



Installation Manual

DFEB

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GENERATOR SETS



Important Safety Precautions

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

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

FUEL, ENGINE OIL, AND FUMES ARE FLAMMABLE AND TOXIC

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

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

EXHAUST GAS IS DEADLY

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

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

Make sure exhaust is properly ventilated.

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

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

BATTERY GAS IS EXPLOSIVE

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

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

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

HOT COOLANT CAN CAUSE SEVERE PERSONAL INJURY

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

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

If the cabinet must be opened for any reason:

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

MEDIUM VOLTAGE GENERATOR SETS (601V TO 15kV)

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

GENERAL SAFETY PRECAUTIONS

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

KEEP THIS DOCUMENT NEAR EQUIPMENT FOR EASY REFERENCE.

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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, explosion, and personal injury or death 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, arcing equipment, 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 away from enclosed or sheltered areas and areas where individuals are likely to congregate. Visually and audibly inspect the exhaust daily for leaks per the maintenance schedule. Ensure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.

MOVING PARTS CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

- Keep your hands, clothing, and jewelry away from moving parts.
- Before starting work on the generator set, disconnect starting batteries, negative (-) cable first. This will prevent accidental starting.
- Make sure that fasteners on the generator set are secure. Tighten supports and clamps, keep guards in position over fans, drive belts, etc.
- Do not wear loose clothing or jewelry in the vicinity of moving parts, or while working on electrical equipment. Loose clothing and jewelry can become caught in moving parts. Jewelry can short out electrical contacts and cause shock or burning.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

ELECTRICAL SHOCK CAN CAUSE SEVERE PERSONAL INJURY OR DEATH

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

GENERAL SAFETY PRECAUTIONS

- Coolants under pressure have a higher boiling point than water. DO NOT open a radiator or heat exchanger pressure cap while the engine is running. Allow the generator set to cool and bleed the system pressure first.
- Benzene and lead, found in some gasoline, have been identified by some state and federal agencies as causing cancer or reproductive toxicity. When checking, draining or adding gasoline, take care not to ingest, breathe the fumes, or contact gasoline.

- Used engine oils have been identified by some state or federal agencies as causing cancer or reproductive toxicity. When checking or changing engine oil, take care not to ingest, breathe the fumes, or contact used oil.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of extinguisher to use. Do not use foam on electrical fires. Use extinguishers rated ABC by NFPA.
- Make sure that rags are not left on or near the engine.
- Remove all unnecessary grease and oil from the unit. Accumulated grease and oil can cause overheating and engine damage which present a potential fire hazard.
- Keep the generator set and the surrounding area clean and free from obstructions. Remove any debris from the set and keep the floor clean and dry.
- Do not work on this equipment when mentally or physically fatigued, or after consuming any alcohol or drug that makes the operation of equipment unsafe.

IMPORTANT

DEPENDING ON YOUR LOCATION AND INTENDED USE, FEDERAL, STATE OR LOCAL LAWS AND REGULATIONS MAY REQUIRE YOU TO OBTAIN AN AIR QUALITY EMISSIONS PERMIT BEFORE BEGINNING INSTALLATION OF YOUR GENSET. BE SURE TO CONSULT LOCAL POLLUTION CONTROL OR AIR QUALITY AUTHORITIES BEFORE COMPLETING YOUR CONSTRUCTION PLANS.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

Section 1. Introduction

GENERAL

This manual provides installation instructions for the DF and KT 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 normally requires qualified electricians, plumbers and sheet metal workers to properly complete the various segments of the installation.

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.

⚠ 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

TABLE 2-1. GENERATOR SET INSTALLATION SPECIFICATIONS

SYSTEMS	400 DFEB	450 DFEC	500 DFFB
Engine Cummins Model	KTA19-G2	KTA19-G3	KTTA19-G2
Coolant Capacity Engine and Radiator	96 Qt. (91 L)	96 Qt. (91 L)	96 QT (91 L)
Oil Capacity	48 Qt. (45 L)	48 Qt. (45 L)	48 Qt. (45 L)
Fuel Pump Inlet Thread Size Outlet Thread Size Maximum Lift	7/8-14 UNF 3/4-16 UNF 6 ft (1.8 m)	7/8-14 UNF 3/4-16 UNF 6 ft (1.8 m)	7/8-14 UNF 3/4-16 UNF 6 ft (1.8 m)
Exhaust Outlet Size Maximum Allowable Exhaust Back Pressure	5 in NPT 40.8 in. H ₂ O (10.2 kPa)	5 in NPT 40.8 in. H ₂ O (10.2 kPa)	5 in NPT 40.8 in H ₂ O (10.2 kPa)
Starting System Voltage	24	24	24
Battery Requirements Battery Cold Cranking Amps	Two, 12V Group 8D 975	Two, 12V Group 8D 975	Two, 12V Group 8D 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.

Wood floors should be covered with sheet metal extending 12 inches (305 mm) beyond the extremities of the set.

Provide a location away from extreme ambient temperatures. Protect the generator set from adverse weather conditions, and unauthorized personnel.

MOUNTING

Generator sets are mounted on a steel subbase that provides proper support. For critical installations, install vibration isolators between the subbase and the foundation.

Mount the generator set on a substantial and level base such as a concrete pad. For typical installations, use 3/4 inch anchored mounting bolts to secure the generator set subbase to the floor to prevent movement. Secure the subbase/vibration isolators using flat or bevel washer and hexagonal nut for each bolt (see Figure 3-1). For proper spacing of mounting bolts and set mounting dimensions, see your generator set outline drawing.

ACCESS TO SET

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

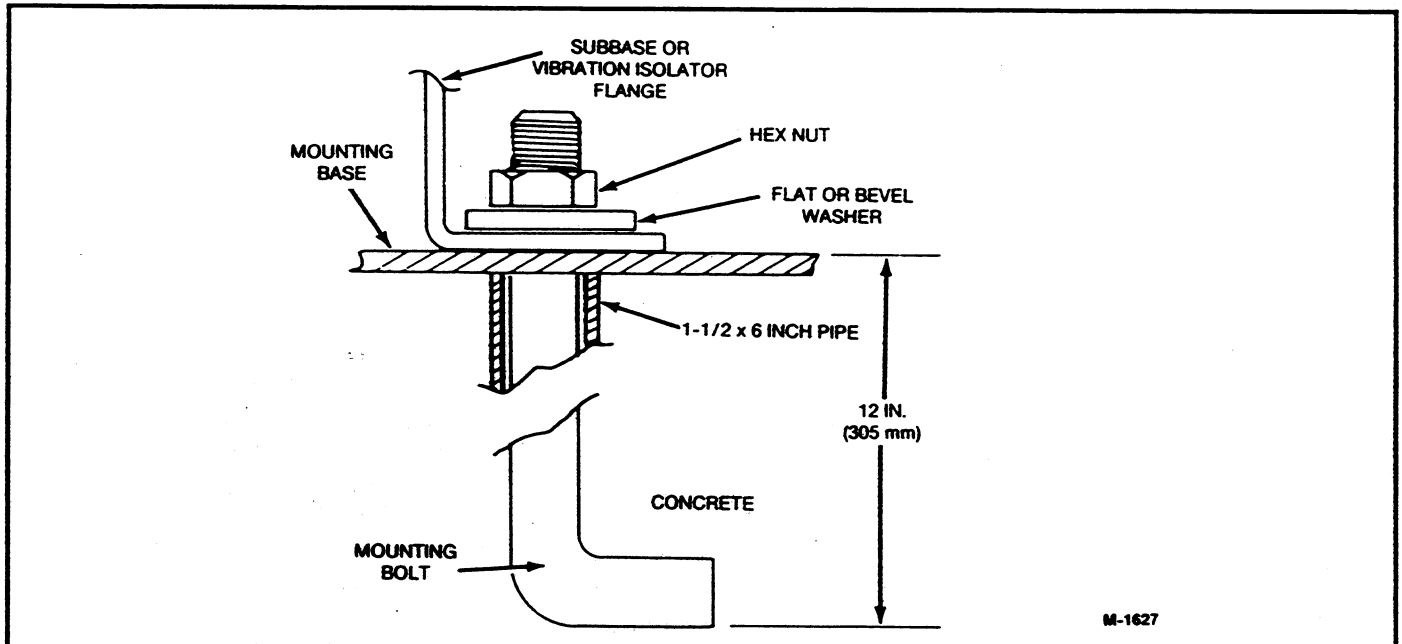
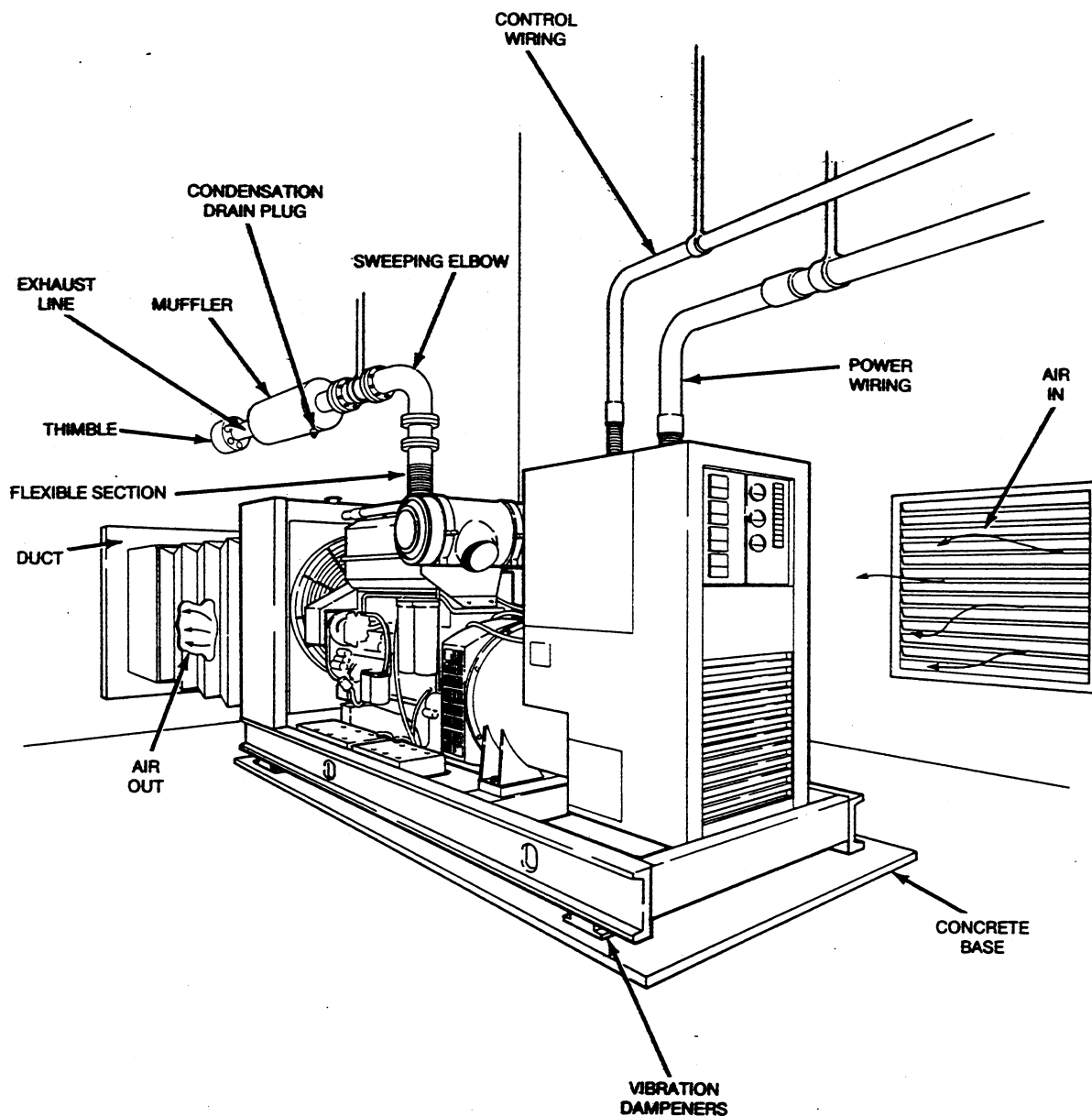


FIGURE 3-1. TYPICAL ANCHOR BOLT DIAGRAM



M-1808-2

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
 LOUVERS.

FIGURE 3-2. TYPICAL INSTALLATION

VIBRATION ISOLATORS

Installation and Adjustment Procedure

1. Place the isolators on the genset support structure. The isolators should be shimmed or grouted to ensure that all of the isolator bases are within 0.25 inch (6 mm) elevation of each other. The surface on which the isolator bases rest on must also be flat.
2. Loosen the side snubber lock nuts so that the top plate of the isolator is free to move vertically and horizontally. Be sure that the top plate is correctly aligned with the base and springs.
3. Place the genset onto the isolators while aligning the skid's mounting with the threaded isolator hole. The top plates will move down and approach the base of the isolator as load is applied.
4. Once the genset is in position, the isolators may require adjusting so that the set is level. The isolators are adjusted by inserting the leveling bolt through

the skid and into the isolator (the leveling bolt's locking nut should be threaded up towards the bolt head).

The leveling bolt will adjust the clearance between the top plate and the isolator base. A nominal clearance of 0.25 inch (6 mm) or greater is desired. This will provide sufficient clearance for the rocking that occurs during startup and shutdown. If the 0.25 inch (6 mm) clearance is not present, turn the leveling bolt until the desired clearance is achieved.

5. The genset may not be level yet, therefore adjust the leveling bolts until the set is level and sufficient clearance still remains. Once all isolators have been set, then lock the leveling bolt in place with the lock nut.
6. The snubber nuts may remain loose and therefore provide better isolation between the genset and support structure.

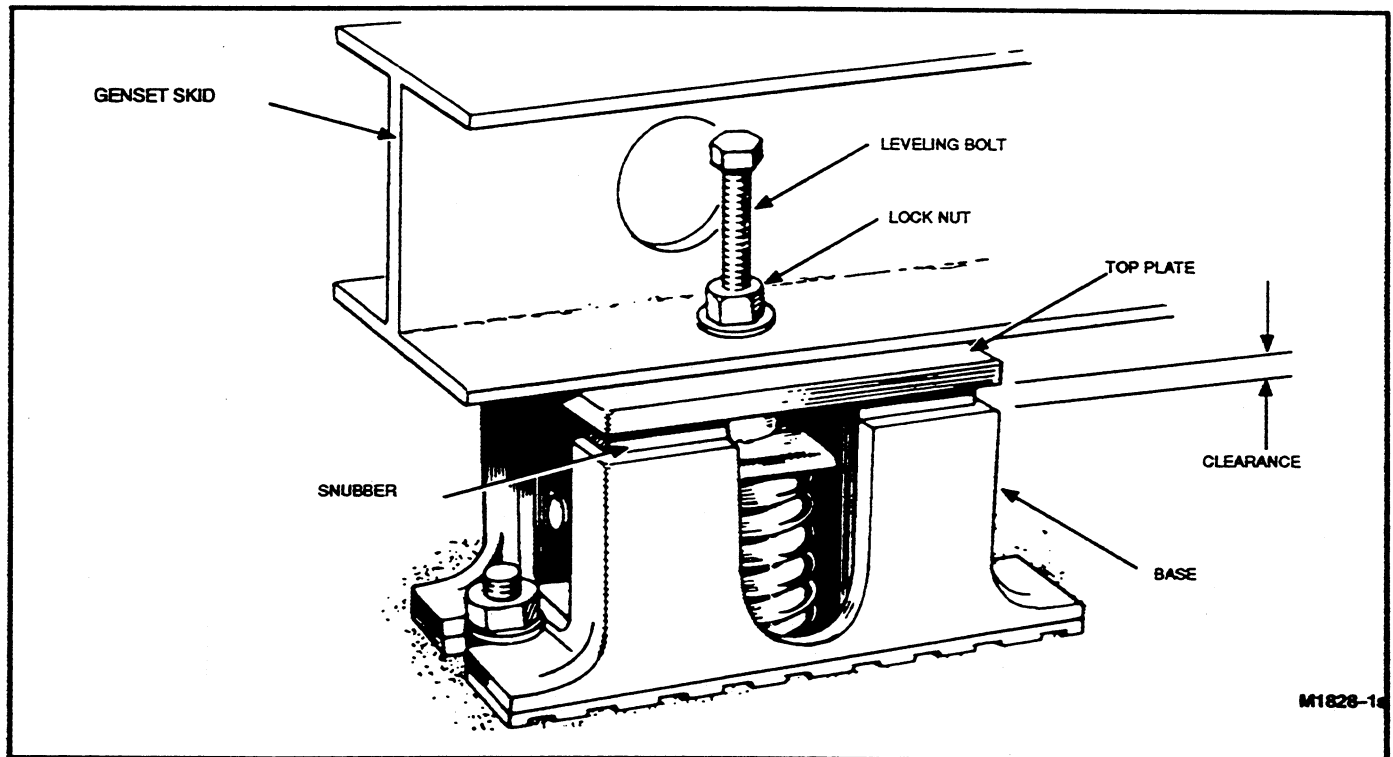


FIGURE 3-3. VIBRATION ISOLATORS

⚠ 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.*

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 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 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 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, 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 other refractory insulation system, where exhaust pipes pass through walls or partitions (see Figure 4-2). Refer to the National Fire Protection Association Bulletin, Volume 4, section 211 covering Standards for Chimneys, Fireplaces and Vents for suggested code requirements. Build according to all applicable code requirements in effect at the installation site.

⚠ 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 a section of flexible exhaust pipe between engine and remainder of exhaust system. Support exhaust system to minimize weight applied to engine exhaust outlet elbow/turbocharger connection.

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

Avoid sharp bends by using sweeping, long radius elbows and provide adequate support for muffler, 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 4-3).

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 are very hot and they can cause severe personal injury or death from direct contact or from fire hazard. Shield or insulate exhaust pipes if there is danger of personal contact or when routed through walls or near other combustible materials.*

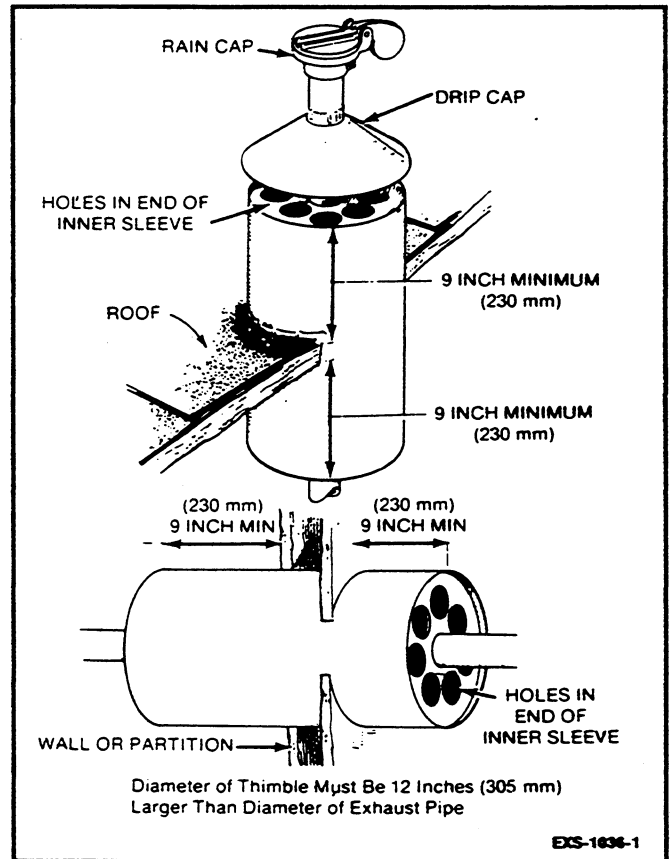


FIGURE 4-2. MOUNTING EXHAUST THIMBLE THROUGH ROOF OR WALL

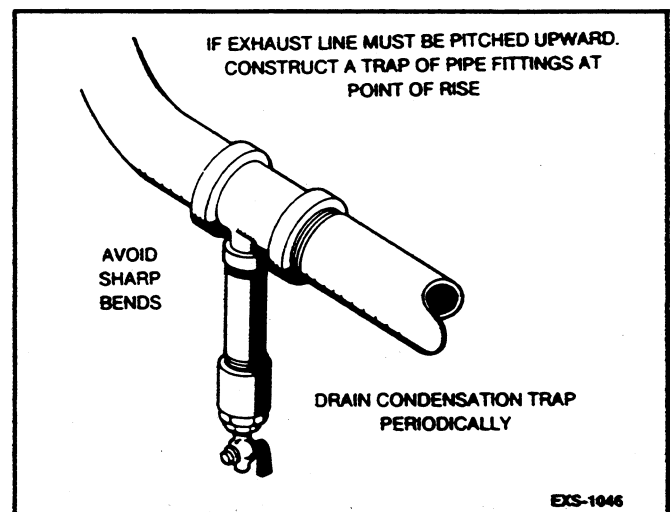


FIGURE 4-3. EXHAUST CONDENSATION TRAP

VENTILATION SYSTEM

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

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 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. Dampers must be open when engine 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.

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 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 rise in the room of 200°F to 300°F (110°C to 170°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.

Standard Radiator Cooling

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)

Remote radiators can be located a horizontal or vertical distance from the generator set. The horizontal distance is limited by the capability of the engine driven water pump and the maximum external friction head pressure. The vertical distance is limited to the maximum static head pressure that can be imposed on coolant system gaskets and seals without leakage of coolant from coolant system components. The friction and static head pressures of each generator set are included in their Product Data Sheets.

The two key design considerations in a remote radiator installation are the vertical distance (X) from the engine centerline to the radiator top and the horizontal distance (Y) from the engine front to the radiator centerline (see Figure 4-4). These distances determine if any additional equipment is required such as a surge tank, auxiliary pump, or hot well. Due to the many design considerations, all remote radiator installations must be engineered to be sure the complete system functions 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 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 do not mix.

This system can reduce set enclosure airflow requirements and 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. Make connections to the set with flexible pipe to absorb 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.

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.

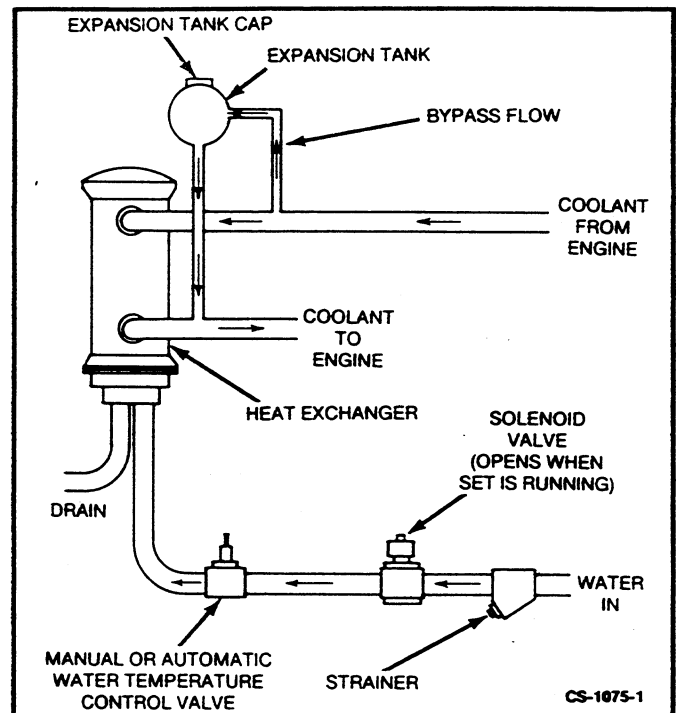


FIGURE 4-5. TYPICAL HEAT EXCHANGER

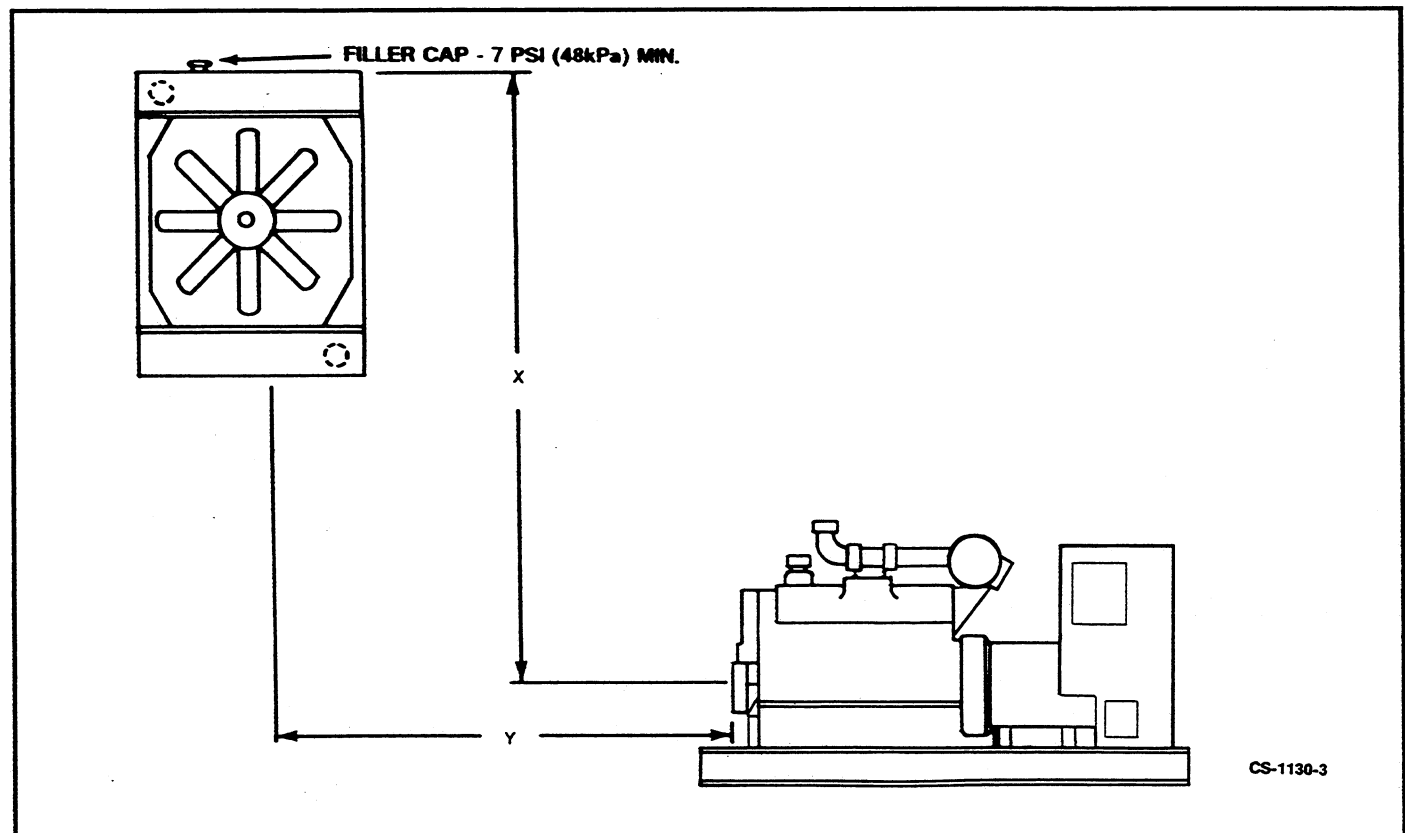


FIGURE 4-4. REMOTE RADIATOR INSTALLATION

Coolant Filter

One spin-on type corrosion filter (Figure 4-6) is standard equipment. This precharge filter is compatible with plain water and all ethylene glycol base permanent anti-freeze 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.

Coolant Heater

A coolant heater 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.

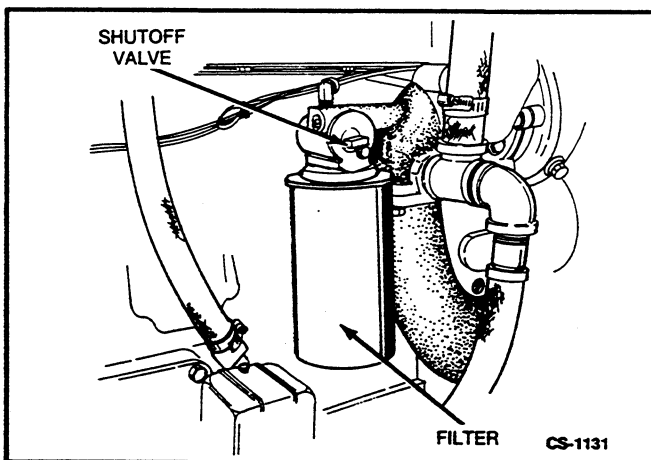


FIGURE 4-6. TYPICAL COOLANT FILTER

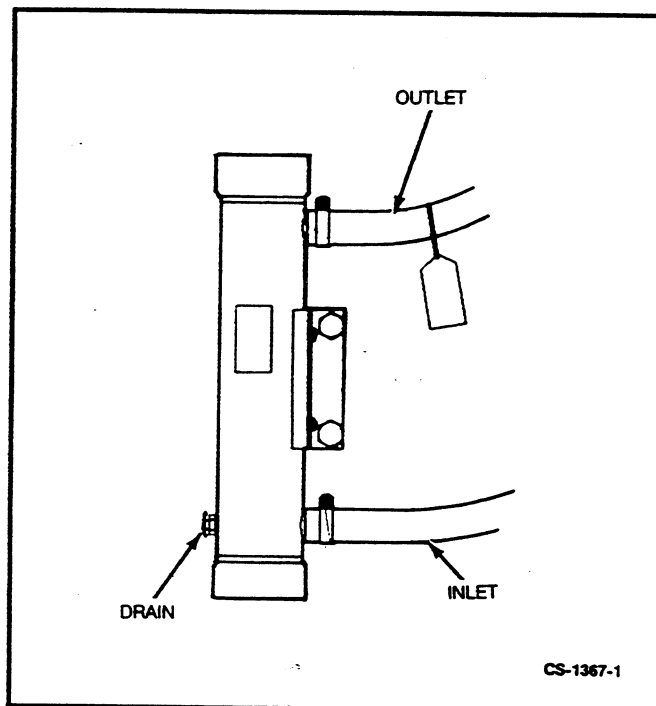


FIGURE 4-7. TYPICAL COOLANT HEATER

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.

AC WIRING

Generator Voltage Connections

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

These generators can be configured for the voltages shown in the Reconnection Diagram (see Figure 5-2). Most of these generators must be reconnected by the installer to give the voltage required for the installation. Before shipping, the factory tests the generator set output by connecting the generator to produce a particular test voltage. The generators may be connected at the factory to produce a specified voltage per customer order. The installer must always check the stator lead connections and perform any necessary reconnect to obtain the voltage desired.

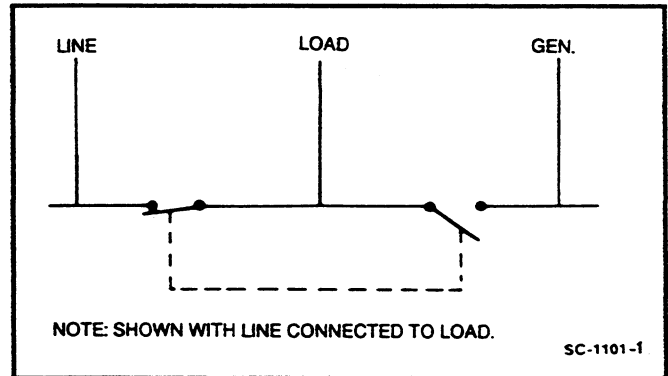


FIGURE 5-1. TYPICAL LOAD TRANSFER SWITCH

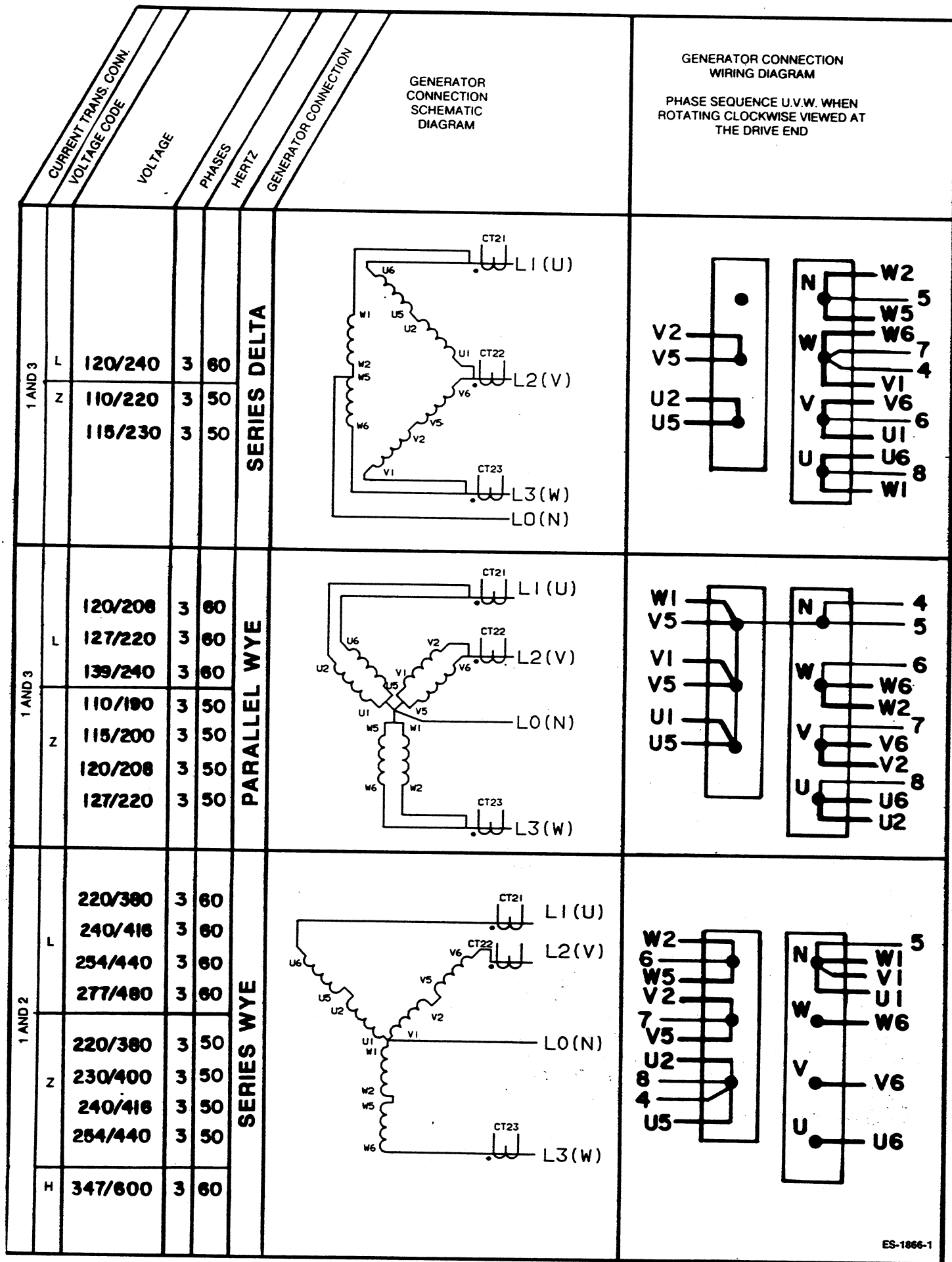


FIGURE 5-2. RECONNECTION DIAGRAM

⚠ CAUTION *Reconnecting factory connected generator set to lower voltages may reduce set ratings, and also cause line circuit breakers to be too small. Consult with your distributor before performing reconnection for different voltage.*

All loads are connected to the generator by bolting the load wires to the appropriate terminals on the generator terminal block (see Figure 5-3). 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 for three phase connections: and N with LO, respectively.)

When installing sets with the optional AC ammeter, the customer load connections must be routed through the current transformers for proper meter operation (see Figure 5-3). The current transformers are identified as CT1, CT2, and CT3 on the wiring diagrams and electrical schematics. Refer to the Reconnection Diagram to identify appropriate transformer post selection for meter lead harness connection. Use cable ties to secure the loose transformer to the generator output leads.

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 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.

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.

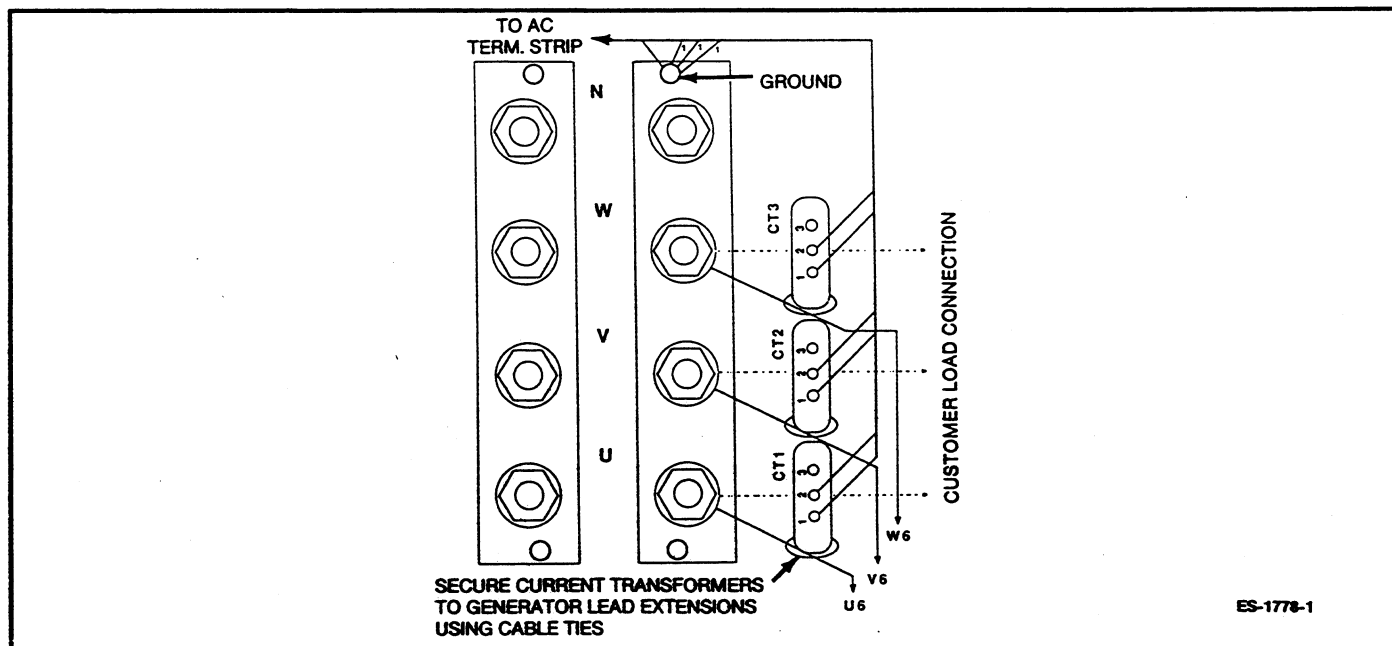


FIGURE 5-3. TYPICAL CURRENT TRANSFORMER CONNECTIONS

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 5-4). 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 5-5).

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

Provisions are made inside the control box for addition of optional remote monitoring on these generator sets employing the optional 12-light Control (NFPA 110). Connections are made on the terminal block (TB2) located on the engine monitor circuit board (A11).

⚠ CAUTION

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

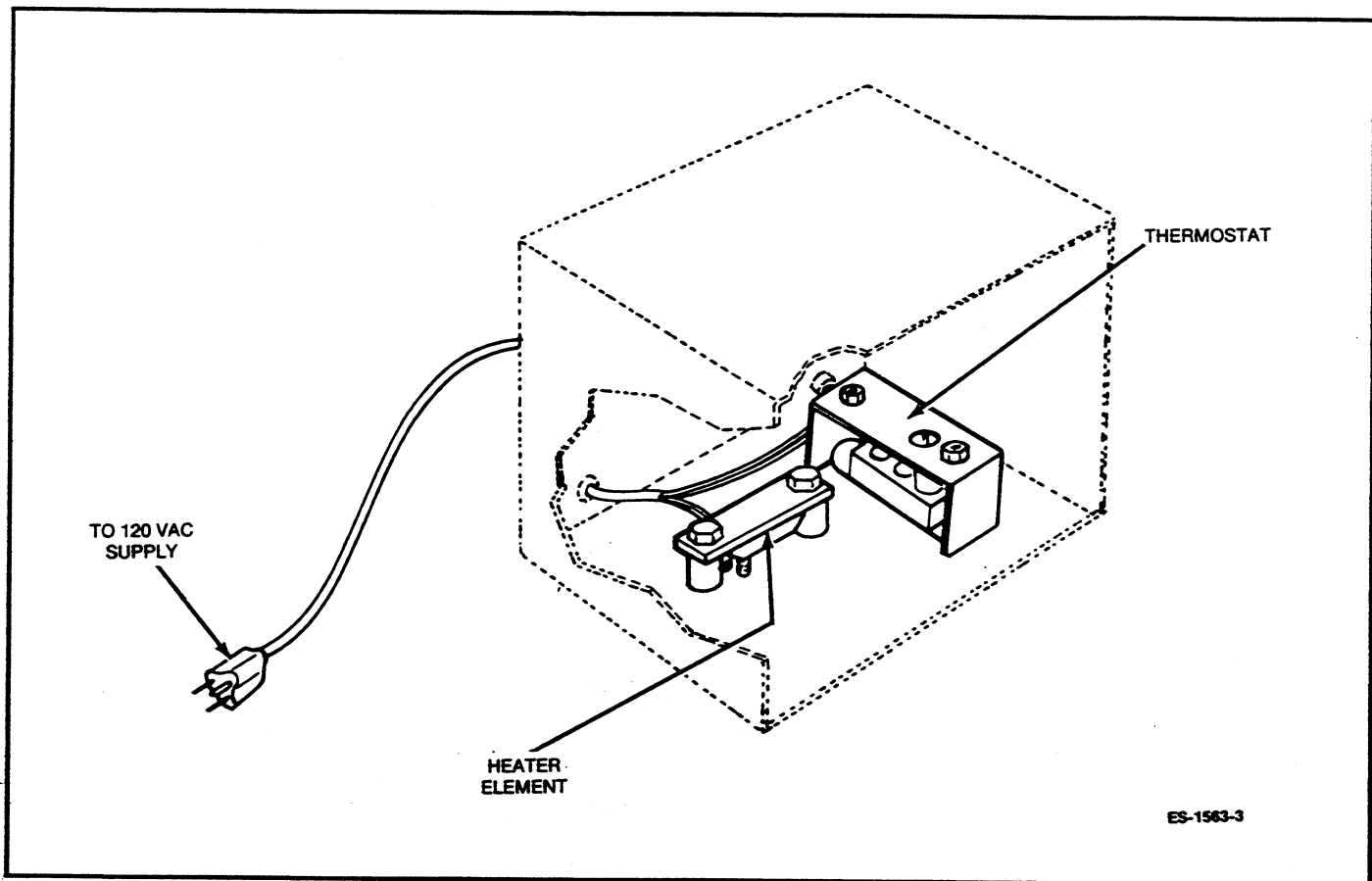


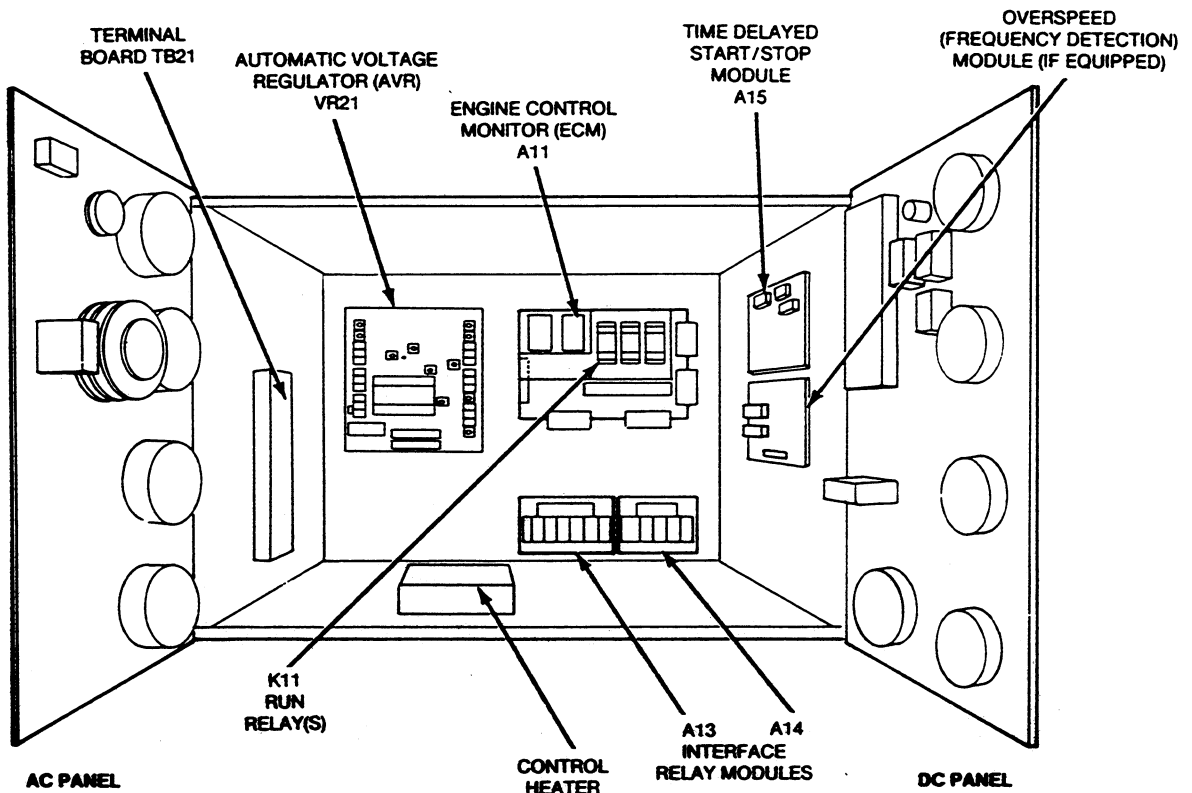
FIGURE 5-4. CONTROL HEATER

TB1

7	B+ (DC POWER)
6	RMT (REMOTE START)
5	GND (GROUND)
4	ALM (COMMON ALARM)

TB2

1	FAULT 2 - INPUT	NON-TIMED
2	FAULT 2 - OUTPUT	
3	FAULT 1 - INPUT	TIMED
4	FAULT 1 - OUTPUT	
5	LAMP TEST/RESET	SHUTDOWN
6	OVERCRANK	
7	OVERSPEED	
8	HIGH ENGINE TEMPERATURE	
9	LOW OIL PRESSURE	
10	PRE-HIGH ENGINE TEMPERATURE	
11	PRE-LOW OIL PRESSURE	
12	SWITCH OFF	
13	LOW ENGINE TEMPERATURE	
14	LOW FUEL - INPUT	
15	LOW FUEL - OUTPUT	
16	SHUT-DOWN	



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

Battery Connections

Starting the unit requires 24-volt battery current. Use two 12-volt (see *Specification* section) batteries for normal installation. Connect the batteries in series (negative post of the first battery to the positive post of the second battery) as shown on Figure 5-6. A battery rack and battery cables are included. Increase the cable size if batteries are located remotely from the generator set. Service the batteries as necessary. Infrequent use (as in emergency standby service) can allow the batteries to discharge to the point where they will not start the generator set. If an automatic transfer switch is not used or is installed without a built-in charge circuit, connect a float charger to the batteries to avoid 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.*

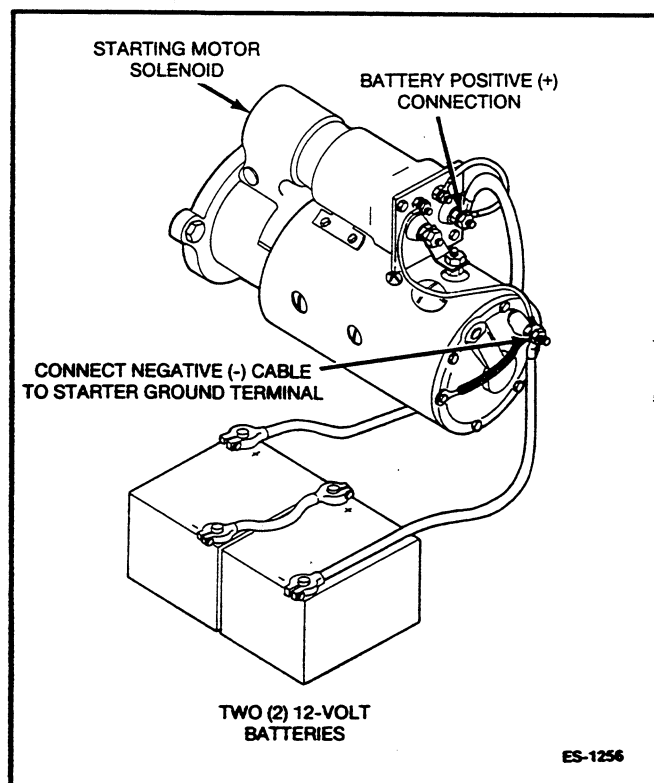


FIGURE 5-6. BATTERY CONNECTIONS

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 two 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.

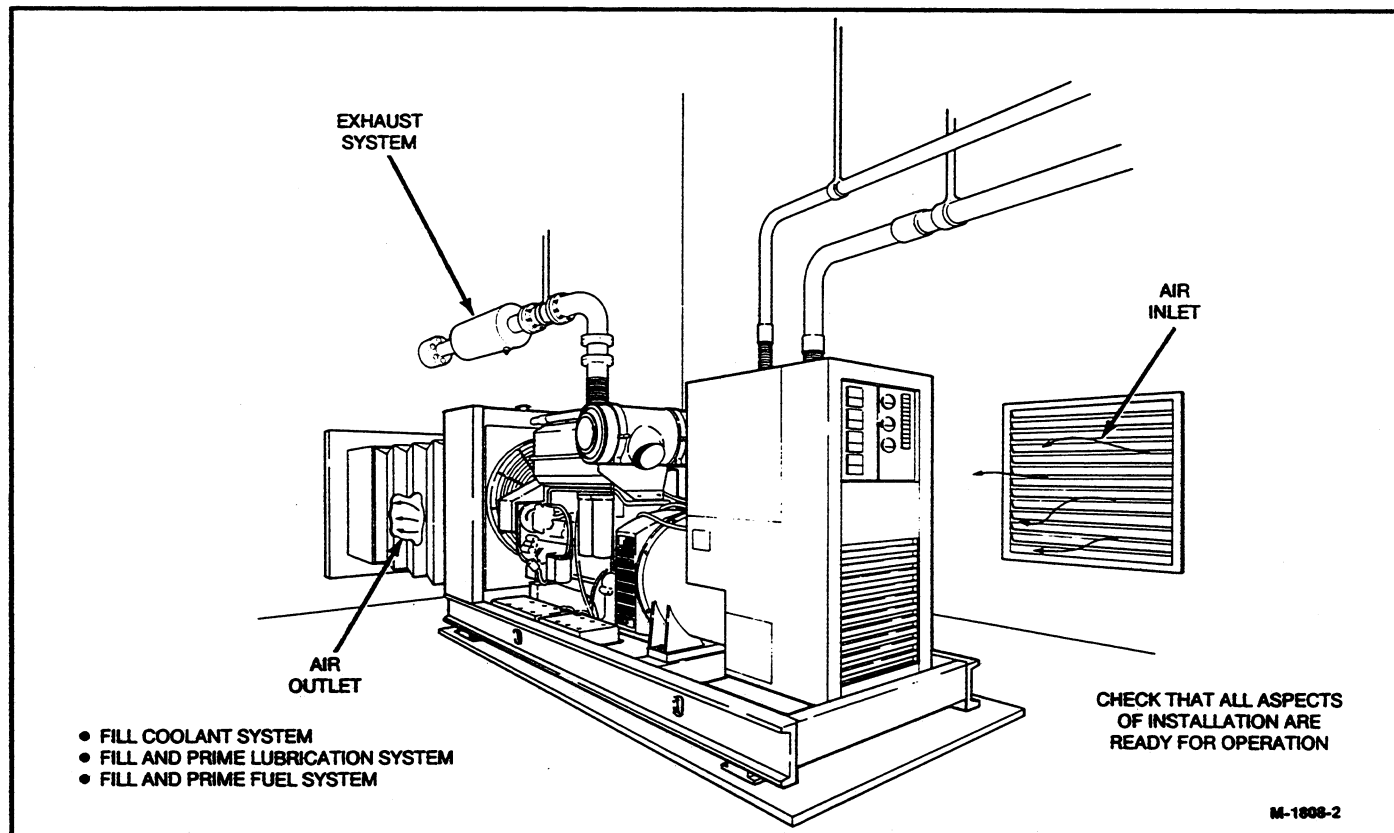


FIGURE 6-1. TYPICAL INSTALLATION

COOLANT

Engine coolant is drained prior to shipment. Before starting, fill the cooling system with the recommended coolant. See Operator's manual *Maintenance* section for more information.

LUBRICATION

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

1. Remove oil inlet line from turbocharger housing (Figure 6-2), fill bearing housing with clean engine lubricating oil; replace line and secure.
2. Fill crankcase to "L" (low) mark on dipstick (see Figure 6-3) and refer to *Maintenance* section in Operator's manual for oil recommendations.
3. Remove plug from head of oil filter housing. Connect a hand or motor driven priming pump, equipped with pressure gauge, from a source of clean lubricating oil to the plug boss in the filter housing.
4. Prime until a 30 psi (207 kPa) pressure is obtained.
5. Disconnect wire from fuel solenoid valve (see Figure 6-4).
6. On the engine control panel, depress the RUN switch to crank the 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, reinstall 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.

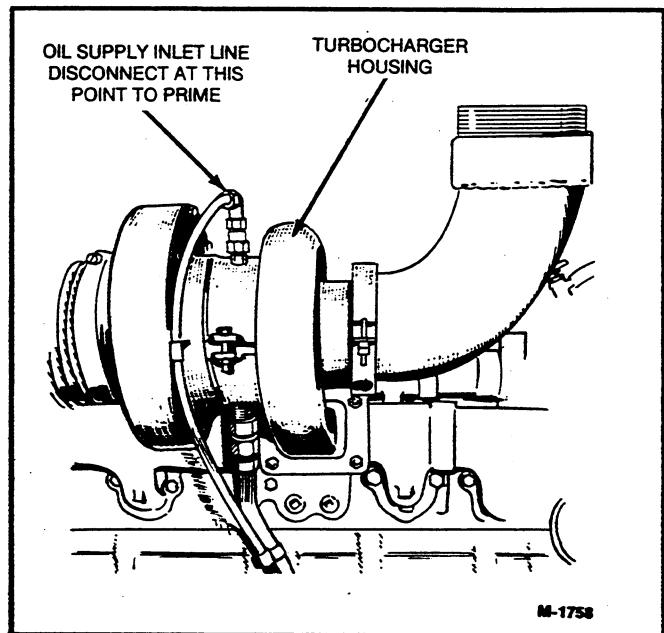


FIGURE 6-2. PRIMING TURBOCHARGER

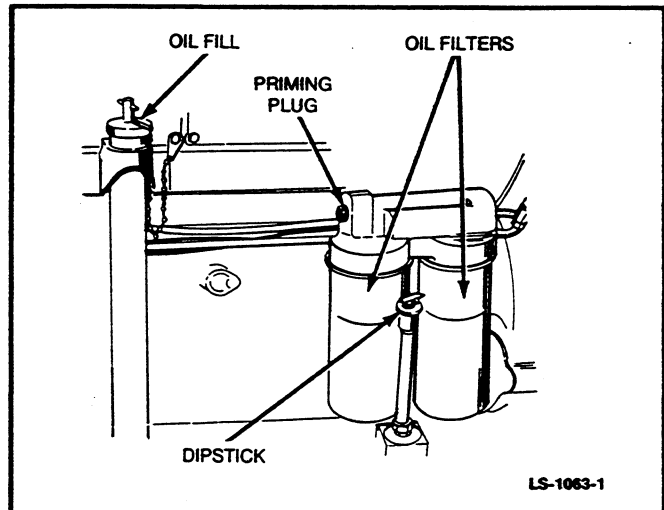


FIGURE 6-3. OIL DIPSTICK LOCATION

FUEL

Fill the fuel tanks with the recommended fuel. 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 and fill with clean fuel (see Figure 6-5).

⚠ CAUTION

Due to the precise tolerances of diesel injection systems, it is extremely important the fuel be kept clean and free of water. Dirt or water in the system can cause severe damage to both the injection pump and the injection nozzles.

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 turn.

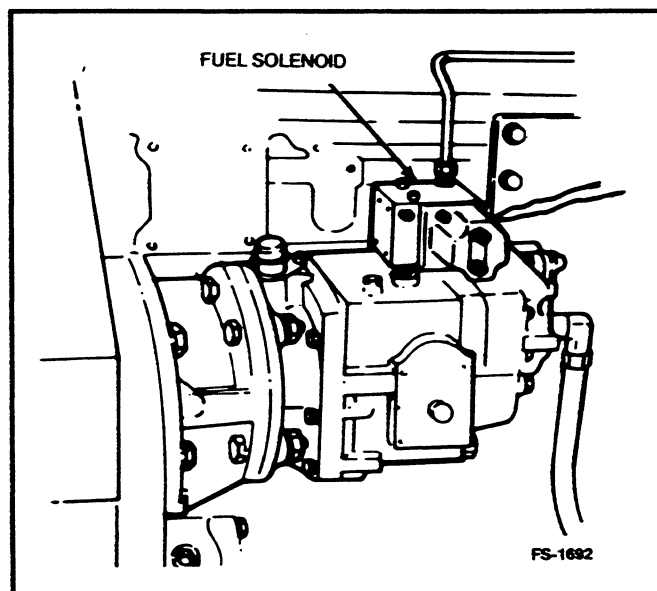


FIGURE 6-4. FUEL SOLENOID VALVE LOCATION

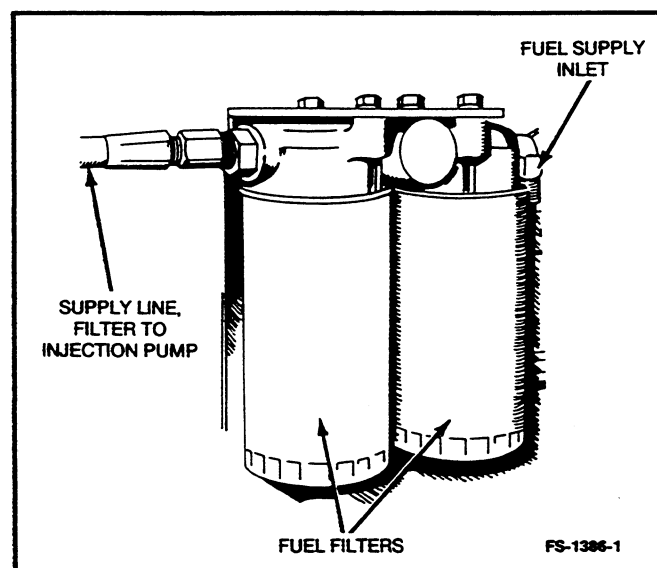


FIGURE 6-5. FUEL FILTERS

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 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.

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.

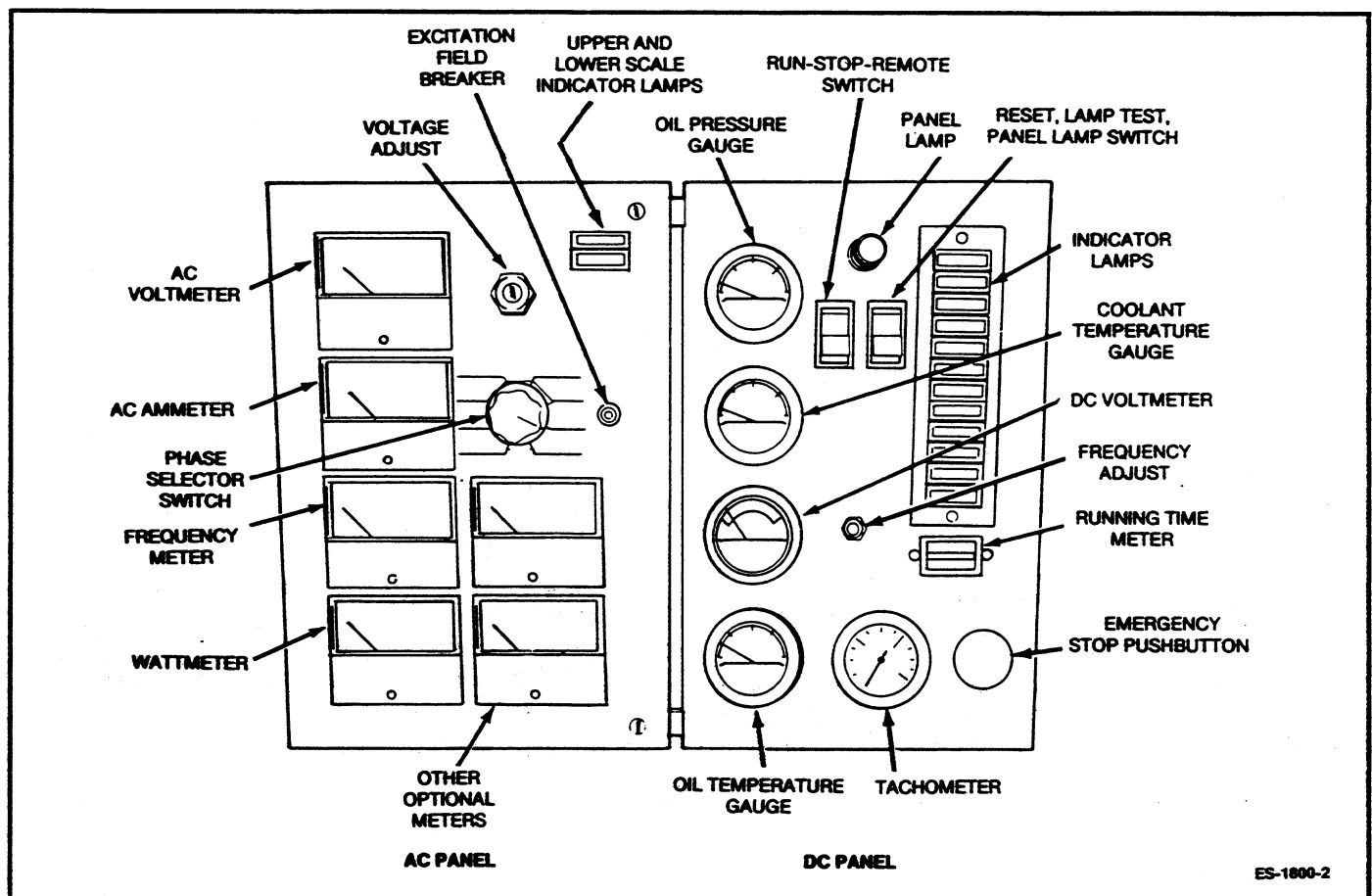


FIGURE 7-1. CONTROL PANEL WITH OPTIONS

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 60 psi (275 to 414 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.

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 *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 the generator set.*

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

⚠ WARNING *Inhalation of exhaust gases can result in severe personal injury or death. Inspect exhaust system audibly and visually for leaks daily. 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 or explosion 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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