGURE 5-2. RECONNECTION DIAGRAM

Load Balancing

When connecting loads to the generator set, balance the loads so that the current flow from each line terminal (L1, L2 and L3) is about the same. This is especially important if both single and three phase loads are connected. Any combination of single and three phase loading can be used at the same time as long as each line current is about the same (within 10 percent of median value) and no line current exceeds the nameplate rating of the generator. During testing, check the current flow from each line terminal by observing the control panel ammeter.

Grounding

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

⚠ WARNING *Contact with 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.*

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

Control Heater (Optional)

A control heater provides a means of humidity and temperature control for the control box interior. The heater protects the components when the generator set is subjected to varying ambient air conditions during extended periods of non-use (see Figure 5-3). The heater element is controlled by an adjustable thermostat.

DC WIRING

Remote Control Connections

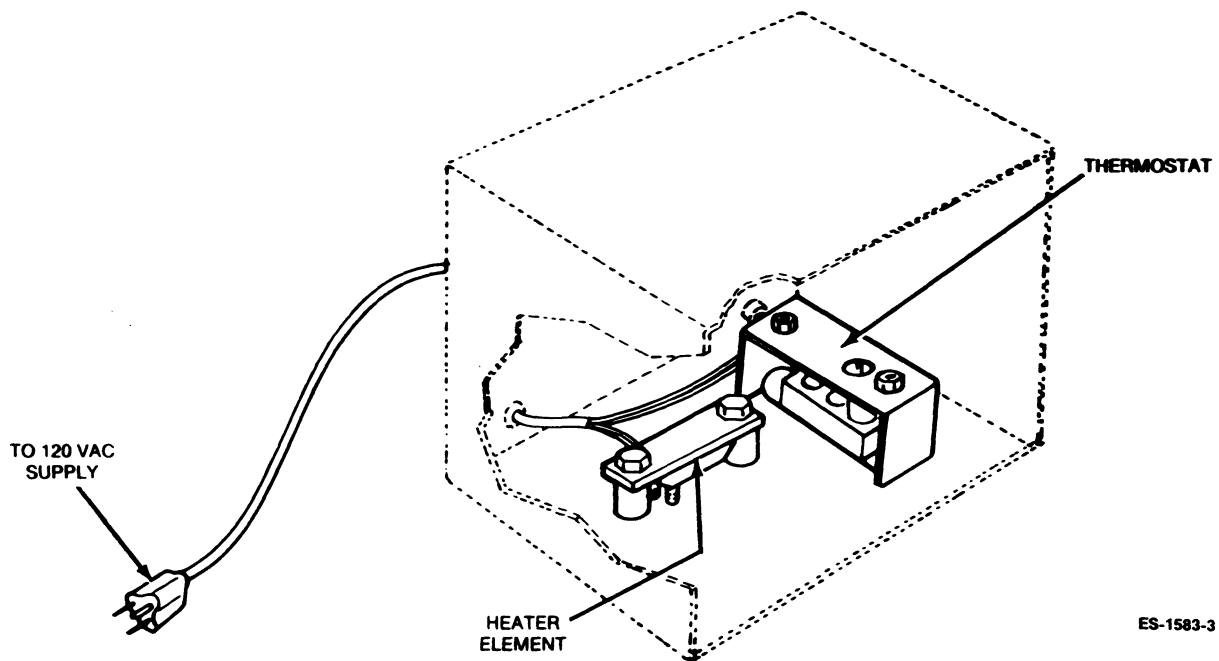
Provisions are made inside the control box for addition of optional remote starting and alarms. Connections are made on the terminal block (TB1) located on the engine monitor circuit board (A11). Connect one or more remote switches across remote terminal and B+ terminal (see Figure 5-4).

If the distance between the set and remote station is less than 1000 feet (305 m), use 18 gauge stranded copper wire. If the distance is 1000 to 2000 feet (305 to 610 m), use 16 gauge stranded copper wire. Always run control circuit wiring in a conduit separate from the AC power cables to avoid interference problems with the control.

Remote Monitor Connections

Connections can be made at terminal blocks TB1 and TB2 on the engine control monitor (A11) for remote monitoring of the set (Figure 5-4).

⚠ CAUTION *Do Not install DC control wiring in the same conduit as AC power wiring. AC currents can induce false signals in the DC wiring, causing shutdowns or erratic control.*



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FIGURE 5-3. CONTROL HEATER

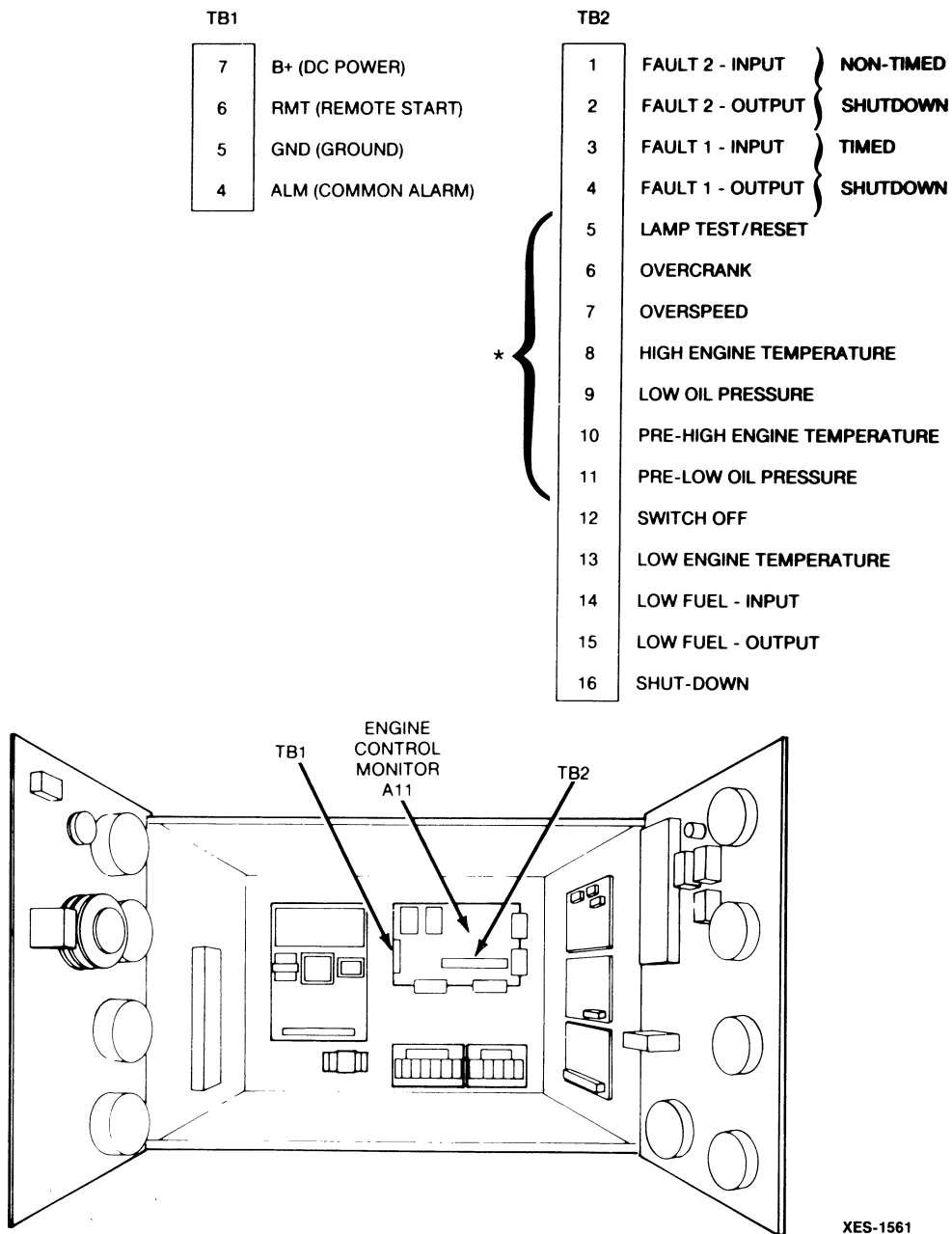


FIGURE 5-4. REMOTE CONTROL AND REMOTE CONTROL MONITOR CONNECTIONS

Battery Connections

Starting the unit requires 24-volt battery current. Use four 12-volt batteries for a normal installation (see Figure 5-15). Connect the batteries in series (negative post of first battery to positive post of second.) 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 discharge to the point where 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.*

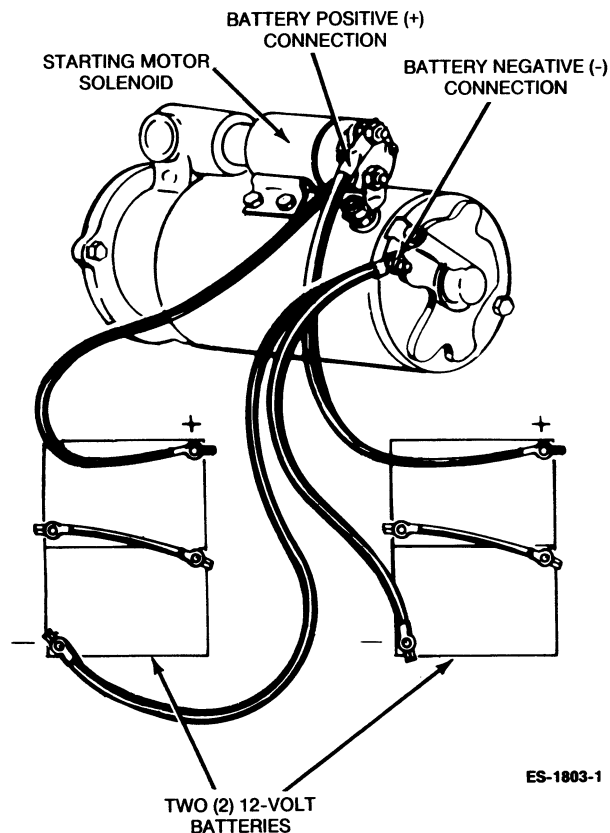


FIGURE 5-5. BATTERY CONNECTIONS

Section 6. Prestart Preparation

GENERAL

Before attempting the initial starting of the generator set, be sure it is serviced and ready for operation (see Figure 6-1). Perform the following:

- Check ventilation and exhaust systems
- Check all mechanical connections
- Fill the coolant, lubrication and fuel systems
- Prime the lubrication and fuel systems
- Check the fuel system for leaks
- Check the lubrication system for leaks

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, and all connections are tight.

MECHANICAL CHECK

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

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.

Load Connections

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

Battery Connections

Use four 12-volt batteries for a normal installation. Connect the negative (-) battery cable last to reduce the risk of arcing.

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

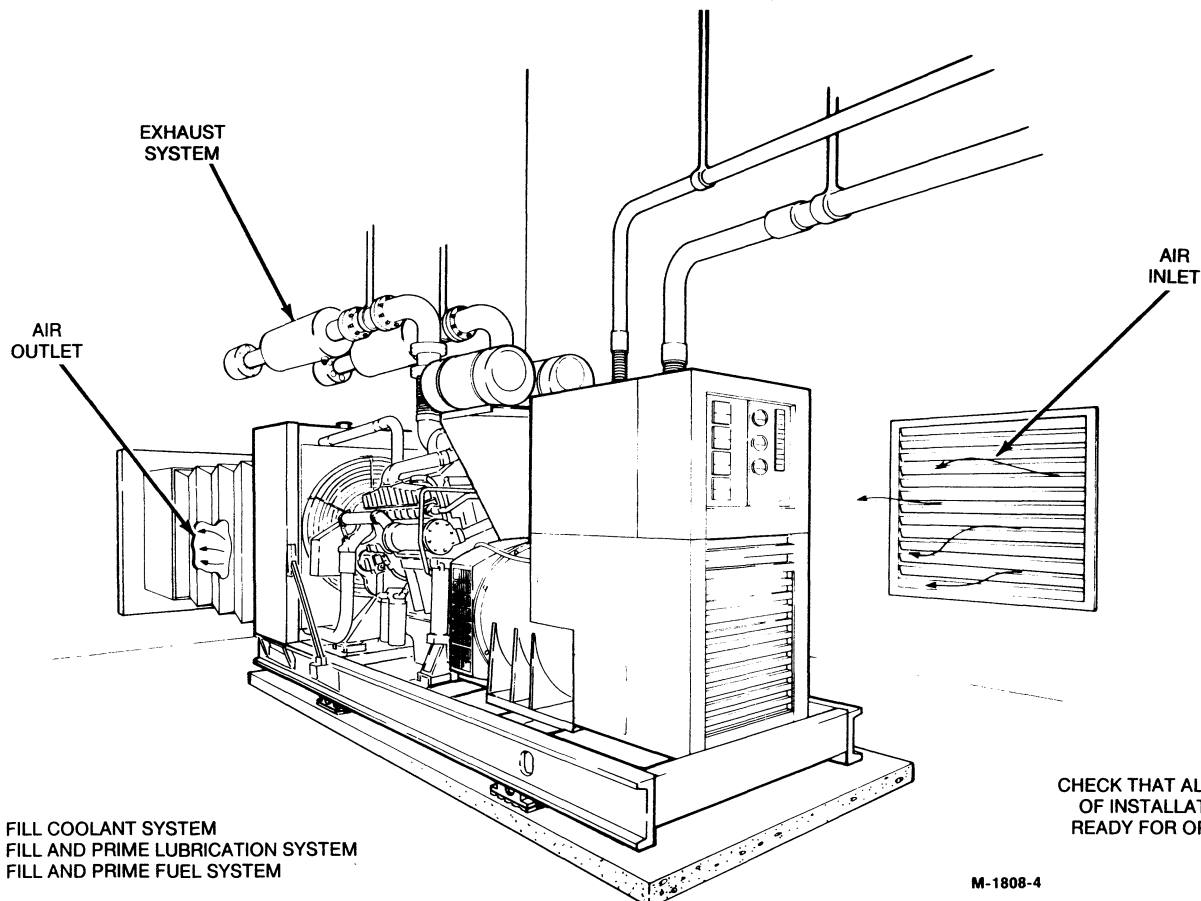


FIGURE 6-1. TYPICAL INSTALLATION

COOLANT

Engine coolant is drained prior to shipment. Before starting, fill the coolant system with the recommended coolant, refer to *Maintenance* section (Coolant instructions).

LUBRICATION

Engine lubrication is drained prior to shipment. Before starting, fill and prime the lubrication system with oil as follows: (see Figure 6-2).

1. Remove oil inlet line from turbocharger housing, fill bearing housing with clean engine lubricating oil; replace line, secure.
2. Fill crankcase to "L" (low) mark on dipstick (see Figure 6-3).
3. Remove plug from head of oil filter housing (see Figure 6-2) and connect a hand or motor-driven priming pump, equipped with pressure gauge, from a source of clean lubricating oil to the plug boss in filter housing.
4. Prime until a 30 psi (207 kPa) pressure is obtained.

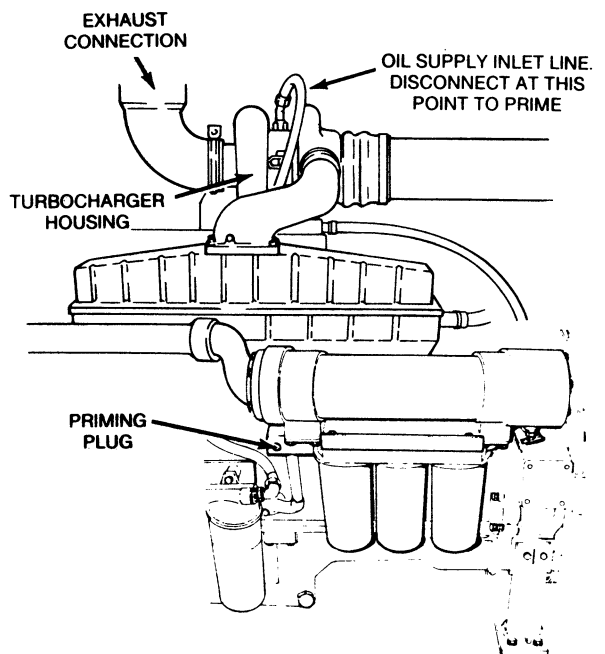


FIGURE 6-2. PRIMING TURBOCHARGER

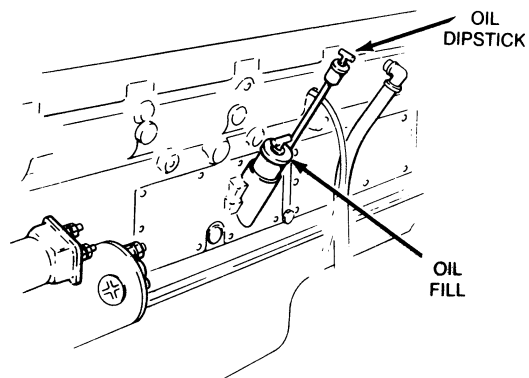


FIGURE 6-3. OIL FILL AND DIPSTICK LOCATION

5. Disconnect wire from fuel solenoid valve (see Figure 6-4).
6. On the Engine Control Panel, depress the Crank switch to crank engine, while maintaining an oil priming pressure of 15 psi (103 kPa), for 15 seconds at filter head priming port.
7. Stop engine cranking, remove external priming equipment, replace plug in filter housing and torque to 15 to 20 ft-lb (20 to 27 N•m).
8. Reconnect wire to fuel solenoid valve.
9. Complete oil fill to "H" (high) mark on dipstick.

FUEL SYSTEM

Engine fuel may not be primed at the fuel filters after shipment (see Figure 6-5). To verify and reprime the fuel system perform the following procedure:

1. Remove each fuel filter 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.

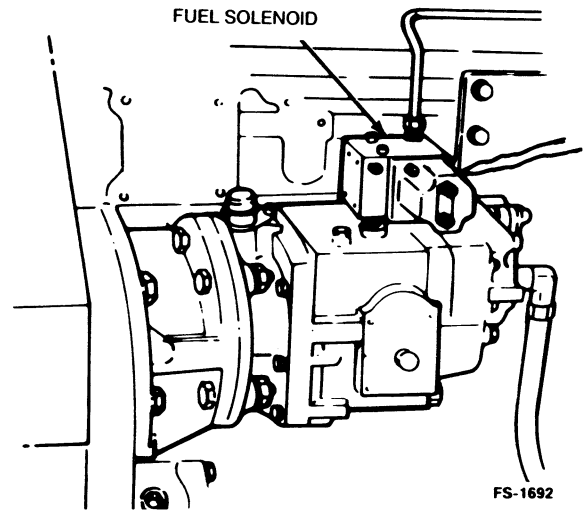


FIGURE 6-4. FUEL SOLENOID VALVE LOCATION

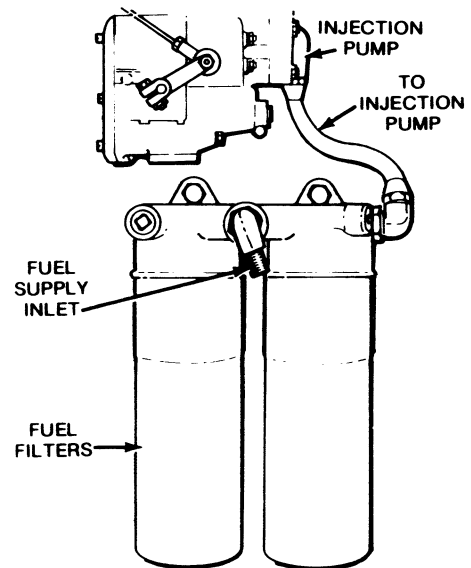


FIGURE 6-5. FUEL FILTERS

Section 7. Initial Start and Checks

GENERAL

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

Mechanical systems

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, have them corrected immediately.

DC Electrical System

With the generator set off, check the terminals on the batteries 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 cables last.

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

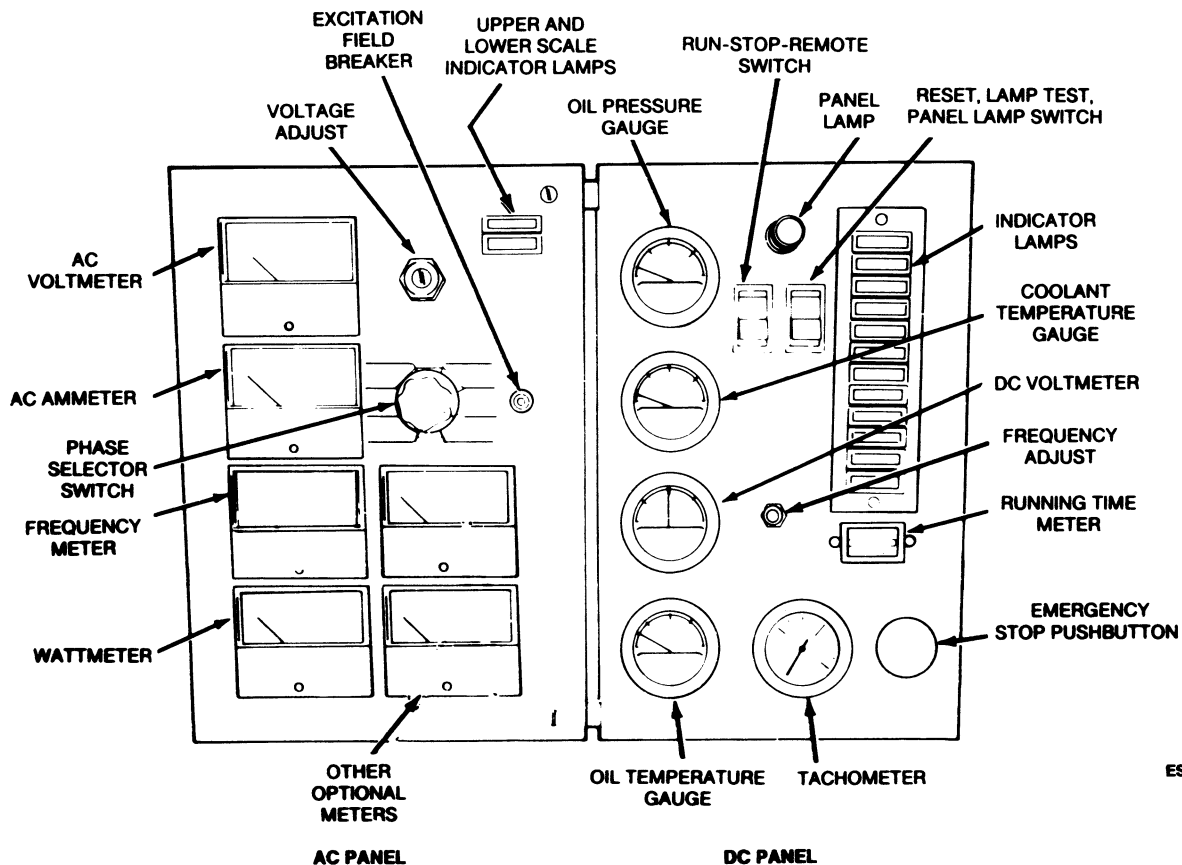
PRESTART CONTROL CHECKS

Perform the following control checks (see Figure 7-1):

- Confirm that Field Circuit Breaker is at Reset position.
- Place the Lamp Test/Reset/Panel Lamp switch at LAMP TEST. All indicator lamps will illuminate. Place the switch at PANEL LAMP.

STARTING

Place the Run/Stop/Remote switch at RUN. 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 if it starts, runs, and then stops, and a fault lamp lights, refer to *Troubleshooting* Section in the Operator's manual.



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FIGURE 7-1. CONTROL PANEL WITH OPTIONS

ENGINE GAUGES

Check the following while the generator set is operating (see Figure 7-1):

Oil Pressure Gauge

The oil pressure gauge should be in the range of 40 to 70 psi (275 to 483 kPa) when the engine is at operating temperature.

Water Temperature Gauge

The water temperature should be in the range of 165° to 220°F (74° to 104°C) depending on the load and ambient temperature.

Battery Gauge (DC Voltmeter)

This is a voltage reference gauge, indicating condition of the batteries and also of battery charging circuit. Gauge should read approximately 24 to 28 volts while set is running. If reading is high or low, check batteries and the battery charger circuit.

AC CHECKS

Frequency Checks

The generator frequency is a result of engine speed, which is automatically controlled. The generator frequency meter should be stable and the reading should be the same as the nameplate rating (50 or 60 Hz). See Figure 7-1.

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.

⚠ WARNING *Shut down the set immediately if the AC output ammeter indicates current when all loads are supposed to be disconnected. Determine the cause and make necessary repairs or reconnections before placing the set in service.*

AC Voltage Check

Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2, L2-L3, and L3-L1). Read the AC voltmeter (using the upper or lower voltage scale as indicated by the scale indicator light). At full-load, the line-to-line voltage should be the same as the set nameplate rating. Adjust the Voltage Adjust rheostat on the control panel as necessary to set voltage.

On generator sets without AC meters, use a remote voltmeter to verify generator set voltages.

EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system including exhaust manifolds, mufflers, turbochargers and exhaust pipes. 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. Shut the generator set down and have any leaks repaired immediately.*

FUEL SYSTEM

With the generator set operating, inspect the fuel supply lines, filters, and fitting 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. If any leaks are detected, shut the generator set down and have any leaks repaired immediately.*

MECHANICAL CHECKS

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.

STOPPING

Stop the generator set by moving the Run/Stop/Remote switch to STOP. Refer to *Operation* Section of the Operator's manual to properly reset the controls for Manual, Remote, or Automatic starting.

BREAK-IN PROCEDURE

Make a special entry in unit log book to drain and replace the crankcase oil after the first 50 hours of operation on new generator sets. Use Running Time Meter (see Figure 7-1.) Refer to the *Maintenance* section of Operator's manual for maintenance schedule.



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