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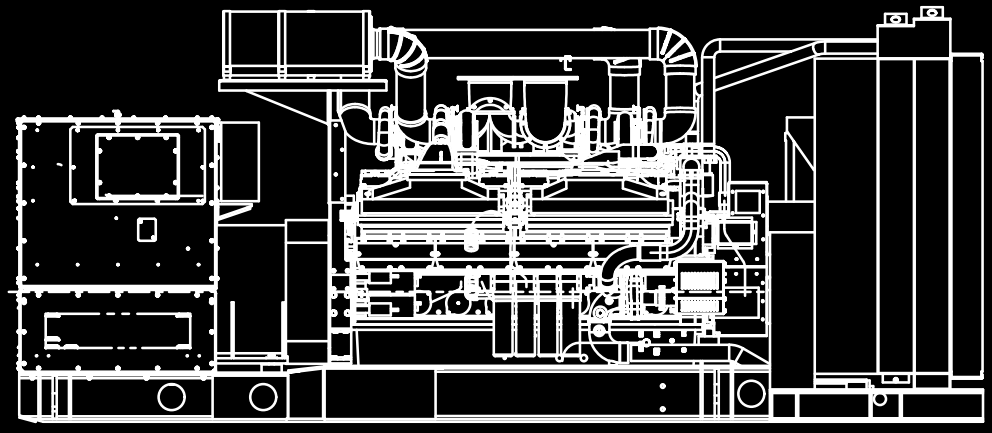
Power Generation

Installation Manual

PowerCommand® Control
3200 Series
Generator Sets



Models
DQKB, DQKC

Printed in U.S.A.

960-0625B 12-2001

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California

Proposition 65 Warning

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS – This manual contains important instructions that should be followed during installation and maintenance of the generator and batteries.

Before operating the generator set (genset), 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 zinc coated or copper fuel lines with diesel fuel.
- Be sure all fuel supplies have a positive shutoff valve.
- Be sure battery area has been well-ventilated prior to servicing near it. Lead-acid batteries emit a highly explosive hydrogen gas that can be ignited by arcing, sparking, smoking, etc.

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. Make sure that exhaust manifolds are secured and not warped. Do not use exhaust gases to heat a compartment.
- Be sure the unit is well ventilated.
- Engine exhaust and some of its constituents are known to the state of California to cause cancer, birth defects, and other reproductive harm.

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 battery charger from its AC source, then 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.
- If adjustment must be made while the unit is running, use extreme caution around hot manifolds, moving parts, etc.

DO NOT OPERATE IN FLAMMABLE AND EXPLOSIVE ENVIRONMENTS

Flammable vapor can cause an engine to overspeed and become difficult to stop, resulting in possible fire, explosion, severe personal injury and death. Do not operate a genset where a flammable vapor environment can be created by fuel spill, leak, etc., unless the genset is equipped with an automatic safety device to block the air intake and stop the engine. The owners and operators of the genset are solely responsible for operating the genset safely. Contact your authorized Cummins Power Generation distributor for more information.

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. Do not wear jewelry. Jewelry can short out electrical contacts and cause shock or burning.
- 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 and lock 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.

MEDIUM VOLTAGE GENERATOR SETS

(601V to 15kV)

- Medium voltage acts differently than low voltage. Special equipment and training is 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. Due to the nature of medium voltage electrical equipment, induced voltage remains even after the equipment is disconnected from the power source. Plan the time for maintenance with authorized personnel so that the equipment can be de-energized and safely grounded.

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.
- 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.
- Keep multi-class ABC fire extinguishers handy. Class A fires involve ordinary combustible materials such as wood and cloth; Class B fires, combustible and flammable liquid fuels and gaseous fuels; Class C fires, live electrical equipment. (ref. NFPA No. 10).
- Make sure that rags are not left on or near the engine.
- Make sure generator set is mounted in a manner to prevent combustible materials from accumulating under the unit.
- 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.
- Substances in exhaust gases have been identified by some state or federal agencies as causing cancer or reproductive toxicity. Take care not to breath or ingest or come into contact with exhaust gases.
- Do not store any flammable liquids, such as fuel, cleaners, oil, etc., near the generator set. A fire or explosion could result.
- Wear hearing protection when going near an operating generator set.
- To prevent serious burns, avoid contact with hot metal parts such as radiator, turbo charger and exhaust system.

KEEP THIS MANUAL NEAR THE GENSET FOR EASY REFERENCE

1. Introduction

ABOUT THIS MANUAL

This manual covers models produced under the Cummins®/Onan® and Cummins Power Generation brand names.

This manual provides installation instructions for the generator set models listed on the front cover. This includes the following information:

Mounting Recommendations - for fastening generator set to base and space requirements for normal operation and service.

Mechanical and Electrical Connections - covers most aspects of the generator set installation.

Prestart – checklist of items or procedures needed to prepare generator set for operation.

Initial Startup – test complete system to ensure proper installation, satisfactory performance, and safe operation. Refer to Operators Manual for troubleshooting information.

Installation Checklist – reference checks upon completion of installation.

This manual DOES NOT provide application information for selecting a generator set or designing the complete installation. If it is necessary to design the various integrated systems (fuel, exhaust, cooling, etc.), additional information is required. Review standard installation practices. For engineering data specific to the generator set, refer to the *Specification* and *Data Sheets*. For application information, refer to Application Manual T-030, "Liquid Cooled Generator Sets".

INSTALLATION OVERVIEW

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

Application and Installation

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

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

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

Safety Considerations

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

2. Specifications

MODEL	DQKB/DQKC
Cummins Diesel Series	QSK60 (50/60 Hz)
Generator kW Rating	See Genset Nameplate for rating information.
Cooling System, Radiator-Cooled Models	
40° C	
Jacket Water Cooling System	82 Gal (310 L)
Low-Temp Aftercooling System	42 Gal (159 L)
50° C	
Jacket Water Cooling System	90 Gal (341 L)
Low-Temp Aftercooling System	40 Gal (152 L)
Oil Capacity, Maximum (see Figure 2-1)	
Oil Pan Only	
Standard Capacity	69 Gal (261 L)
High Capacity	100 Gal (379 L)
System (w/Std. Filters)	
Standard Capacity	74 Gal (280 L)
High Capacity	105 Gal (398 L)
***Oil Type**	
Engine Fuel Connection	
Inlet/Outlet Thread Size	Refer to Generator Outline Drawing
****Fuel Consumption**	
Standby/Full Load/60Hz GPH(LHR)	118.9 (450.6) / 136.6 (517.7)
Exhaust	
Outlet Size	ASME B16.1 Class 125 NPS 10
Maximum Allowable Back Pres.	
H_20	27 in (686 mm)
kPa	6.8
Hg	2.0 in (51 mm)
Electrical System	
Starting Voltage	24 Volts DC
Battery	Four, 12 Volt
Group number	8D
CCA (minimum)	
Cold Soak @ 0° F (-18° C)	1800

* Refer to Cummins QSK45/60 Series Engine Operation and Maintenance Manual for lubricating oil recommendations/specifications.

** Refer to Data Sheet for other applications.

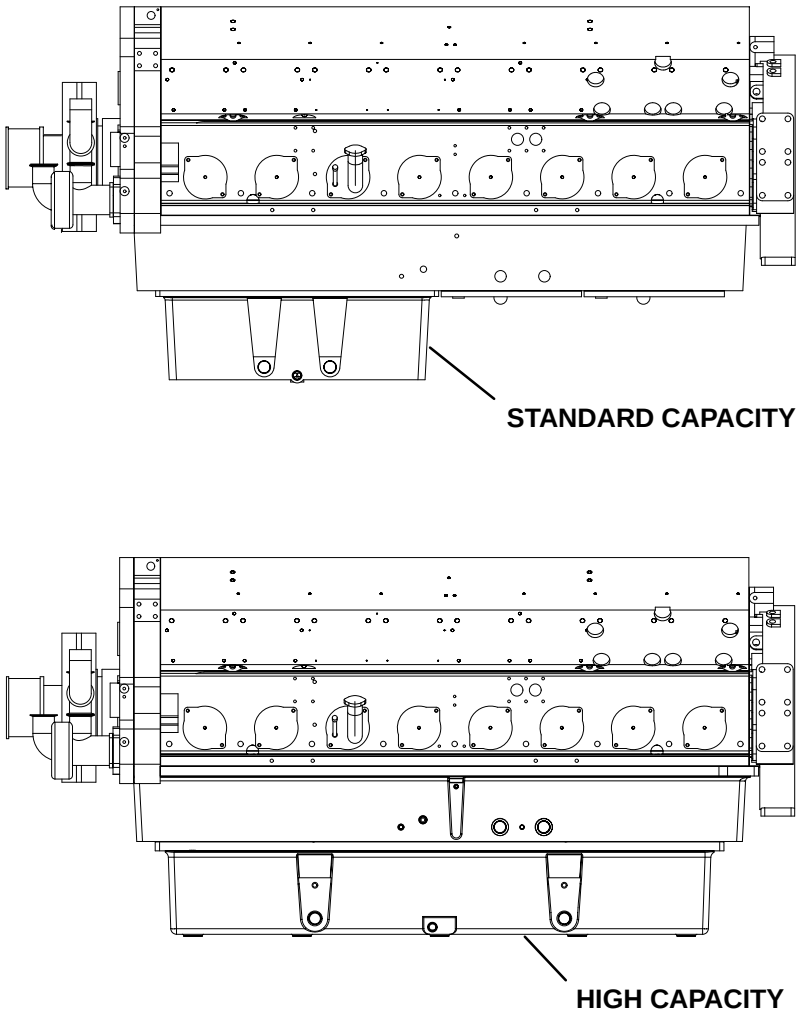

FIGURE 2-1. OIL PAN TYPES

3. Mounting the Generator Set

GENERAL

Generator set installations must be engineered so the generator set will function properly under the expected load conditions. Use these instructions as a general guide only. Follow the instructions of the consulting engineer when locating or installing any components. The complete installation must comply with all local and state building codes, fire ordinances, and other applicable regulations.

Requirements to be considered prior to installation:

- Level mounting surface
- Adequate cooling air
- Adequate fresh induction air
- Discharge of generator set air
- Discharge of exhaust gases
- Non-combustible mounting surface.
- Electrical connections
- Accessibility for operation and servicing
- Noise levels
- Vibration isolation

The set mounted radiator cooling system can be shipped installed or as a separate item. If shipped separately, the radiator cooling system must be installed before the genset is mounted. For radiator assembly instruction, refer to Section 9 of this manual.

⚠ CAUTION ***If the set mounted radiator cooling system is shipped INSTALLED, the alignment of the cooling system fan drive must be checked after the genset is mounted. Failure to check fan drive alignment can result in severe fan/radiator damage. Refer to Section 9 for alignment procedure.***

LOCATION

Generator set location is decided mainly by related systems such as ventilation, wiring, fuel, and exhaust. The set should be located as near as possible to the main power service entrance. Exhaust must not be able to enter or accumulate around inhabited areas.

Provide a location away from extreme ambient temperatures and protect the generator set from adverse weather conditions.

⚠WARNING

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

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.

MOUNTING

Generator sets are mounted on a steel skid that provides proper support. The engine-generator assembly is isolated from the skid frame by rubber mounts that provide adequate vibration isolation for normal installations. Where required by building codes or special isolation needs, generator sets may be mounted on rubber pads or mechanical spring isolators. The use of unapproved isolators may result in harmful resonances and may void the genset warranty.

Mount the generator set on a substantial and level base such as a concrete pad. A non-combustible material must be used for the pad.

Use 3/4 inch anchored mounting bolts to secure the vibration isolators to the base. Secure the vibration isolators to the skid using flat or bevel washer and hexagonal nut for each bolt (see Figure 3-1). The 1-1/2 x 6 inch pipe inserted over the mounting bolts allows minor adjustment of the bolts to align them to the holes in the subbase or vibration isolator.

Locate the isolators as shown on the generator set *Outline Drawing* referenced in the *Data Sheet*.

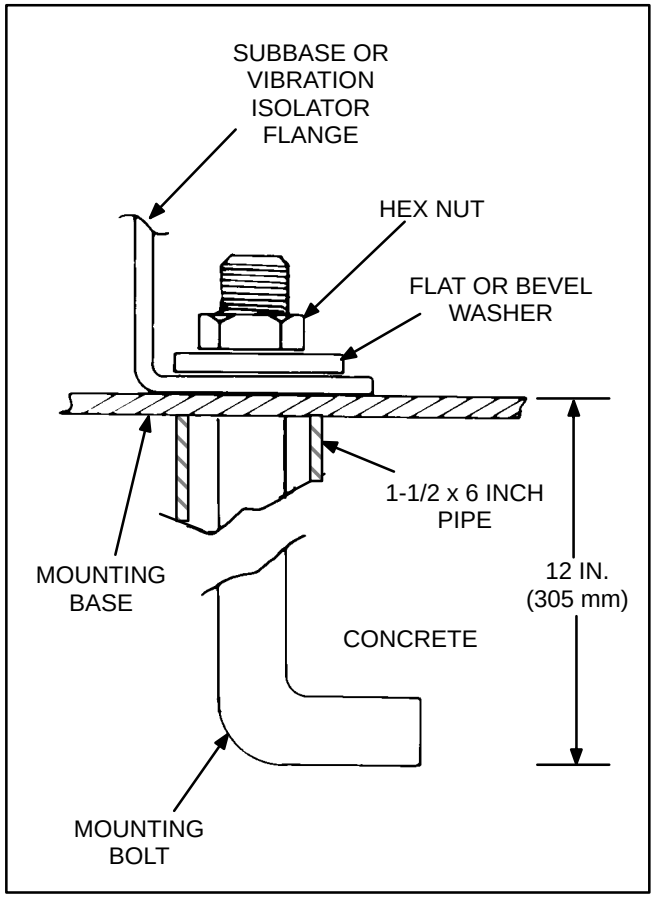

FIGURE 3-1. BOLT DIAGRAM

ACCESS TO SET

Generally, at least 1 meter (3 feet) of clearance should be provided on all sides of the generator set for maintenance and service access. A raised foundation or slab of 150 mm (6 inches) or more above floor level will make servicing easier.

Lighting should be adequate for operation, maintenance and service operations and should be connected on the load side of the transfer switch so that it is available at all times.

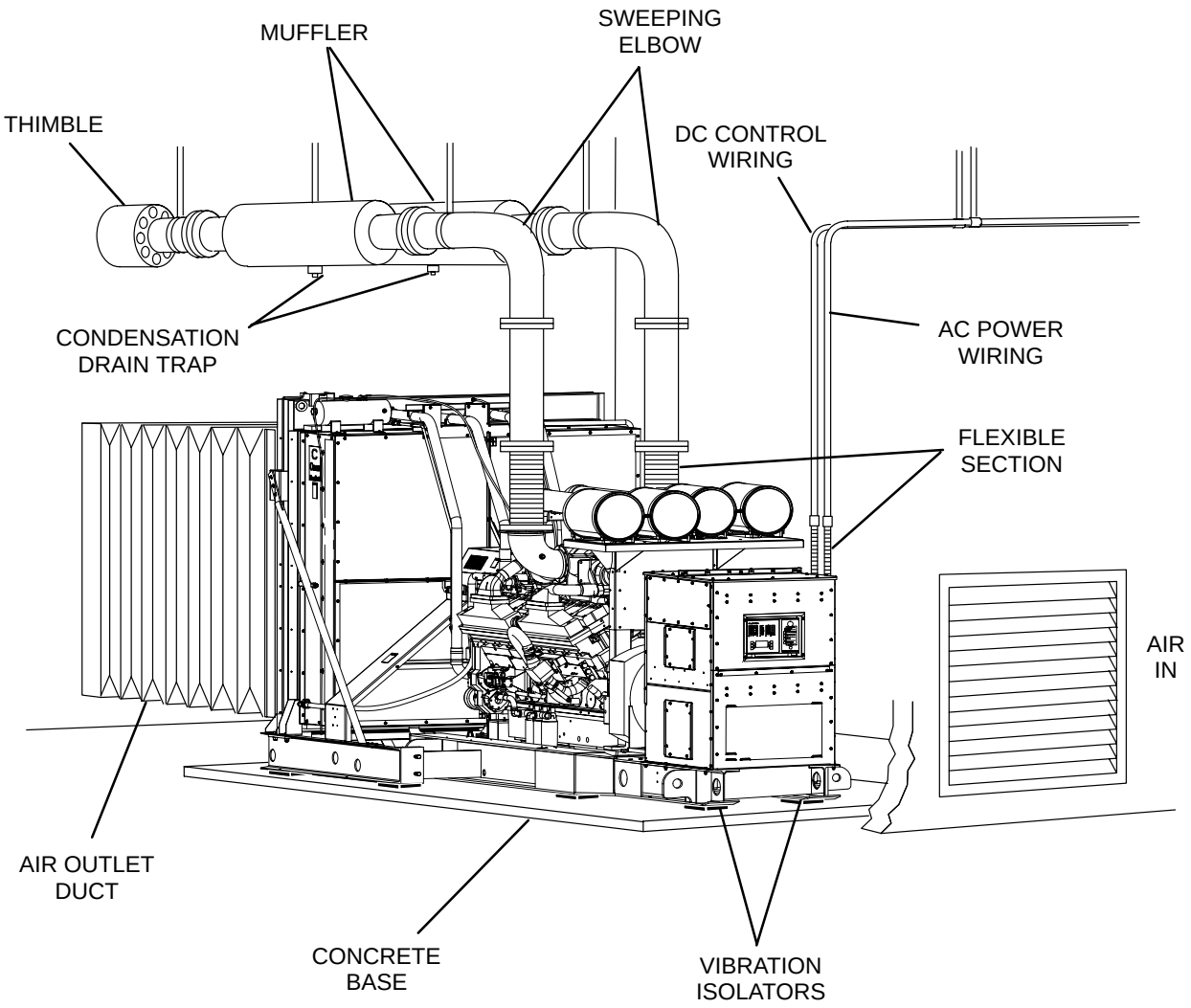

FIGURE 3-2. TYPICAL INSTALLATION

VIBRATION ISOLATORS

Installation and Adjustment Procedure

1. Place the vibration isolators (Figure 3-3) 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 that the isolator bases rest on must also be flat and level.
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.

   Set mounted radiator-cooled generator sets: Make sure radiator skid and engine/alternator skid are level with each other after adjusting isolators. If not level, proper fan belt alignment cannot be achieved (*Section 9*).

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

⚠ CAUTION ***Fan belt alignment for set mounted radiators must be performed after genset is leveled. This includes a genset shipped with preinstalled radiator cooling system. Refer to Section 9 for fan belt alignment procedure.***

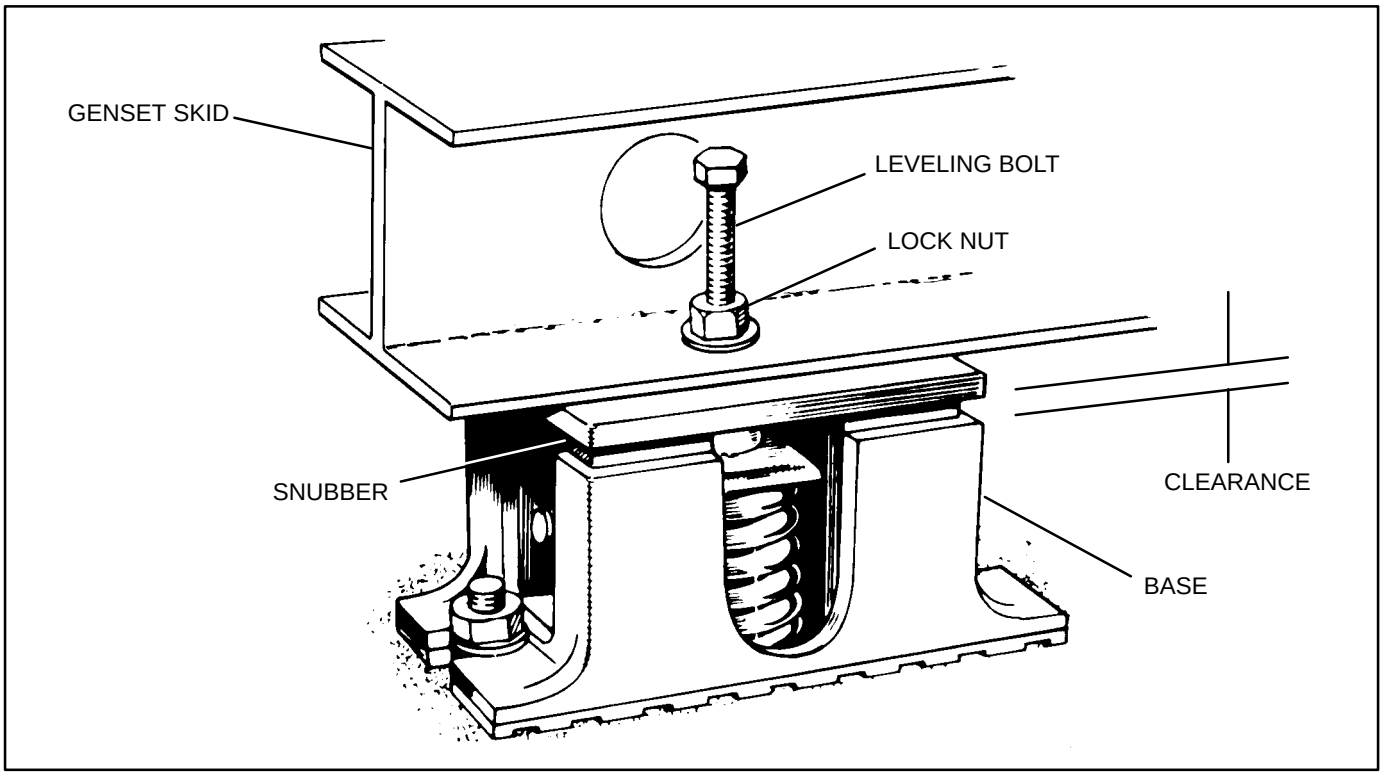

FIGURE 3-3. VIBRATION ISOLATORS

4. Mechanical Connections

GENERAL

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

FUEL SYSTEM

Cummins engines normally use ASTM No. 2 Diesel fuel. They will, however, operate on alternate diesel fuels within the specifications shown in the Cummins *QSK45/QSK60 Series Engine Operation and Maintenance Manual*.

In all fuel system installations, cleanliness is of the upmost importance. Make every effort to prevent entrance of moisture, dirt or contaminants of any kind into the fuel system. Clean all fuel system components before installing.

A fuel filter/strainer/water separator of 100-120 mesh or equivalent (approximately 150 microns nominal) must be fitted between either the main tank and day tank or between the main tank and the engine.

Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Buried fuel lines must be protected from corrosion.

⚠ CAUTION ***Never use galvanized or copper fuel lines, fittings or fuel tanks. 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 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 genset "Switched B+" circuit to open the valve during generator set operation.

Separate fuel return lines to the day tank or supply tank must be provided for each generator set in a multiple-set installation to prevent the return lines of idle sets from being pressurized. Fuel return lines must not contain a shutoff device. Engine damage will occur if the engine is run with the return fuel lines blocked or restricted.

⚠ CAUTION ***Never install shutoff device in fuel return line(s). If fuel return line(s) is blocked or exceeds fuel restriction limit, engine damage will occur.***

Fuel Return Restriction (or Pressure) Limit: Fuel return drain restriction (consisting of friction head and static head) between the engine injector return line connection and the fuel tank must not exceed the limit stated in the *Generator Set Data Sheet*.

Fuel Lines – Routing

A flexible fuel hose(s) or section of flexible fuel hose(s) must be used between the engine's fuel system and fuel supply and return line(s) to protect the fuel system from damage caused by vibration, expansion and contraction. Flexible lines for connecting between the engine and the stationary fuel lines are supplied as standard equipment.

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

Installation of the fuel hose must be done according to all applicable codes and standards, and installation recommendations provided by the manufacturer. The supplied flexible hose is approved by the hose manufacture for use with the genset fuel type and product application.

Support fuel lines to restrain movement and prevent chaffing or contact with sharp edges, electrical wiring and hot exhaust parts.

⚠ WARNING ***Sparks and hot surfaces can ignite fuel, leading to severe personal injury or death. Do not route fuel lines near electrical wiring or hot exhaust parts.***

Fuel lines must be routed and secured to maintain a 1/2 inch (12.7 mm) minimum clearance from electrical wiring and a 2 inch (51 mm) minimum clearance from hot exhaust parts.

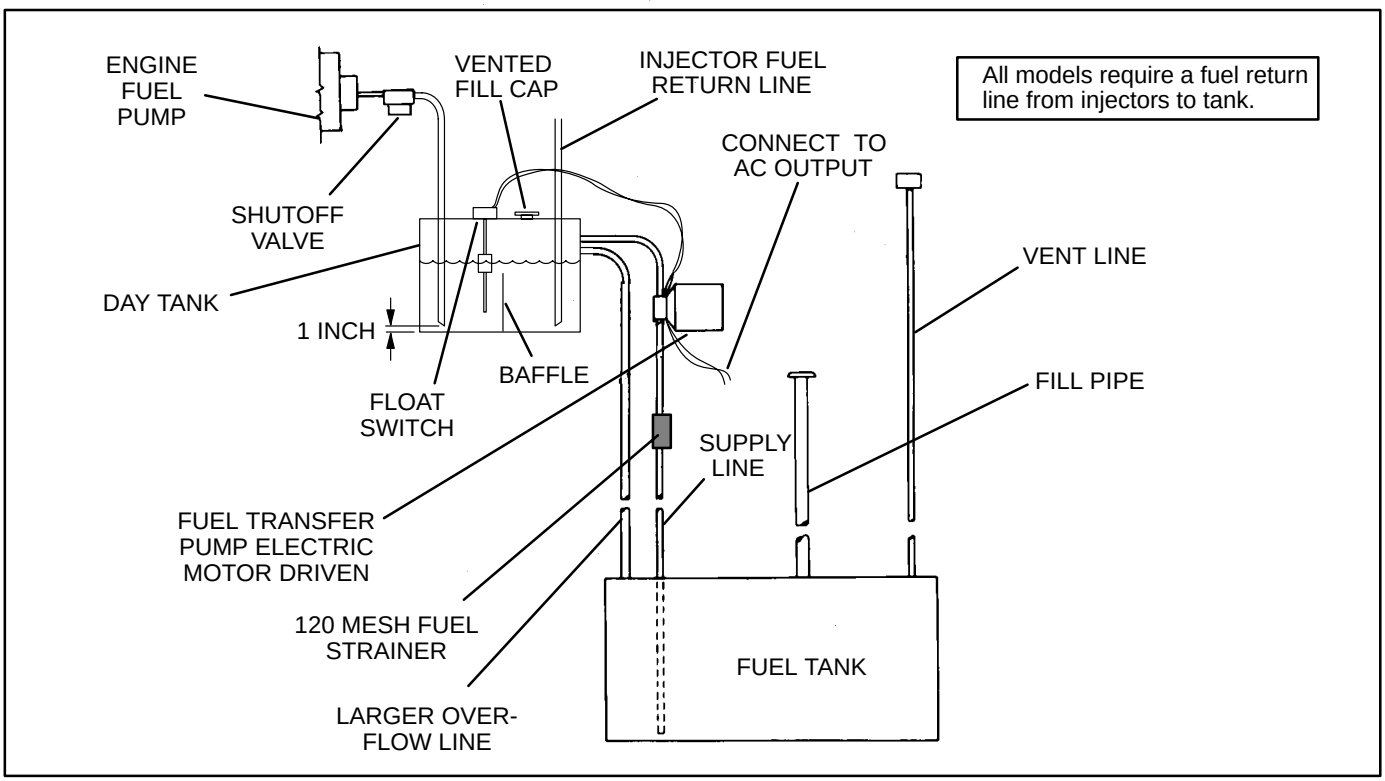

FIGURE 4-1. TYPICAL FUEL SUPPLY INSTALLATION

Engine Fuel Connections

Identification tags are attached to the fuel supply line and fuel return line connections.

Supply Tank

Locate the fuel tank as close as possible to the generator set and within the restriction limitations of the fuel pump.

Install a fuel tank that has sufficient capacity to supply the genset operating continuously at full rated load for the planned period of operation or power outage. Refer to *Data Sheet* for fuel consumption data.

If the fuel inlet restriction exceeds the defined limit due to the distance/customer-supplied plumbing between the genset and the main fuel tank, 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.

For critical start applications, where generator sets are paralleled or must satisfy emergency start-time requirements, it is recommended that a fuel tank or reservoir be located such that the lowest possible fuel level is not less than 6 inches (150 mm) above the fuel pump inlet. This will prevent air from accumulating in the fuel line while the set is in standby, eliminating the period during startup when it has to be purged.

Fuel Inlet Pressure/Restriction Limit: Engine performance and fuel system durability will be compromised if the fuel inlet pressure or restriction limits are not adhered to. Fuel inlet pressure or restriction must not exceed the limits stated in the *Generator Set Data Sheet*.

Day Tank (If Used)

Fuel day tanks are used when fuel inlet restriction limits can not be met, or the supply tank is overhead and presents problems of high fuel head pressure for the fuel inlet and return lines.

Supply Tank Lower Than Engine: With this installation, the day tank is installed near the generator set, below the fuel injection system and within the fuel inlet restriction limit. Install an auxiliary fuel pump, 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 to the day tank.

Provide a return line from the engine injection system return connection to the day tank. Plumb the return line to the bottom of day tank as shown in Figure 4-1. 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 valve in the fuel line between the fuel supply tank and the day tank to stop fuel flow when the generator set is off.

⚠WARNING Spilled fuel can create environmental hazards. Check local requirements for containment and prevention of draining to sewer and ground water.

EXHAUST SYSTEM

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlets away from any air inlets to avoid 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 or sheltered areas, windows, doors and vents.***

For indoor installation, the exhaust system must use sealed joint type fittings, (for example NPT fittings) to provide a tighter exhaust system. Use of slip type fittings (secured with a muffler clamp) may allow leakage of exhaust gases into the building.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Use extreme care during installation to provide a tight exhaust system. Use NPT or equivalent type fittings for all indoor installations.***

Use an approved thimble (Figure 4-2) where exhaust pipes pass through wall or partitions. Insulated wall/roof thimbles are used where exhaust pipes pass through a combustible roof or wall. This includes structures, such as wood framing or insulated steel decking, etc. Uninsulated wall/roof thimbles are used where exhaust pipes pass through a non-combustible wall or roof, such as concrete. Refer to NFPA 37, Section 6-3. “Stationary Combustion Engines and Gas Turbines” for accepted design practices. Build according to the code requirements in effect at the installation site.

⚠WARNING ***Hot exhaust pipes can start a fire and cause severe injury or death if improperly routed through walls. Use an approved thimble where exhaust pipes pass through walls or partitions.***

⚠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 the engine and remainder of exhaust system. Support exhaust system to prevent weight from being 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 engine exhaust elbow.***

The exhaust system design should meet local code requirements.

Liability for injury, death, damage, and warranty expense due to use of unapproved mufflers or modifications becomes the responsibility of the person installing the unapproved muffler or performing the modification. Contact a Cummins Power Generation distributor for approved exhaust system parts.

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 (away from engine) 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 (Figure 4-3).

Shield or insulate exhaust lines if there is danger of personal contact. Allow at least 12 inches (305 mm) of clearance if the pipes pass close to a combustible wall or partition. Before installing insulation on exhaust system components, check the exhaust system for leaks while operating the genset under full load and correct all leaks.

⚠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.***

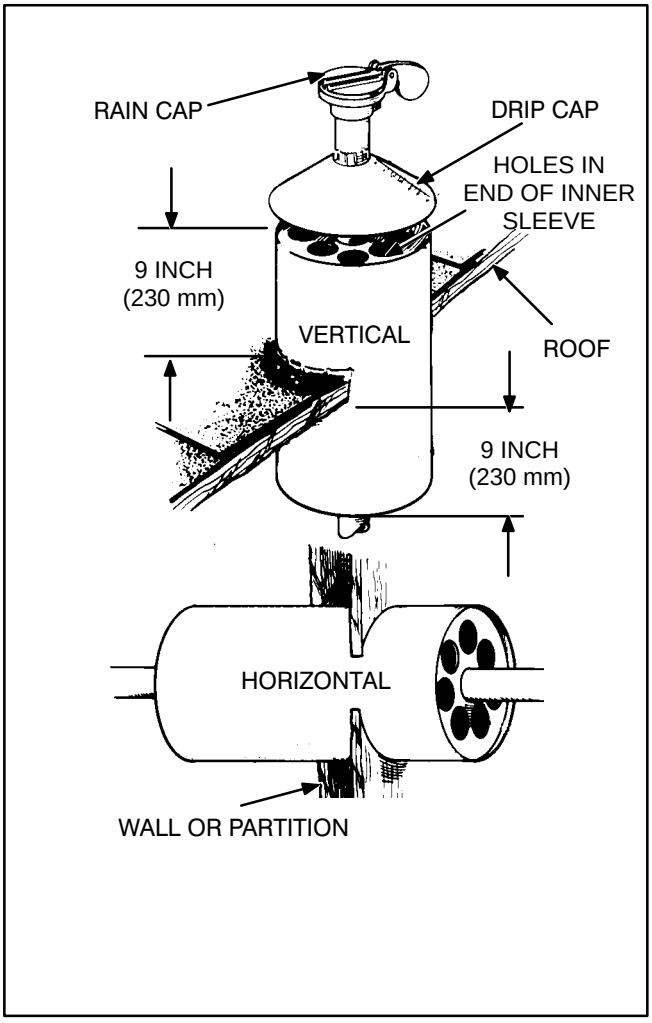

FIGURE 4-2. MOUNTING EXHAUST THIMBLE

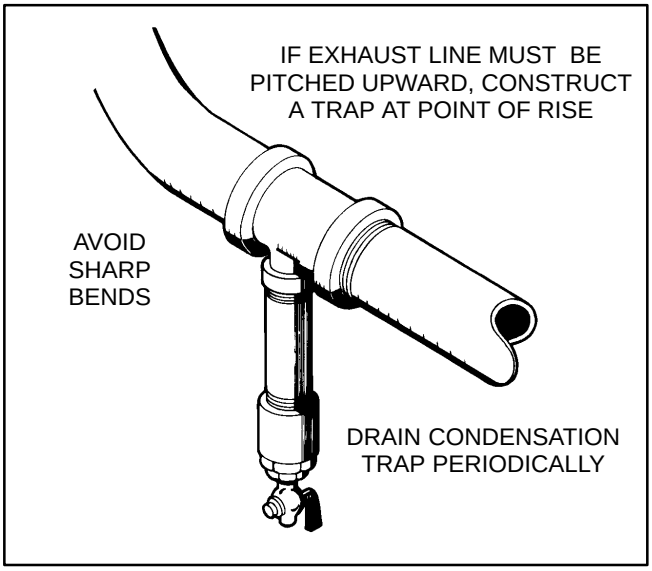

FIGURE 4-3. CONDENSATION TRAP

VENTILATION AND COOLING

Generator sets create considerable heat that must be removed by proper ventilation. Outdoor installations normally rely on natural air circulation but indoor installations need properly sized and positioned vents for required airflow.

Vents and Ducts

For indoor installations, locate vents so incoming air passes through the immediate area of the installation before exhausting. Install the air outlet higher than the air inlet to allow for convection air movement.

Size the vents and ducts so they are large enough to allow the required flow rate of air. The ”free area” of ducts must be as large as the exposed area of the radiator. Refer to the genset *Data Sheet* for the airflow requirements and allowed airflow restriction.

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. See Figure 4-4.

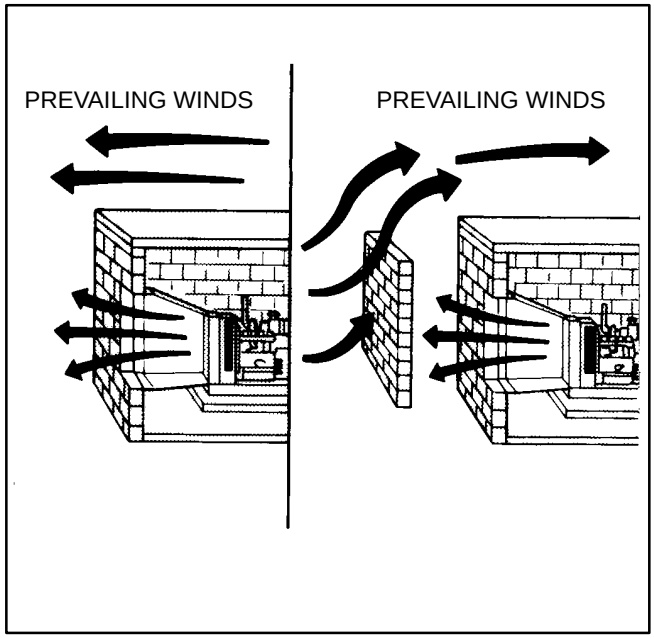

FIGURE 4-4. WIND BARRIER

Dampers

Dampers or louvres protect the genset and equipment room from the outside environment. Their operation of opening and closing should be controlled by operation of the genset.

In cooler climates movable or discharge dampers are used. These dampers allow the air to be recirculated back to the equipment room. This enables the equipment room to be heated while the genset engine is still cold, increasing the engine efficiency.

Engine Coolant Heater (Optional)

An optional jacket water coolant heater is available to keep the engine warm for improved starting and code compliance. Connect the heater to a power source that will be energized when the engine is NOT running.

Set Mounted Radiator Cooling

Set mounted radiator cooling uses a set mounted radiator and engine pusher fan to cool engine water. Air travels from the generator end of the set, across the engine and out through the radiator. An integral discharge duct adapter flange surrounds the radiator grille.

⚠ CAUTION ***The set mounted radiator cooling system can be shipped installed or as a separate item. If shipped INSTALLED, the alignment of the cooling system fan drive must be checked before genset operation. Failure to check fan drive alignment can result in severe fan/radiator damage. Refer to Section 9 for alignment procedure.***

Radiator Set Requirements: Radiator set cooling air is drawn past the control end of the set by a pusher fan that blows air through the radiator (Figure 4-5). Locate the air inlet to the rear of the set. Make the inlet vent opening 1-1/2 to 2 times larger than the radiator area.

Louvers and screens over air inlet and outlet openings restrict air flow and vary widely in performance. A louver assembly with narrow vanes, for example, tends to be more restrictive than one with wide vanes. The effective open area specified by the louver or screen manufacturer should be used.

Locate the cooling air outlet directly in front of the radiator and as close as possible. The outlet opening must be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow.

Attach a canvas or sheet metal duct to the flange and the air outlet opening using screws and nuts so duct can be removed for maintenance purposes. The duct prevents circulation of heated air. Before installing the duct, remove the radiator core guard.

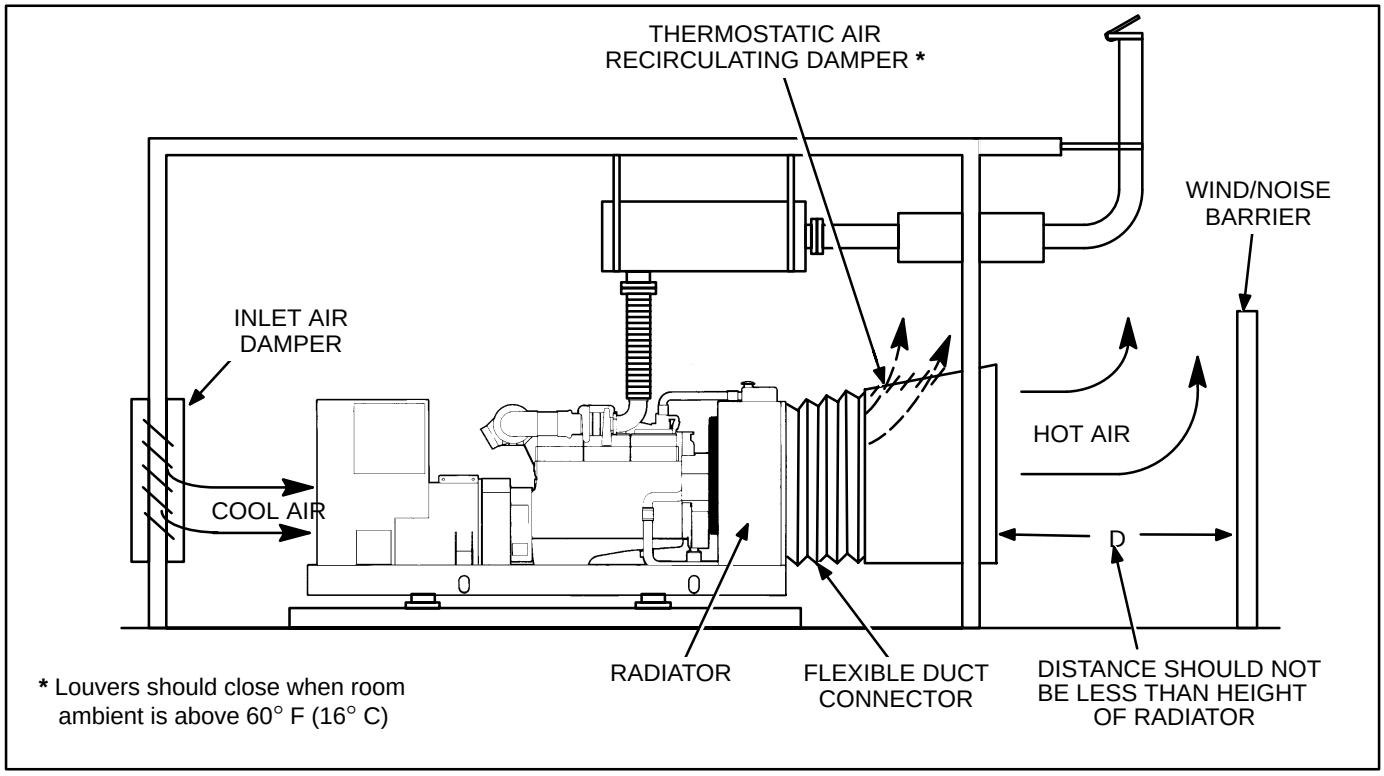

FIGURE 4-5. TYPICAL RADIATOR SET INSTALLATION

Remote Radiator Cooling (Optional)

Remote radiator cooling substitutes a remote mounted radiator and an electrically driven fan in place of the set mounted components. Removal of the radiator and the fan from the set reduces noise levels without forcing dependence on a continuous cooling water supply (necessary with heat exchanger cooling). The remote radiator installation must be completely protected against freezing.

Remote radiator plumbing will vary with installation. Follow recommendations given in Application Manual T-030. See product *Data Sheet* for friction head and static head limits.

Before filling cooling system, check all hardware for security. This includes hose clamps, capscrews, fittings and connections. Use flexible coolant lines with heat exchanger or remote mounted radiator.

Heat Exchanger (Optional)

The optional heat exchanger (Figure 4-6) uses a shell and tube type heat exchanger instead of the standard radiator and fan. 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 may reduce set enclosure airflow requirements and noise levels. Proper operation depends on a constant supply of raw water for heat removal. Adjust the flow to maintain engine coolant temperature between165° F and 195° F (74° C and 91° C) while viewing the water temperature gauge. The engine coolant side of the system can be protected from freezing; the raw water side cannot be protected.

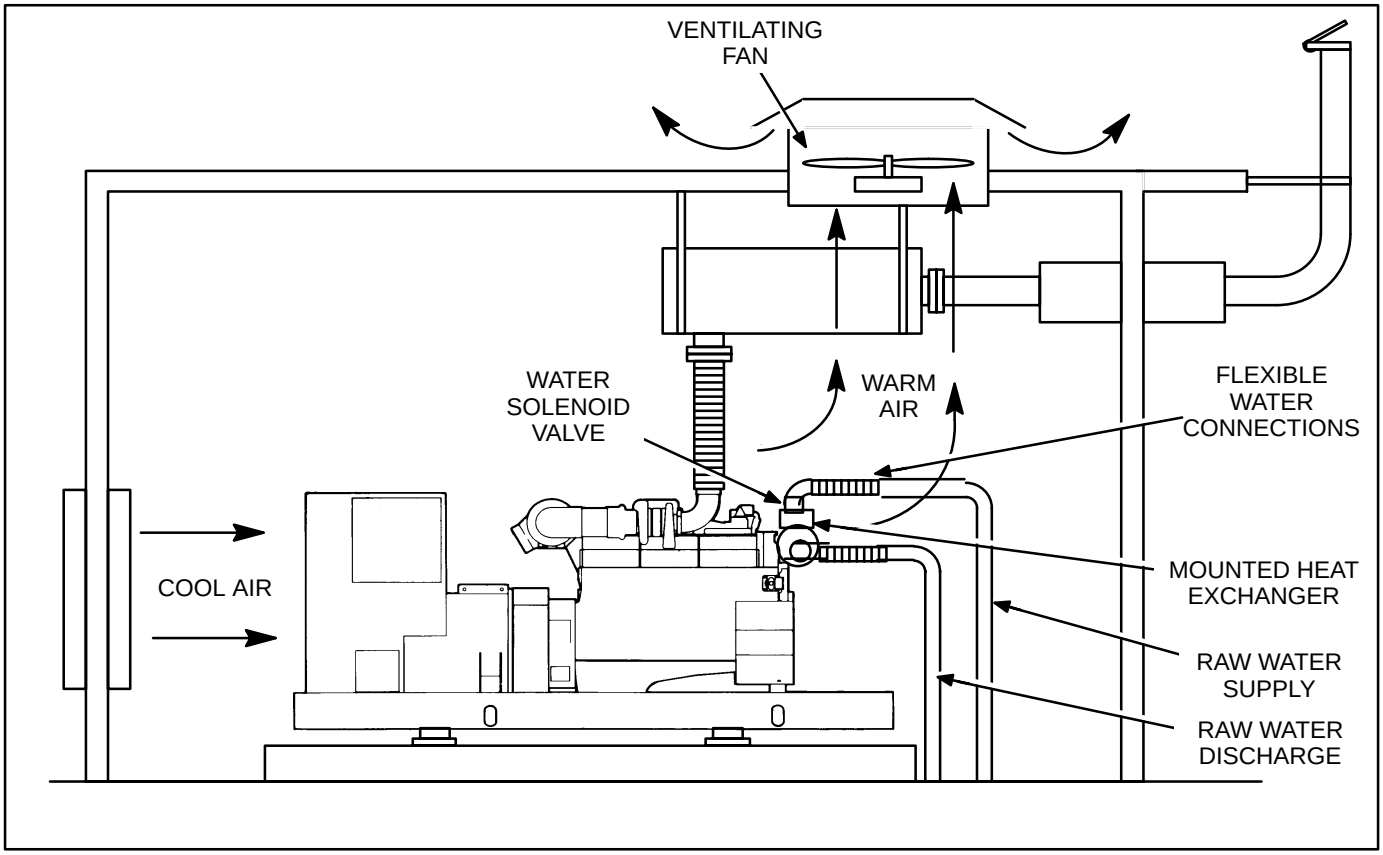

FIGURE 4-6. TYPICAL HEAT EXCHANGER INSTALLATION

COOLANT

The cooling system of radiator type gensets can be shipped installed or as a separate item. If shipped with the cooling system installed, both radiators are filled with the proper fluids at the factory. Make sure that the coolant levels of both radiators are correct before starting.

The procedure for checking and filling the cooling system of a set mounted radiator is provided in Section 9 of this manual.

Coolant Filters

Two spin-on type corrosion filters (Figure 4-7) are standard equipment. To prevent coolant loss during filter replacement, a coolant shut off valve is provided (Figure 4-7). Make sure shutoff valve is in the **ON** position before operating the generator set.

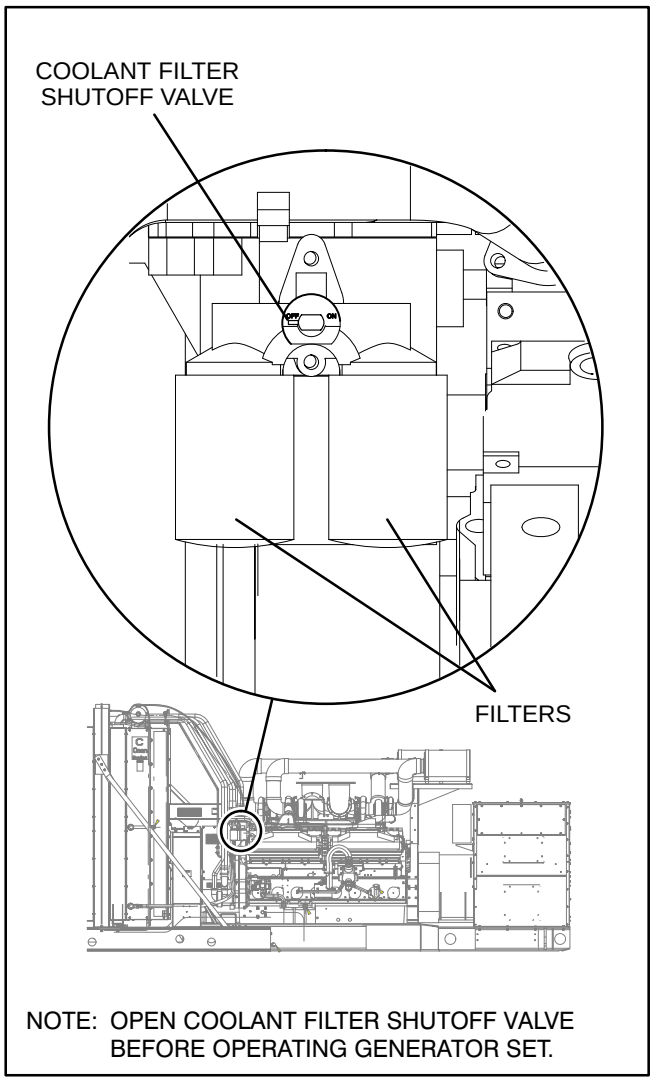

FIGURE 4-7. TYPICAL COOLANT FILTER

5. DC Control Wiring

CONTROL WIRING

The generator set electronics box, which is located on the backside of the control housing, contains connection points for remote control and monitor options. These connection points are located in two different locations within the electronics box as shown in Figure 5-1.

⚠ CAUTION ***Do not attach conduit to the electronics box for any reason. All conduit must be attached to the control housing. Attaching conduit to the electronics box will compress the electronics box vibration isolators, causing the box to vibrate and damage the electronic circuitry.***

Use flexible conduit for all wiring connections to the generator set. All conduit used for control wiring must be attached to the control housing, not to the electronics box. Route the control wiring through the control housing and into the access hole on the back panel of the electronics box. Use cable ties to keep control wiring away from sharp edges and AC power cables within control housing.

⚠ CAUTION ***Stranded copper wire must be used for all customer connections to the electronics box. Solid copper wire may break due to genset vibration.***

REMOTE MONITOR/CONTROL CONNECTIONS

Customer monitor/control connections are attached to terminal blocks TB3, TB4 TB5 and TB8. Optional equipment such as a remote annunciator panel, sensing devices used to monitor genset operation, remote start/stop switches, control box heater, and etc. are attached to these terminal blocks. Driver signals for customer supplied relays are also provided for several alarm and shut down conditions. Refer to Customer Connections diagram in Section 10.

⚠ CAUTION ***When removing terminal block connectors (TB4, TB5, or TB8) from cards in card cage, note orientation of connector. These terminal block connectors are not keyed and can be installed incorrectly, which will cause control failures.***

Terminal Block Wiring

⚠ CAUTION ***Always run control circuit wiring in a separate metal conduit from AC power cables to avoid inducing currents that could cause problems within the control.***

Digital Connections: Connection points, other then relayed outputs, network, switched B+ and B+ are considered digital connections to the terminal blocks. The type/gauge wire to use for these connections are:

- Less than 1000 feet (305m), use 20 gauge stranded copper wire.
- 1000 to 2000 feet (305 to 610m), use 18 gauge stranded copper wire.

Relay Connections: Due to the wide variety of devices that can be attached to the relay outputs of terminal blocks, the electrical contractor must determine the gauge of the **stranded copper** wire that is used at this installation site. Refer to Customer Connections diagram in Section 10 for the relay specifications.

Switched B+: (Fused at 20 amps.) Same as Relay Connection description.

B+: (Fused at 20 amps.) Same as Relay Connection description.

Network Connections: Refer to 900-0366 *PowerCommand Network Installation and Operation* manual for the type/gauge wire to use for these connections.

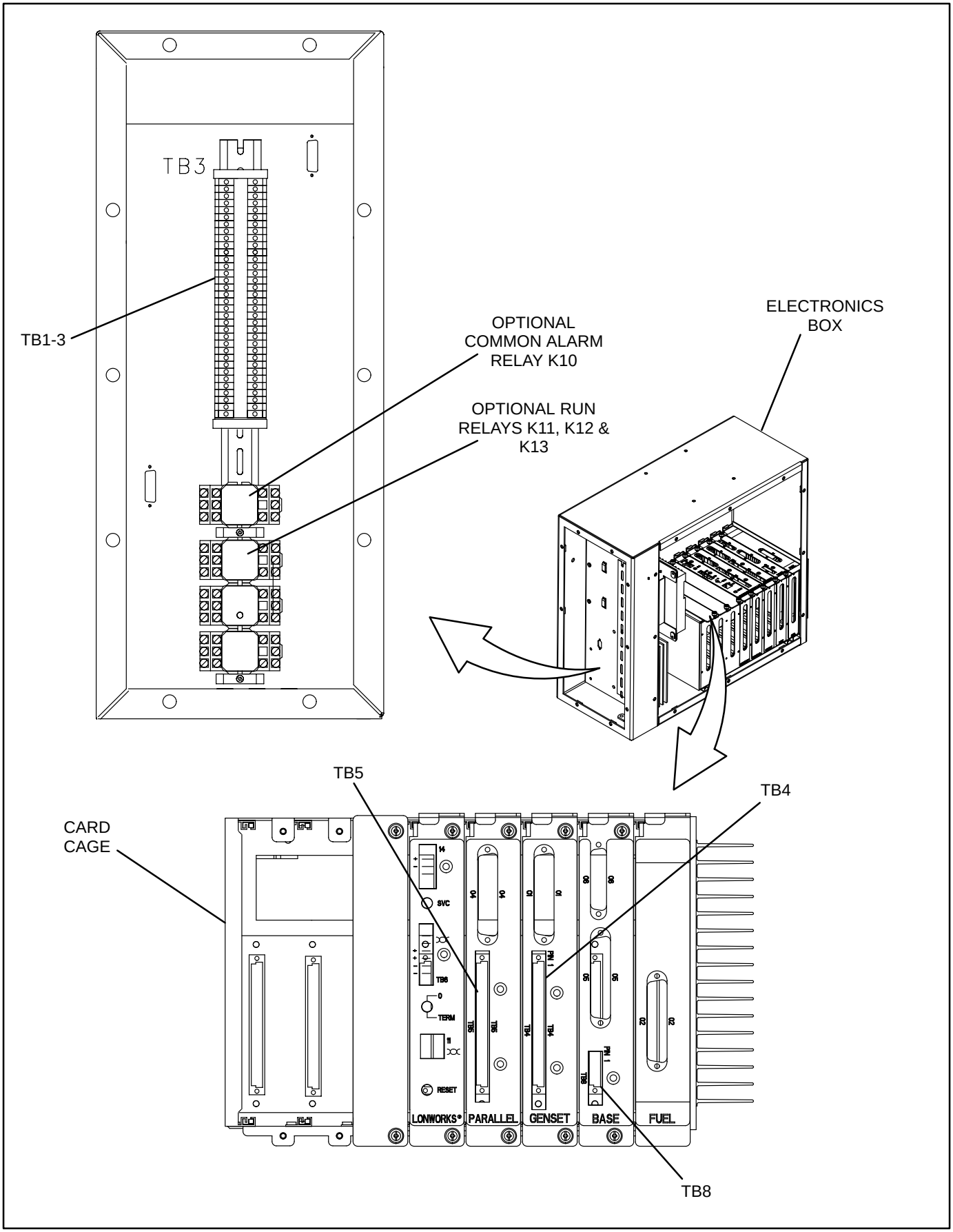

FIGURE 5-1. ELECTRONICS BOX

RUN RELAYS (K11, K12, K13)

The optional run relays are rail mounted inside the electronics box (Figure 5-1). The rail mount allows you to easily remove and replace the snap-on relays. The generator set can be equipped with one, two or three run relays.

The three-pole, double-throw run relays (Figure 5-2) are used to control auxiliary equipment such as fans, pumps and motorized air dampers. The run relays are energized when the generator set reaches operating speed.

The contacts are rated:

- 10 amps at 28 VDC or 120 VAC, 80%PF
- 6 amps at 240 VAC, 80%PF
- 3 amps at 480/600 VAC, 80%PF

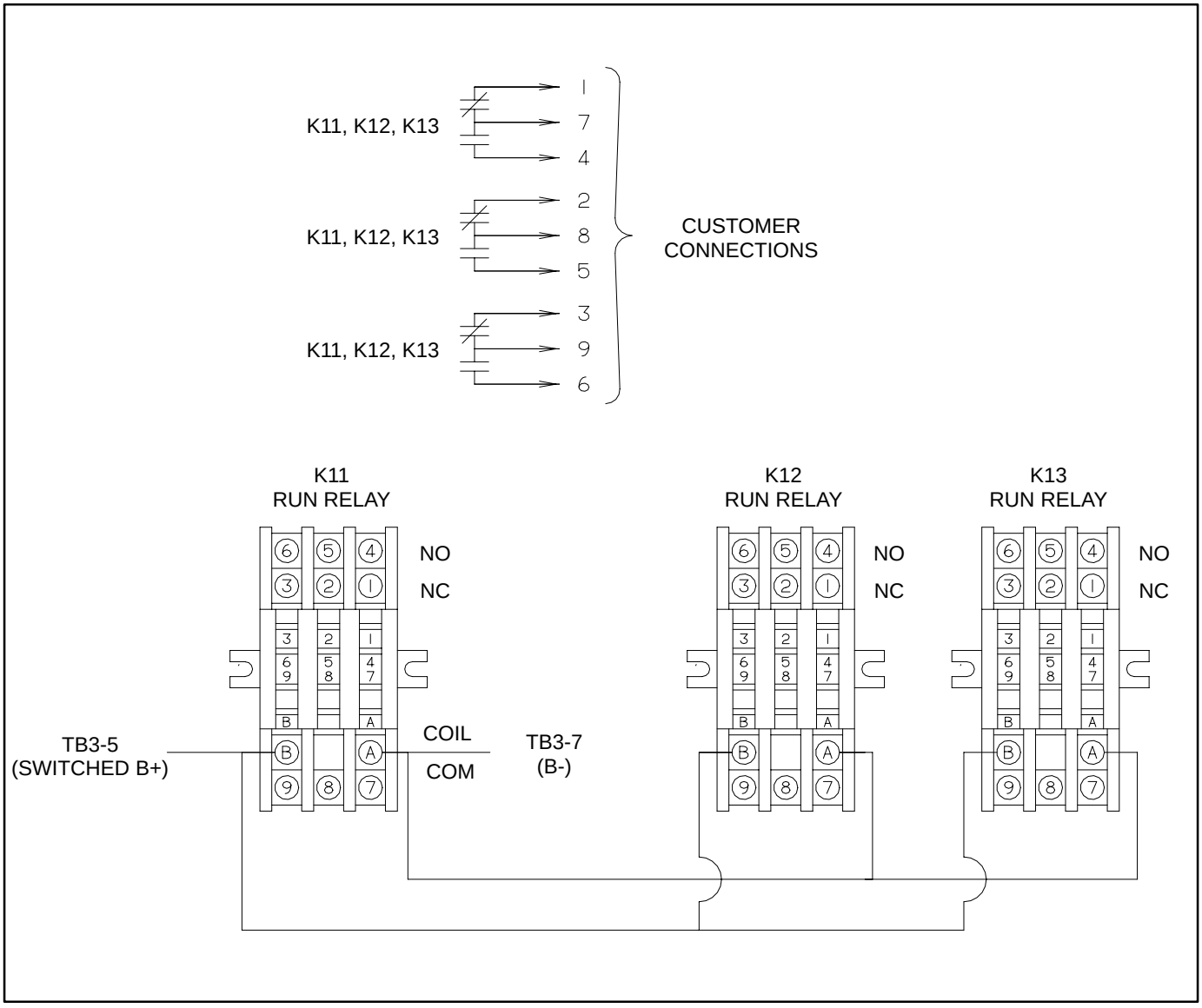

FIGURE 5-2. OPTIONAL RUN RELAYS (K11, K12, K13)

ALARM RELAY (K10)

The optional alarm relay is rail mounted inside the electronics box (Figure 5-1). The rail mount allows you to easily remove and replace the snap-on relay.

The three-pole, double-throw alarm relay (Figure 5-3) is often used to energize warning devices such as audible alarms. Any generator set warning or shutdown will energize the alarm relay.

The contacts are rated:

- 10 amps at 28 VDC or 120 VAC, 80%PF
- 6 amps at 240 VAC, 80%PF
- 3 amps at 480/600 VAC, 80%PF

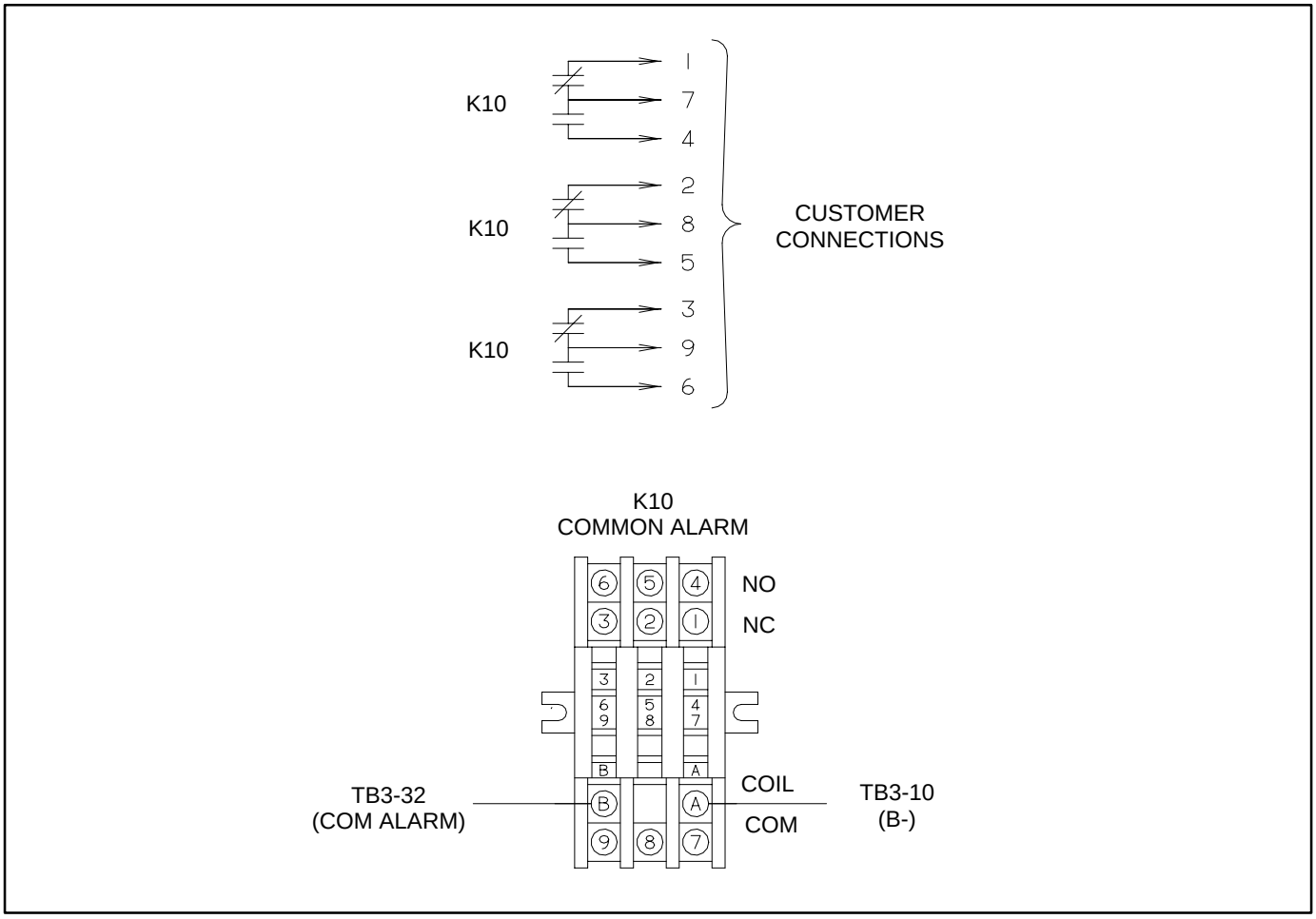

FIGURE 5-3. OPTIONAL ALARM RELAY (K10)

6. AC Electrical Connections

GENERAL

This section provides the procedure that is used to connect the AC electrical system of the genset.

Before making any AC electrical connections, make certain the generator set cannot be accidentally started. Move the O/Manual/Auto switch on the control panel to the O (off) position. Turn off or remove AC power from the battery charger and then remove the negative (–) battery cable from the set starting battery.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury or death. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.***

Ventilate battery area before working on or near battery—Wear goggles—Stop genset and disconnect charger before disconnecting battery cables—Disconnect negative (–) cable first and reconnect last.

⚠ CAUTION ***Disconnect battery charger from AC source before disconnecting battery cables. Otherwise, disconnecting cables can result in voltage spikes damaging to DC control circuits of the set.***

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Prevent accidental starting by disconnecting the negative (–) cable from the battery terminal.***

⚠WARNING ***Each of the operations described in this section should be done only by persons trained and experienced in electrical maintenance. Improper procedures may result in property damage, bodily injury or death.***

Connecting the genset AC electrical system involves:

- Generator insulation check
- Installation of transfer switch
- Generator output voltage selection
- Load cable connection
- Standard and optional AC equipment connections (e.g., control box heater, coolant heater, etc.

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

⚠WARNING ***Improper wiring can cause a fire or electrocution, resulting in severe personal injury or death and/or property and equipment damage.***

Before starting the genset, check to make sure that all electrical connections are secure, and that all wiring is complete. Replace and secure any access panels that have been removed during installation. Check that the load cables from the genset are properly connected.

⚠WARNING ***Backfeed to utility system can cause electrocution or property damage. Do not connect to any building electrical system except through an approved device and after building main switch is opened.***

INSULATION RESISTANCE (MEGGER) & POLARIZATION INDEX (PI) TESTING

Megger and PI testing **must** be performed on all medium voltage (601 through 15,000 volts) generator sets before initial start-up. PI testing for low voltage (less than 600 volts) generator sets is recommended by Cummins Power Generation.

These tests are used to verify that the windings are dry before the generator set is operated and develop a base line for future test comparisons.

Before these tests can be performed on medium voltage generator sets, you must first perform the generator grounding procedure.

Generator Set Grounding Procedure

Prior to performing service or inspection procedures that may expose personnel to conductors normally energized with voltages greater than 600 volts, the following generator set grounding procedure must be followed.

⚠WARNING ***No person should attempt to perform these procedures unless they are fully trained in medium voltage grounding procedures and have the necessary safety tools and equipment. Persons who attempt these procedures without these qualification are at risk of severe injury or death due to high voltage electrical shock.***

1. Open, lock-out and tag-out all sources of power to the immediate work area.
2. Disable the starting system of the generator set:
   a. Disconnect the battery charger from its AC source.
   b. Remove the negative battery cable from the battery.
   c. Install a lockout device on the battery cable end. (For engines equipped with an air-powered starting system, close air valve and install valve locking device.)
3. Put on high voltage gloves with leather protectors.
4. Using two pre-tested voltage detection devices (of the proper rating), verify de-energized condition in the work area. (Retest voltage detection devices immediately after verification of de-energized condition.)
5, Remove the metal cover from the generator output box to gain access to generator load terminals.
6. Securely install the Grounding Cluster ground clamp to a verified “grounded” conductor.

   ⚠WARNING ***Hazardous voltage. Can cause severe personal injury or death. After DC voltage from the test equipment has been applied to the windings and ground, there will be a definite static charge on the windings. Reconnect Grounding Cluster to remove static charge from the winding after each generator test.***

7. With the Grounding Cluster in place, you are protected from all static and/or induced charges that may have been present in the generator stator.

   Leave grounds connected for one minute to insure static charge dissipation. Remove ground cluster and perform PI and/or any other tests required on the stator winding. Reconnect grounds if additional generator service is necessary.
8. When work on the generator set is complete, remove the Grounding Cluster in the reverse order of installation.
9. After getting clearance from all personnel involved in the lock-out/tag-out procedure, remove all lock-out devices in reverse order of installation.

Megger and PI Test

⚠WARNING ***Medium-voltage, 601 to 15,000 volts, present special hazards of severe personal injury or death. Even after genset shutdown, an electrical shock hazard may exist. Service personnel must be well trained and qualified to work with distribution voltages.***

⚠WARNING ***Windings of medium voltage (601 through 15,000 volts) generator sets must be dry before the generator is operated. Failure to ensure dry windings before start-up may result in catastrophic failure, severe personal injury and death.***

Megger Test: The megger test consists of applying voltage for up to one minute. The highest resistance values shown in Table 6-1 should be obtained for a new generator with dry windings. For a set that has been in service, the resistance reading should not be less than the lower value shown.

PI Test: The PI test consists of applying a voltage between the winding and ground for ten minutes and recording resistance values at one minute and at ten minutes. The PI is the ratio of a ten minute reading in megohms divided by a one minute reading in megohms. A ratio of two or greater is considered good for new and in-service sets.

If low readings are obtained, investigate the cause and correct before the generator set is returned to service.

1. Perform the *Generator Set Grounding Procedure* in this section.
2. Disconnect connector **10** from the voltage regulator output stage module and the AC control input leads from the generator output terminals. The AC control leads are marked 5, 6, 7 and 8. Refer to the reconnection diagram, which is located on the upper side cover of the control housing.
3. If the RTD (resistive thermal device) option is installed, ground all six resistive thermal device temperature leads. Each RTD has three leads, one red and two white leads. Total of 18 leads must be grounded.

Main Stator:

4. Remove and separate the neutral leads of the generator from the generator load terminal marked “N”.
5. Connect the megger between one phase of the stator and ground while grounding the other two phases and conduct the test. Refer to Table 6-1 for megger voltage selection and required resistance values.

   Repeat this step in turn for the other two phases.

Main Rotor:

6. Disconnect the main rotor and voltage suppressor leads from terminals **F1+** and **F2–** on the rotating rectifier assemblies and isloate them from ground. Tag and mark each lead with its terminal number (**F1+** or **F2–**).
7. Connect the megger between one of the rotor leads and ground and conduct the test. Refer to Table 6-1 for megger voltage selection and required resistance values.

TABLE 6-1. GENERATOR INSULATION RESISTANCE

GENERATOR VOLTAGE	MEGGER VDC SETTING	MINIMUM RESISTANCE (MEG)	
		MAIN STATOR	MAIN ROTOR
600 VAC or less	500	5.0 – 1.0	5.0 – 1.0
601 thru 5000 VAC	2500	400 – 50	
	1000		5.0 – 1.0
5001 thru 15000 VAC	5000	1000 – 200	
	1000		5.0 – 1.0

TRANSFER SWITCH

If the installation is for standby service, a transfer switch must be used for switching the load from the normal power source to the genset (see Figure 6-1). 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.

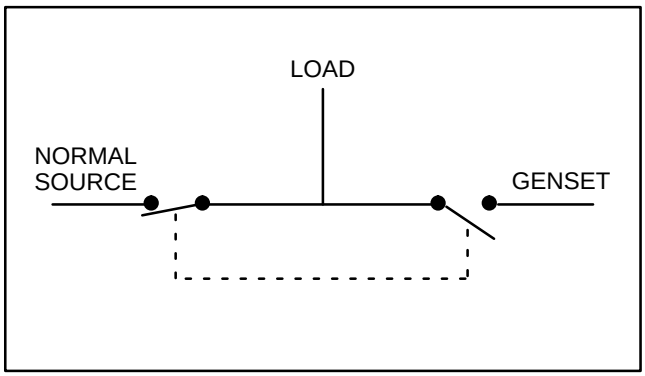

FIGURE 6-1. TYPICAL LOAD TRANSFER FUNCTION

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.

The generators are available at the voltages shown in the Wiring Diagram located on the upper side cover of the control housing. The generator is connected at the factory to produce a specified voltage per customer order (they cannot be reconfigured for different voltages in the field). Before shipping, the factory tests the generator set at the specified voltage.

Load Connections

Flexible conduit and stranded conductors must be used for connections to take up movement of the generator set.

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

Load Balancing

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

Grounding

The following is a brief description of system and equipment grounding of permanently installed AC generators within a facility wiring system. It is important to follow the requirements of the local electrical code.

Figure 6-2 illustrates typical system grounding for a 3-pole and a 4-pole automatic transfer switch (ATS). In the 3-pole ATS, note that the generator neutral is connected to the ATS and is NOT bonded to ground at the generator. In the 4-pole ATS system, a grounding electrode conductor and a bonding jumper are used to connect the generator neutral to ground. In some installations, a CT may be required for ground fault monitoring (refer to Figure 6-2 for CT location).

Make sure the genset is grounded to earth in one location only. On generators without a circuit breaker, ground to the point indicated on the top of the generator. On gensets with circuit breakers, use the ground lug provided in the circuit breaker box.

⚠WARNING ***Electric current can cause severe personal injury or death. Bonding and grounding must be done properly. 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.

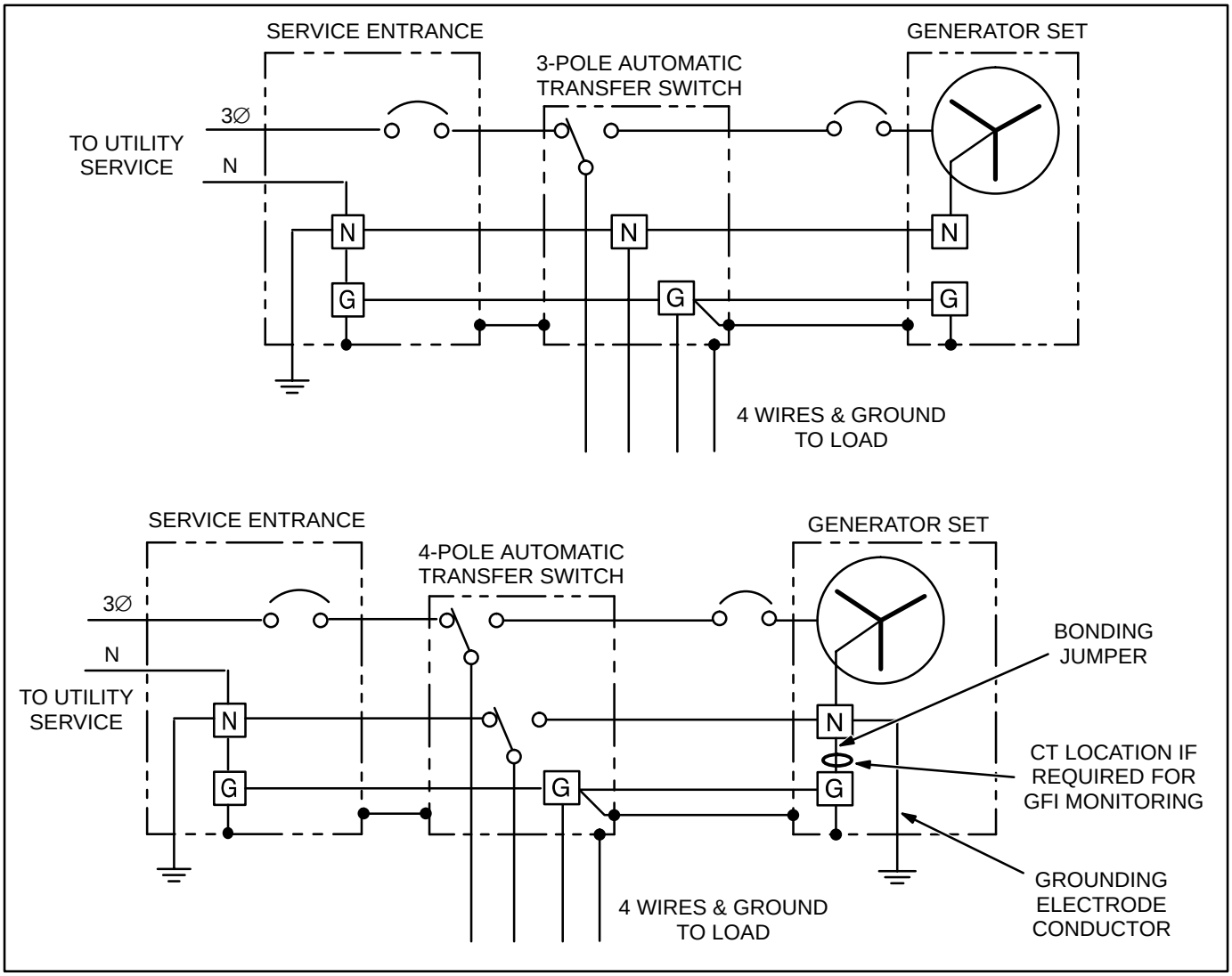

FIGURE 6-2. TYPICAL SYSTEM GROUNDING ONE-LINE DIAGRAMS

CONTROL HEATER (OPTIONAL)

A control heater (Figure 6-3) provides a means of humidity /temperature control of the control box interior. It protects the components when the generator set is subjected to varying ambient air conditions during extended periods of non-use.

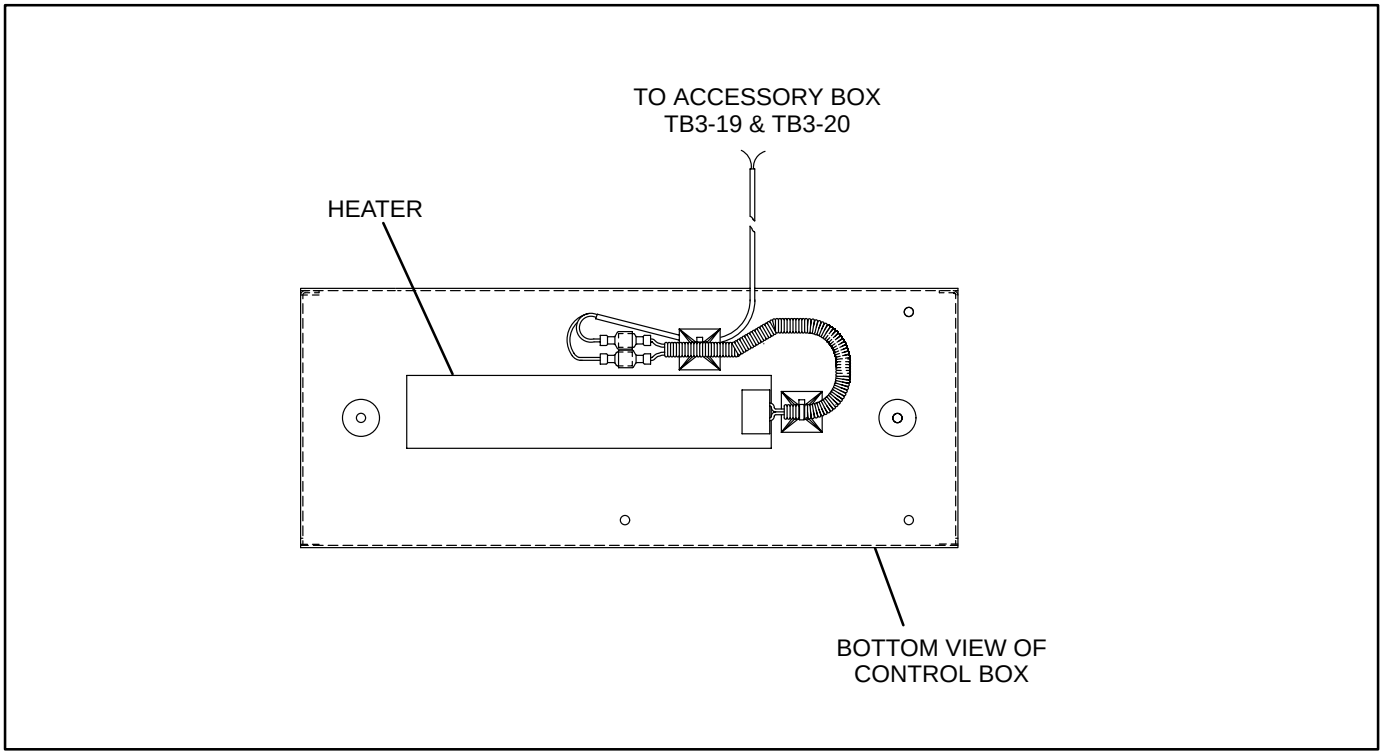

FIGURE 6-3. OPTIONAL CONTROL HEATER

COOLANT HEATER

Coolant heaters 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.

⚠ CAUTION ***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 6-4 shows a typical coolant heater. Connect the heater to a source of power that will be on during the time the engine is not running. Be sure the supply voltage and circuit amperage is correct for the heater element rating.

A battery charger is required to prevent battery discharge. The heater control relay draws 83 mA of current when the heater(s) is off. The heater is off when the engine has reached the proper temperature or the engine is running.

⚠ CAUTION ***Do not connect AC power to the heater before connecting battery cables. Heater will run continuously without DC power and can overheat and damage heater.***

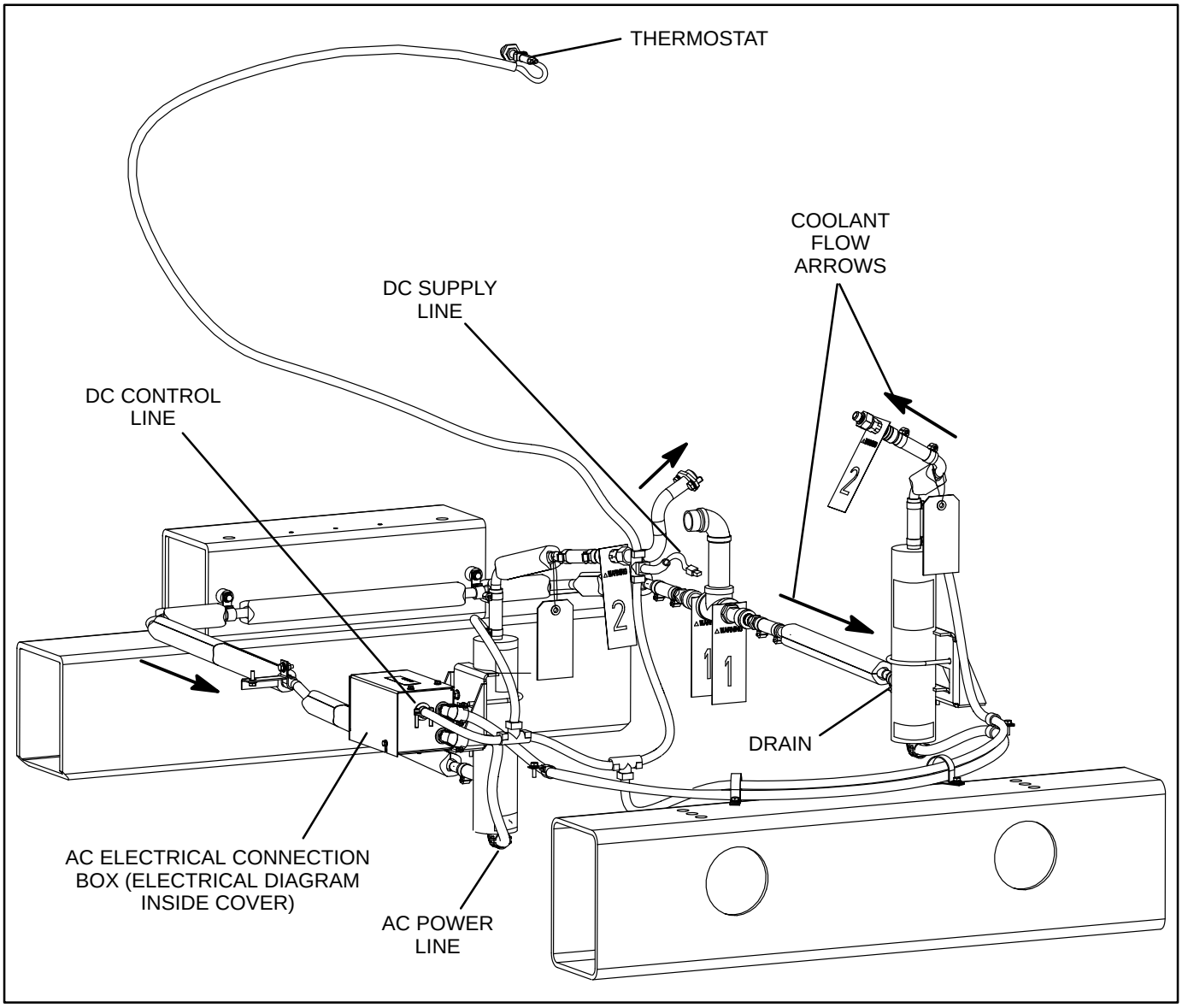

FIGURE 6-4. TYPICAL COOLANT HEATER

GENERATOR HEATER

A generator heater(s) is used to help keep the generator free of condensation when the generator set is not running. During cool and humid conditions, condensation can form within a generator, creating flashing and a shock hazard.

⚠WARNING ***Water or moisture inside a generator increases the possibility of flashing and electrical shock, which can cause equipment damage and severe personal injury or death. Do not use a generator which is not dry inside and out.***

Figure 6-5 illustrates the installation of two heater elements. Connect the heater(s) terminals to a source of power that will be on during the time the engine is not running. Be sure the supply voltage and circuit amperage is correct for the heater element rating.

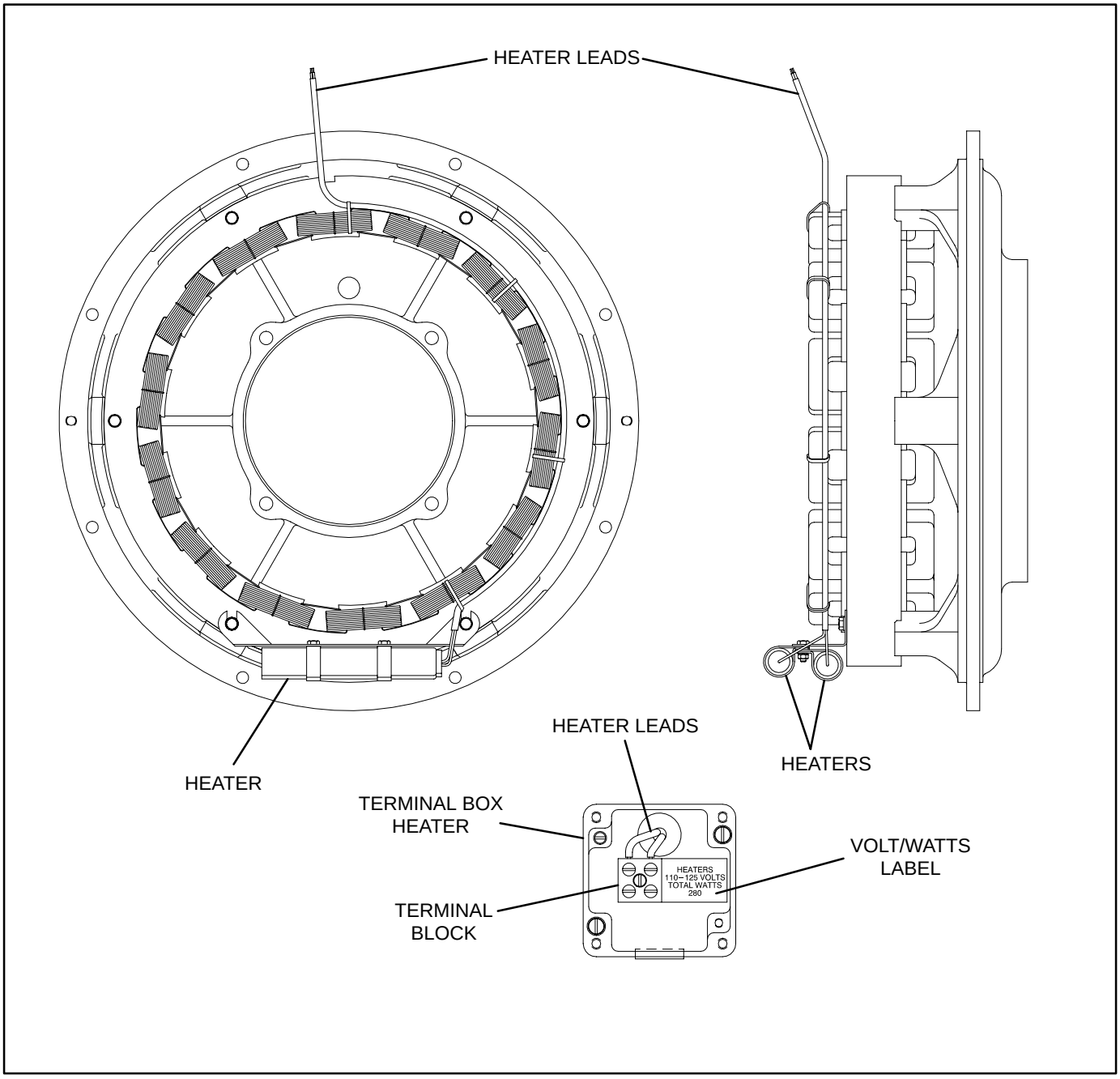

FIGURE 6-5. TYPICAL GENERATOR HEATER INSTALLATION

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7. Prestart Preparation

GENERAL

Before attempting the initial start of the generator set, be sure to complete the *Installation Checklist* in *Section 8*.

ELECTRICAL SYSTEM

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

Battery Connections

⚠WARNING ***Accidental starting of the generator set can cause severe personal injury or death. Make sure that the Run/Off/Auto switch on the control panel is set to the Off position before connecting the battery cables.***

Starting the unit requires 24 volt battery current, using four, 12 volt batteries (see *Specification* section). Connect the batteries in series (negative post of first battery to the positive post of the second battery) as shown in Figure 7-1.

Necessary battery cables are on the unit. Service batteries as necessary. Infrequent use (as in emergency standby service), may allow battery to self-discharge to the point where it cannot start the unit. If installing an automatic transfer switch that has no built-in charge circuit, connect a separate trickle charger. Cummins Power Generation automatic transfer switches include such a battery charging circuit.

⚠WARNING ***Ignition of explosive battery gases can cause severe personal injury or death. Always connect negative (–) battery cable last to prevent arcing.***

⚠WARNING ***Ventilate battery area before working on or near battery. Arcing at battery terminals, light switch or other equipment, flame, pilot lights and sparks can ignite battery gas. Do not smoke, or switch trouble light ON or OFF near battery. Discharge static electricity from body before touching batteries by first touching a grounded metal surface.***

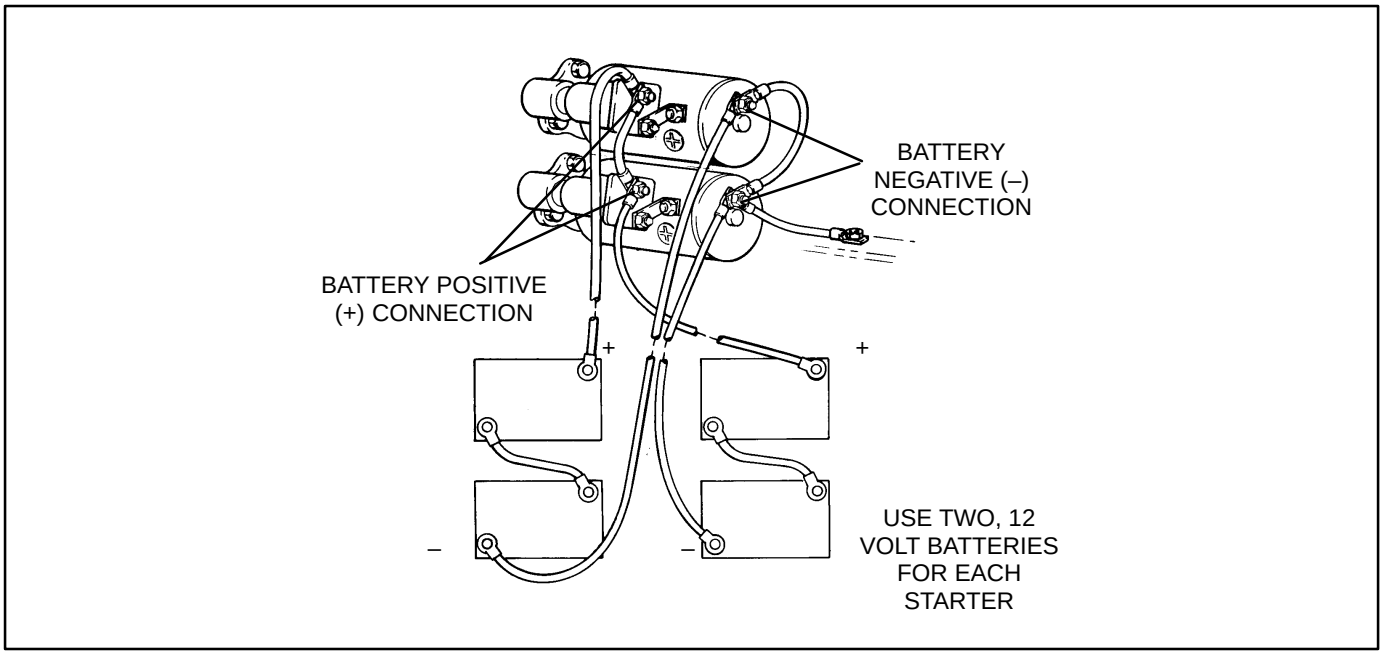

FIGURE 7-1. GENSET BATTERY CONNECTIONS

CONTROL PRESTART CHECKS

All generator set configuration options are set at the factory except for site related options, (e.g., Start/Stop Delays, Cycle Crank, Customer Fault names, etc.).

Adjustments of these options are divided into two categories within the menu driven system. These two categories are Setup and Adjust.

The Setup submenus are intended for qualified service personnel only. The Adjust submenu is intended for qualified service and site personnel only. For this reason, a separate password is required to modify the Setup submenus. The Adjust submenu may or may not require a password (site dependent).

The following procedure describes how to modify the Adjust submenu options that are required to complete the genset installation.

The Adjust submenu allows you to calibrate the generator set voltage/frequency and start/stop time delays. For the prestart checks, adjustment of only the start/stop delays is required.

ADJUST Submenu

Figure 7-2 shows the main menus (Menu A and Menu B) of the system control and the Adjust submenu.

To display the Adjust submenu, press the **MORE>>** button in Menu A and then the **ADJUST** button in Menu B.

The Adjust procedure is intended for qualified service personnel and site personnel only and may require a **USER** password. If a password is required, the **USER** password menu will appear when you try to modify the Adjust submenu. (Refer to *PASSWORD Menu* in this section to enter password.

Changes are automatically saved when you exit this menu.

Use the + and – buttons to increase or decrease the values in the following fields. Use the arrow (→) button to move the cursor within a field or to the next field. Selected field is highlighted.

START DELAY: This delay applies only to remote starting in the Auto mode. The Start Delay adjustment range is 0 to 300 seconds.

STOP DELAY: This delay applies only to remote stopping in the Auto mode. The Stop Delay adjustment range is 0 to 600 seconds.

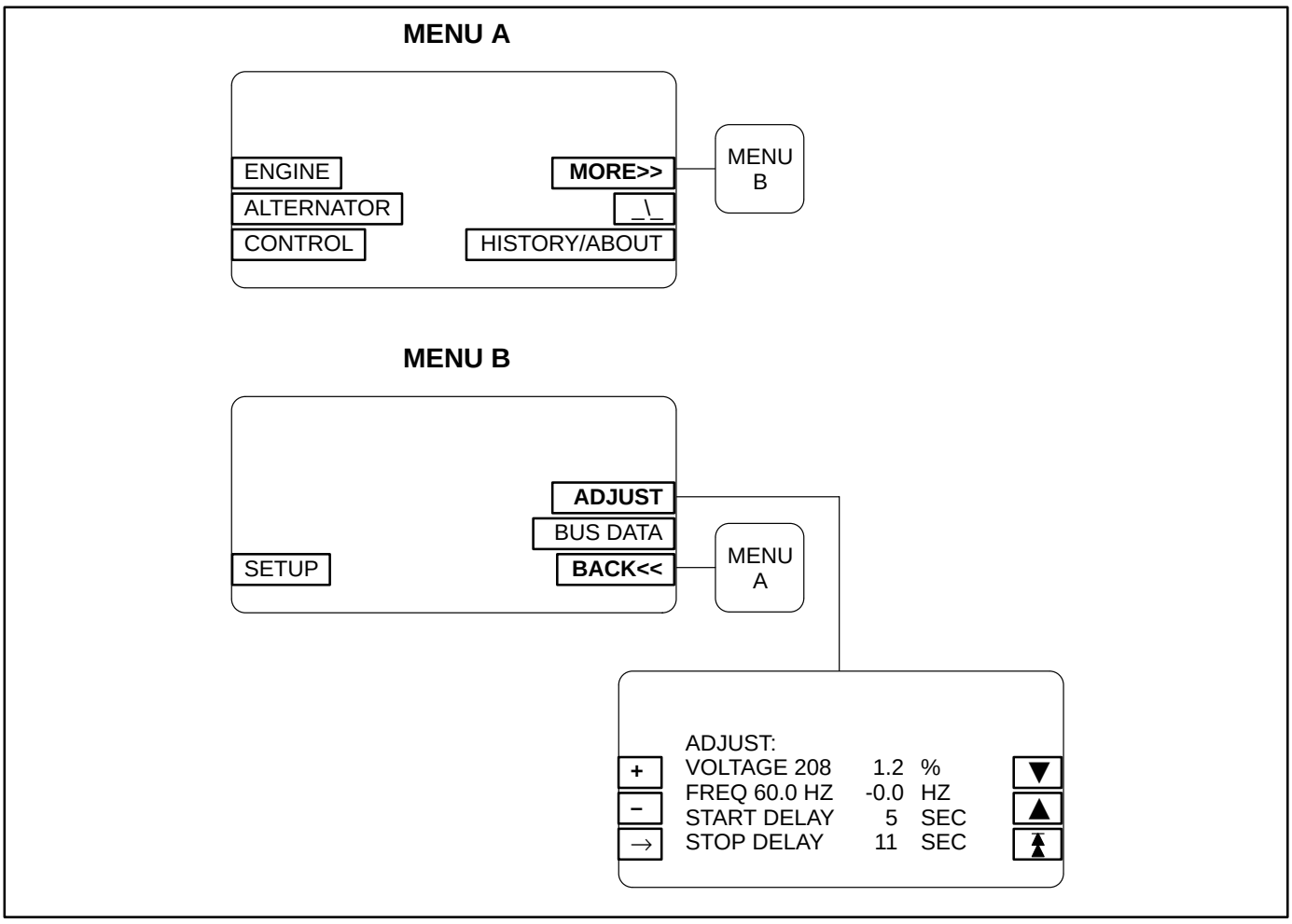

FIGURE 7-2. ADJUST SUBMENU

PASSWORD Menu

When viewing the Adjust submenu, pressing either the **+** or **–** button will display the Password menu (Figure 7-3) if a ***User*** password is assigned to this field. After entering the correct password, the system will allow you to modify the submenu. To prevent unauthorized adjustment, the entered password is valid for only 10 minutes after the last button is pressed.

To enter the password:

1. Display Adjust submenu.
2. Press either the **+** or **–** button within the displayed submenu. The Password menu appears. (Adjustment is allowed if Password menu does not appear.)
3. Press the **+** and **–** button to select the first character of the **User** password.
4. Press the → button to select the next character field.
5. Repeat steps 3 and 4 to enter remaining password characters.
6. Press the **Enter** button after entering the password. The Adjust submenu will reappear.
7. Exit Adjust submenu to save changes.

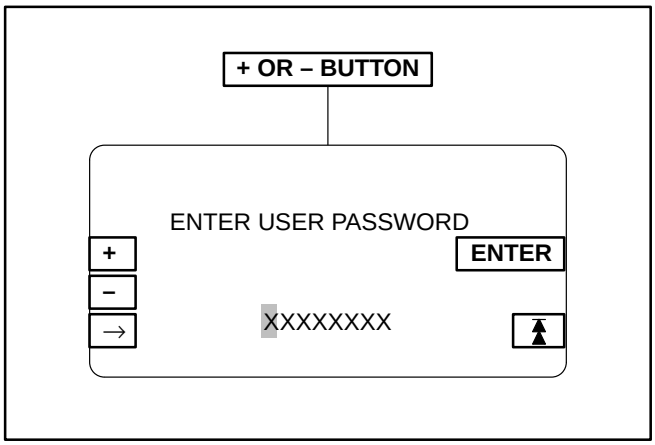

FIGURE 7-3. PASSWORD MENU

STARTING

Refer to the generator set *Operator's* manual for important safety precautions and recommended procedures for starting the genset and verifying proper operation. Start the generator set and verify all engine and generator gauges are displaying the correct values.

8. Installation Checklist

GENERAL

- ☐ Generator set wattage capacity is sufficient to handle maximum anticipated load.
- ☐ At least 3 feet of clearance (or greater for housing door) is provided around entire generator set for servicing and ventilation.
- ☐ Fan drive of set mounted cooling system is aligned (refer to Section 9).
- ☐ Generator set is located in an area not subject to flooding.
- ☐ All operating personnel have read and are familiar with Operator's Manual.
- ☐ All operators have been thoroughly briefed on preventive maintenance procedures.
- ☐ All operators have read and understand all Important Safety Instructions in Operator's Manual.

GENERATOR SET SUPPORT

- ☐ Floor, roof or earth on which the generator set rests is strong enough and will not allow shifting or movement. Observe local codes on soil bearing capacity due to freezing and thawing.
- ☐ Generator set is properly supported and retained to approved base.
- ☐ Supporting base is large enough and is of non-combustible material – extends 6-inches all around set.

COOLING AIR FLOW

- ☐ Generator set air inlet is faced into direction of strongest, prevailing winds.
- ☐ Air inlet openings are unrestricted and at least 1–1/2 times larger than air outlet area.
- ☐ Cooling air outlet is on downwind side of building (if not, wind barrier is constructed).
- ☐ Proper ducting material (sheet metal, canvas) is used between radiator and air outlet.

DIESEL FUEL SYSTEM

- ☐ Fuel tanks meet or exceed all Local, State or National codes.
- ☐ Fuel lines are properly installed, supported and protected against damage.
- ☐ Approved flexible fuel line is installed between main fuel supply line and generator set's fuel system, near the generator set, to protect the fuel system from damage caused by vibration, expansion and contraction.
- ☐ Strainer or fuel screen (100 to 120 mesh) is installed in the fuel supply line to protect the fuel lift pump, day tank transfer pump or float valve seat from fuel supply tank debris.
- ☐ Fuel supply line shutoff valves are installed to prevent fuel flow in case of leaks.
- ☐ No shutoff valves are installed on engine fuel return line.
- ☐ External fuel pumps are connected and operational at all times (generator set started or shut down).
- ☐ Fuel system is properly primed.
- ☐ No fuel leaks are found in supply line or engine fuel system.

EXHAUST SYSTEM

- ☐ Operators are thoroughly briefed on the dangers of carbon monoxide gas.
- ☐ Areas around set are well ventilated. No possibility of exhaust fumes entering building doors, windows, or intake fans.
- ☐ Exhaust gases are piped safely outside and away from building.
- ☐ The correct length of approved rigid pipe is connected to the generator set flexible pipe using approved securing methods with no weight resting on engine exhaust components. There are no bends in flex section.
- ☐ Condensation drain is provided in lowest section of exhaust piping.
- ☐ Exhaust piping is insulated to guard against burns to personnel.
- ☐ Exhaust piping passing through walls or ceilings have approved fire-proof materials and are in compliance with all codes.
- ☐ Exhaust piping is large enough in diameter to prevent excessive back pressure on engine.

AC AND DC WIRING

- ☐ Wire sizes, insulation, conduits and connection methods all meet applicable codes.
- ☐ AC and DC wires are separated in their own conduit to prevent electrical induction.
- ☐ All load, line and generator connections are proper and correct.
- ☐ Flexible conduit between generator set and building or surrounding structure.

GENERATOR SET PRESTART

- ☐ Generator set engine is properly serviced with oil and coolant.
- ☐ Batteries are properly installed, serviced and charged.
- ☐ Battery charger and engine coolant heater are connected and operational.
- ☐ All generator set covers and safety shields are installed properly.
- ☐ All fuel and coolant shutoff valves are operational.

9. Radiator Assembly Installation

GENERAL

The following procedure describes how to install the radiator assembly when the radiator and genset are shipped as separate items. The order of installation is as follows:

1. Remove radiator from shipping skid and position radiator vertically.
2. Assemble generator set to cooling system.
3. Mount generator set.
4. Fill cooling system.
5. Align cooling system fan drive.
6. Install the fan drive guard.
6. Check the fan drive alignment during initial start–up procedure.

For remote–cooled or heat exchanger generator sets, only mounting, leveling and coolant pipe hook-up is required.

Read these instructions completely and become familiar with safety warnings, cautions, and procedures before starting the installation.

The installer must be familiar with the techniques of working on heavy machinery. A hoist must be available which can support the weight of the radiator, with an appropriate lifting strength margin.

SPECIAL TOOLS

This installation requires the following tools:

- 8 mm hexagon wrench
- Straightedge at least 48 inches (1219 mm) long
- Large pry bar to align radiator to skid

SHIPPING SKID REMOVAL

The following procedure describes how to remove the shipping skid and reposition the radiator assembly from the horizontal shipping position to the installed vertical position.

⚠WARNING ***The radiator cooling system is heavy, approximate dry weight is 5,000 pounds (2,250 kg). Dropping can cause severe personal injury or death. Use a hoist of sufficient capacity, do not stand under a raised radiator and keep hands and feet clear of the perimeter of the radiator while maneuvering it.***

1. Cut cable ties and remove radiator parts (hoses, fan drive belt, wiring harness, etc.) from the fan blade guard.
2. Attach hoist to the lifting channels at the top and bottom of the radiator (Figure 9-1**A**). Four cables should be used; two at the top and two at the bottom of the radiator.
3. Hoist the radiator and remove packing crate and then position wooden blocks under radiator. Lower radiator onto wooden blocks.
4. Position the radiator onto its back (fan pulley facing upward) using hoist attached to lifting channels (Figure 9-1**B**). Slowly lower radiator onto wooden blocks while making sure protruding interconnecting pipework cannot be damaged. (Wooden blocks are not required under skid-end of radiator.)
5. Attach hoist to **ALL FOUR** lifting brackets mounted to the top of the radiator assembly (Figure 9-1**C**). All four brackets should be used when moving the radiator for any reason.
6. Raise the radiator into the vertical position while making sure protruding interconnecting pipework cannot be damaged.

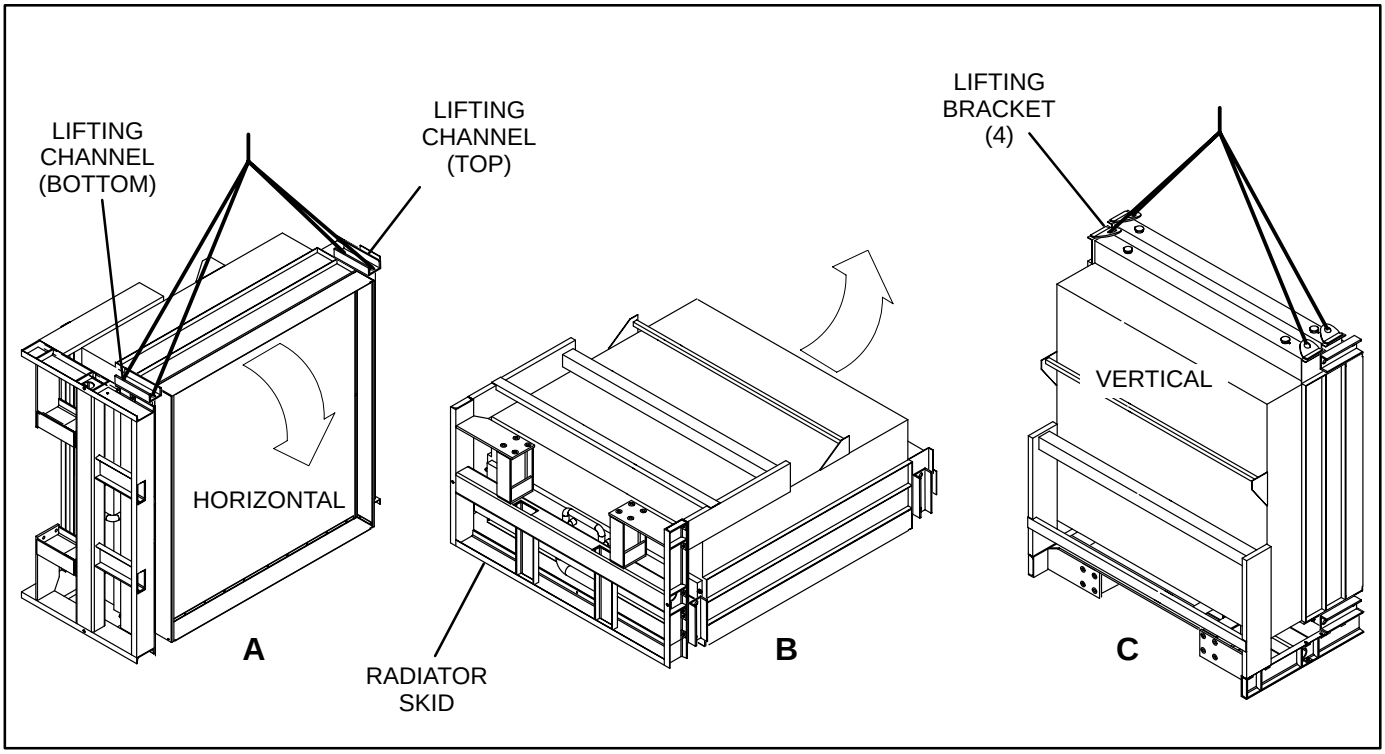

FIGURE 9-1. LIFTING SEQUENCE FOR UNPACKING

ASSEMBLE GENERATOR SET

Assemble the generator set as near as possible to the final mounting location of the set. Moving the generator set with the cooling system installed is permissible using only the lifting lugs provided on the main engine/generator skid. Assembly should take place on a floor surface that is flat and level.

⚠WARNING ***The engine/generator platform and radiator cooling system are heavy, approximate dry weight of the radiator cooling system is 5,000 pounds (2,250 kg) and the engine/generator can weigh up to 38,700 pounds (17,450 kg). Dropping can cause severe personal injury or death. Use a hoist or fork lift of sufficient capacity, do not stand under a raised radiator or engine/generator and keep hands and feet clear of the perimeter of the radiator or engine/generator while maneuvering them.***

1. Move the radiator into location.
2. Move the engine/generator platform into position next to the radiator.
3. Align the mounting holes in the radiator skid with the mounting holes in the engine/generator skid. Use a pry bar or some other tool to align the holes in the two skids.
4. Fasten the radiator and engine skids together with the hardware provided (M20 x 70mm and M20 flat washer and locknut). Tighten all skid/bracket fasteners to 450 ft-lbs (610 N•m) torque.
5. After the radiator is fastened to the engine skid, remove the four lifting brackets from the top of the radiator (Figure 9-1**C**). The cooling system will be damaged if these brackets are used for lifting with the radiator skid attached to the engine skid.

The generator set is now prepared for mounting and leveling (refer to Section 3).

Install Radiator Pipes

Begin to install the radiator pipes at one side and proceed in order to the other side. This procedure requires two people: one at the top and one on the floor.

1. Install the J/W outlet tube bracket (Figure 9-2) to the skid using two M8 x 25 mm screws.
2. If necessary, loosen clamp to adjust engine water inlet tube (LTA) so that the tube outlet faces the radiator.
3. Slide radiator hose all the way on both ends of each tube. Apply a lubricant such as WD40 or soap/water solution to mating surfaces to ease installation.
4. Open the hose clamps enough so that they slip over the radiator hose and slip clamps over the ends of the tubes and onto the mating tubes on the engine and the radiator.
5. Move the tube into position and slide the radiator hose over the mating tube at the top and tighten the clamps enough so that they stay in place.
6. Slide the radiator hose over the bottom mating tube and tighten the clamps.
7. Tighten the clamps on both ends of all tubes to 90–105 inch-lbs (10–12 N-m).
8. Install the tube clamp on J/W outlet tube to the bracket installed in Step 1.

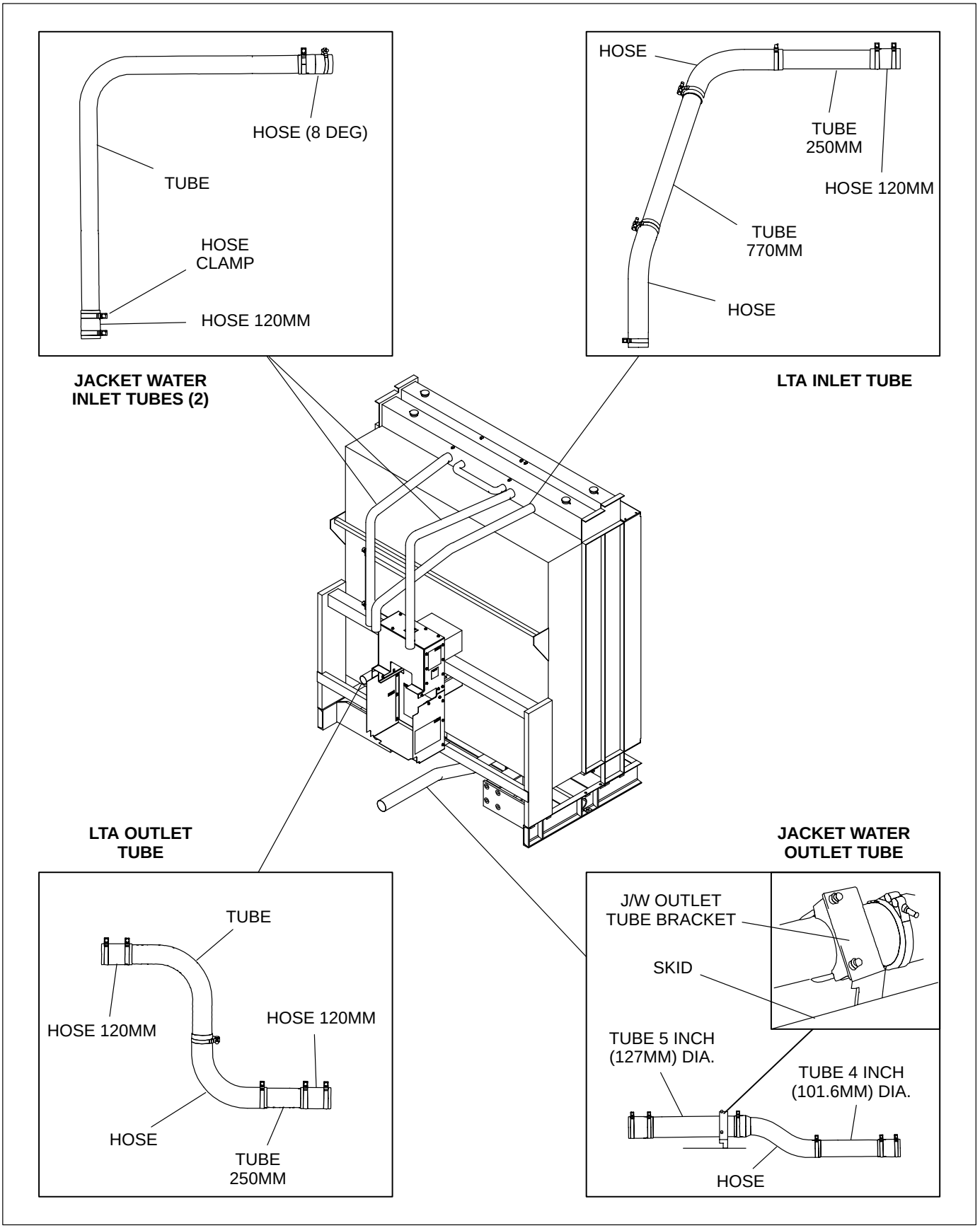

FIGURE 9-2. RADIATOR TUBES

Install Vent Lines & Low Coolant Level Sensor/Cable

1. Connect the vent line hoses. Be sure to install the check valve as shown in Figure 9-3.
2. Thread the low coolant level sensor into the radiator. Use pipe thread sealant on sensor threads (do not use Teflon tape).
3. Connect the harness lead of the low coolant level (LCL) sensor to the connector located by the engine coolant filters.
4. Secure the vent pipes and harness to the radiator tubes with cable ties as shown in Figure 9-3.

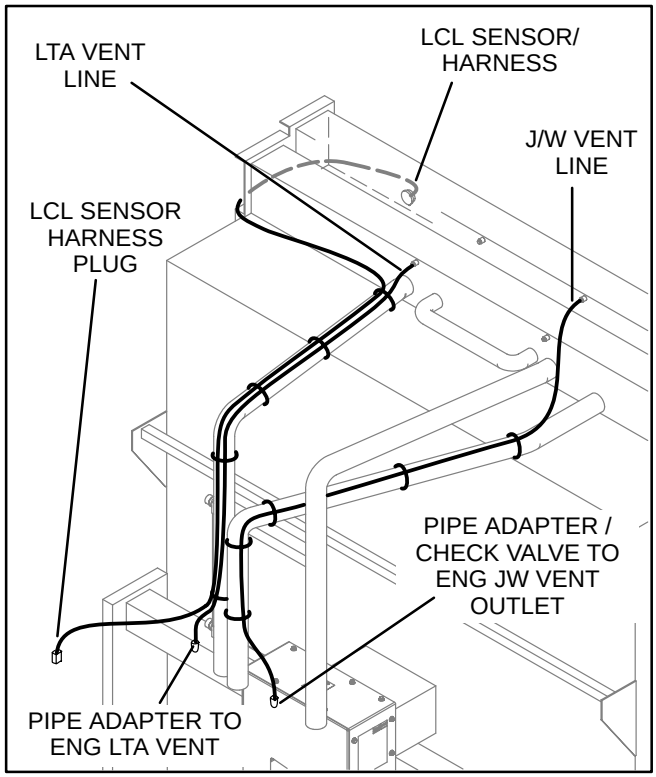

FIGURE 9-3. VENT PIPES/LOW COOLANT LEVEL SENSOR

Install Return Fuel Cooler Hose

Connect the return fuel cooler hose between the radiator and the fuel return line of the engine as shown in Figure 9-4.

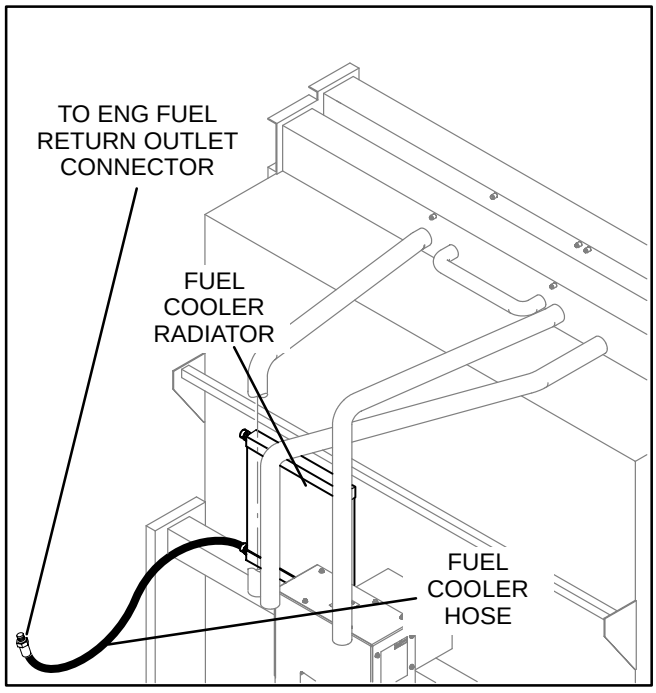

FIGURE 9-4. FUEL COOLER HOSE

Fill Cooling System

After the generator set has been properly assembled and mounted, fill the cooling system. Note that the cooling system must be filled before belt alignment. Weight of coolant can change alignment.

The engine cooling system for these models consists of two separate liquid cooling system circuits. This two-circuit system is commonly referred to as a “two pump two loop” (2P2L) cooling system. One system is dedicated to the engine jacket water (JW) circuit. The other is for the engine low-temperature aftercooling (LTA) circuit.

Both circuits require a blend of 50% ethylene or propylene glycol and 50% water. The quality requirements are defined by PGA drawing 0880–0152. Each radiator-cooled genset is shipped with 200 units (5 gallons [19 liters]) of Fleetguard supplemental coolant additive (SCA), tradename DCA4. If the radiators are not filled using Fleetguard “Compleat” brand antifreeze or equivalent antifreeze, the DCA4 needs to be added to the cooling systems.

Add 120 units (3 gallons [11.5 liters]) to the jacket water (front) radiator when filling, and 80 units [2 gallons (7.5 liters)] to the LTA (rear) radiator when filling.

⚠ CAUTION ***Failure to use the correct type of coolant, maintain the correct level and bleed the systems of air can result in severe engine damage.***

1. **Water-cooled turbochargers:**
   Open the petcock at the top of each of the four turbochargers.

   N**on-water-cooled turbochargers:**
   Loosen the vent line at the engine jacket water (JW) vent outlet located on top of the engine thermostat housing (Figure 9-3).
2. Remove the radiator cap on the jacket water cooling (front) radiator. Begin filling the radiator with antifreeze, water, and SCA. The capacity of this J/W cooling system is 90 gallons (341 liters) minus amount of DCA4, if used.
3. **Water-cooled turbochargers:**
   When coolant begins to flow from a petcock, close the petcock and continue filling the radiator.

   Non-water-cooled turbochargers:
   Tighten vent line when coolant begins to flow from the vent outlet.
4. Observe the coolant level through the sight glass at the top of the J/W radiator. Coolant level should be approximately in the middle of the sight glass with a cool engine.
5. When the radiator is full, replace the radiator cap securely. Push down and twist clockwise until the cap lip hits the tank stop flange.

   ⚠WARNING ***Failure to properly replace coolant caps can result in hot pressurized coolant escaping from the radiator fill necks, causing severe personal injury and engine damage. Always make sure the radiator caps are properly secured before operating the genset.***
7. Remove the radiator cap on the low-temperature aftercooling (rear) radiator. Begin filling the radiator with antifreeze, water, and SCA. The capacity of this radiator is 40 gallons (151 liters) minus amount of DCA4, if used.
8. Observe the coolant level in the radiator through the sight glass at the top of the LTA radiator. Coolant level should be approximately in the middle of the sight glass with a cool engine.
9. When the radiator is full, replace the radiator cap securely. Push down and twist clockwise until the cap lip hits the tank stop flange.

   ⚠WARNING ***Failure to properly replace coolant caps can result in hot pressurized coolant escaping from the radiator fill necks, causing severe personal injury and engine damage. Always make sure the radiator caps are properly secured before operating the genset.***

Align Cooling System Fan Drive

Align the fan drive after the genset is assembled, mounted, filled with coolant and leveled (see *Section 3*). The fan drive pulleys must be aligned for proper fan drive operation.

1. Use a long straightedge (not supplied) to align the crankshaft pulley to the fan drive pulley. The straightedge should be flat against the vertical surface of the engine pulley near the center. See Figure 9-5. The fan drive pulley should be 0.25” nominal toward engine from straight edge.

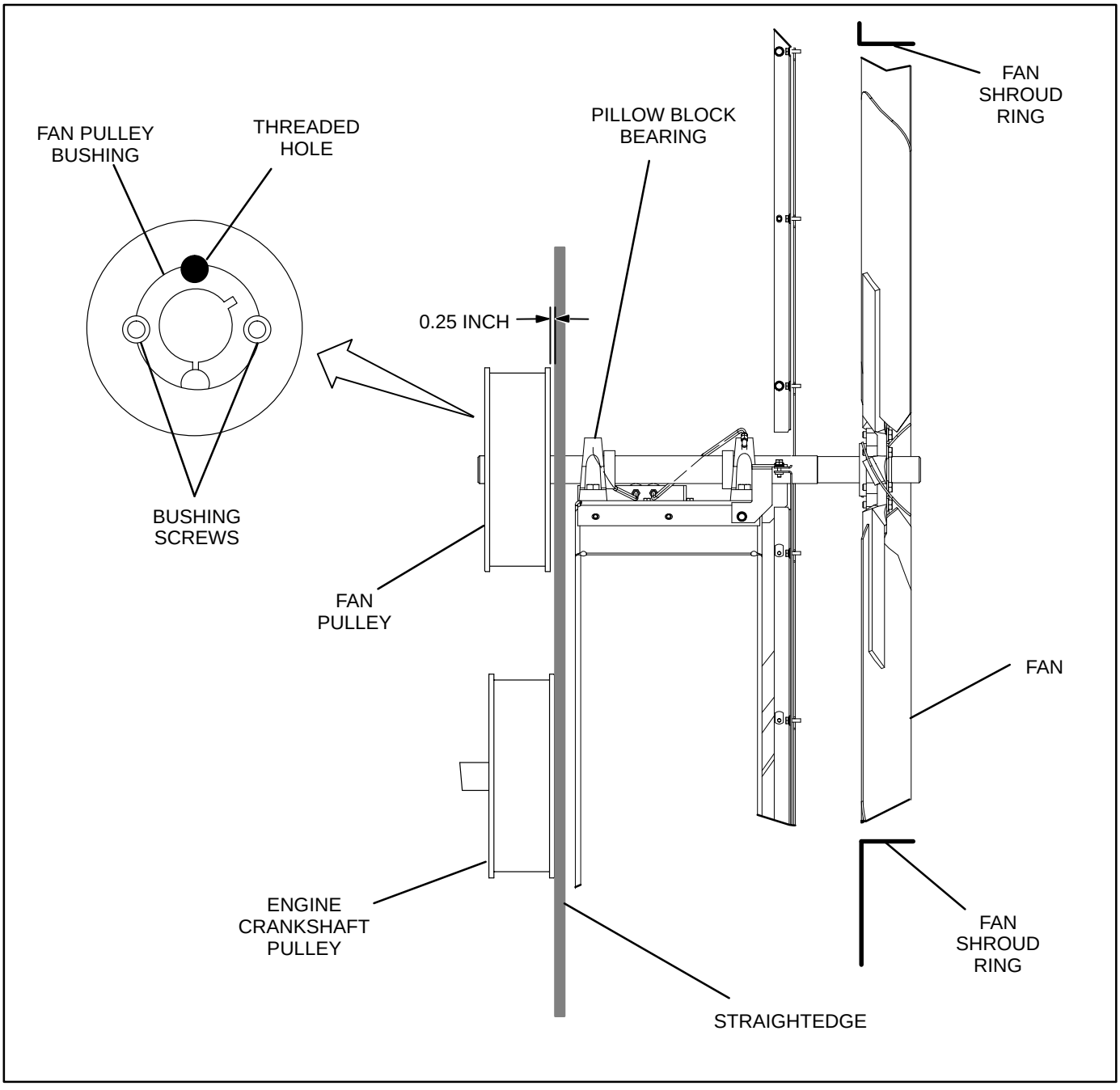

FIGURE 9-5. FAN DRIVE PULLEY ALIGNMENT

2. To align the fan drive pulley so that it is 0.25” toward engine from the crankshaft pulley:

   A. Use pencil to mark current location of fan drive pulley on shaft.

   B. Mark estimated (new) location on shaft, determined by width of gap found in Step 1.

   C. Remove the two screws from the fan pulley bushing. Install one of these screws into the threaded hole located between the two screws that were removed. (Figure 9-5). Tighten the screw to separate bushing from pulley and remove the screw.

   D. Move bushing to the new location mark.

   E. Install the two screws into the bushing and tighten alternately to 67 ft-lbs (91 N•m) torque.

   F. Recheck alignment and repeat procedure until alignment is achieved.

   Perform a final check by rotating the fan slowly by hand and make sure the specified clearance is achieved. Make sure any loosened shroud or safety guard fasteners are retightened.

3. Install the drive belt. This procedure requires two people.

   ⚠WARNING ***The fan belt idler is under tension. Do not allow your hands to get between the idler and the belt or the fan hub. Personal injury will result.***

   Use an 8-point socket and breaker bar or a large wrench to hold the idler in position against the spring tension (Figure 9-6). Turn the wrench until the idler pulley position is sufficient to position the belt in front of the idler pulley. Align the grooves of the belt on the ribs of the pulley and shaft and then slowly release spring tension onto belt.

   The spring-loaded idler used on this design automatically maintains the correct belt tension.

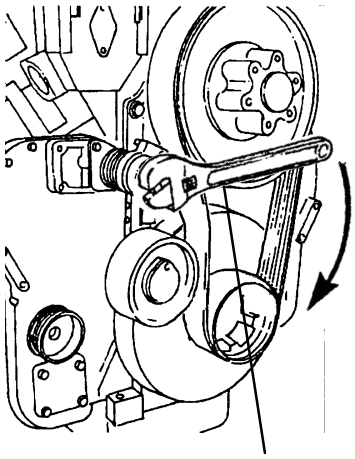

FIGURE 9-6. FAN BELT INSTALLATION

Install the Fan Drive Guard

Install the fan drive guard (Figure 9-7) as follows.

Assemble the fan guard with M8 x 25 mm self-locking hex washer head screws.

1. Attach the lower guard to the cooling system frame and attach the lower front guard to the lower guard.
2. Install the left and right side brackets.
3. Install the upper front guard.
4. Install the upper guard.
5. Install the rear guard.
6. Check to make sure that all fan guards are in place and secure. You should not be able to touch any moving part with guards properly installed.

⚠WARNING ***Contact with fan, belt, or pulleys can result in severe personal injury. All shroud and guard pieces must be properly fastened in place to prevent unintended contact.***

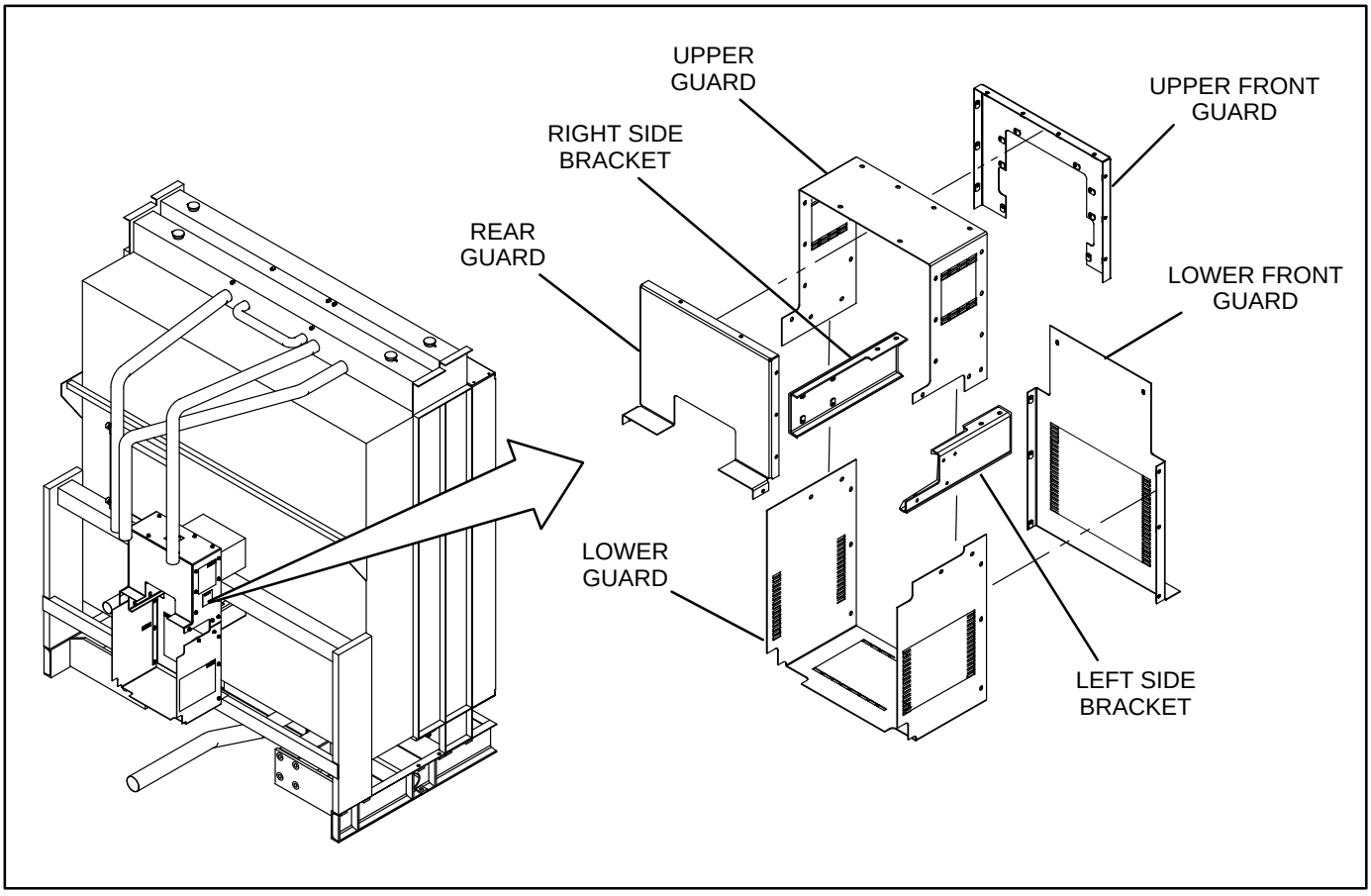

FIGURE 9-7. FAN DRIVE GUARD

Run The Generator Set

The final check is to observe the drive belt when the genset is running.

1. When starting the engine for the first time after completing the generator set site installation, confirm that the drive belt is properly seated in all grooves in both pulleys. This only requires visual inspection.

   ⚠WARNING ***Wear safety glasses and stand far from the running fan drive without guards installed. A misaligned fan drive or improperly installed drive belt can cause the belt to break, causing severe injury to near by personnel. A properly aligned and installed belt can grab loose clothing or body parts causing severe personal injury.***

2. If the belt "wanders", "walks", or jumps between pulleys, either the fan drive needs to be re-aligned, or the belt was improperly installed.
3. If the belt or drive should be corrected, stop the engine, disconnect the negative lead (**–**) of the starting batteries (or close the pneumatic supply valve and bleed pressurized air if equipped with air starters). Disassemble the fan drive guard, realign the fan drive pulley, and check the alignment again.
4. After the belt is properly installed, start the genset and check belt walk again.

   ⚠WARNING ***Contact with fan, belt, or pulleys can result in severe personal injury. All shroud and guard pieces must be properly fastened in place to prevent unintended contact.***

5. Attach and secure all fan guard pieces that were removed for belt adjustment.

   ⚠WARNING ***Contact with hot coolant can result in serious burns. Allow the engine to cool before loosening the radiator cap or coolant drain.***

6. Recheck coolant levels after engine cools. Add coolant if required.

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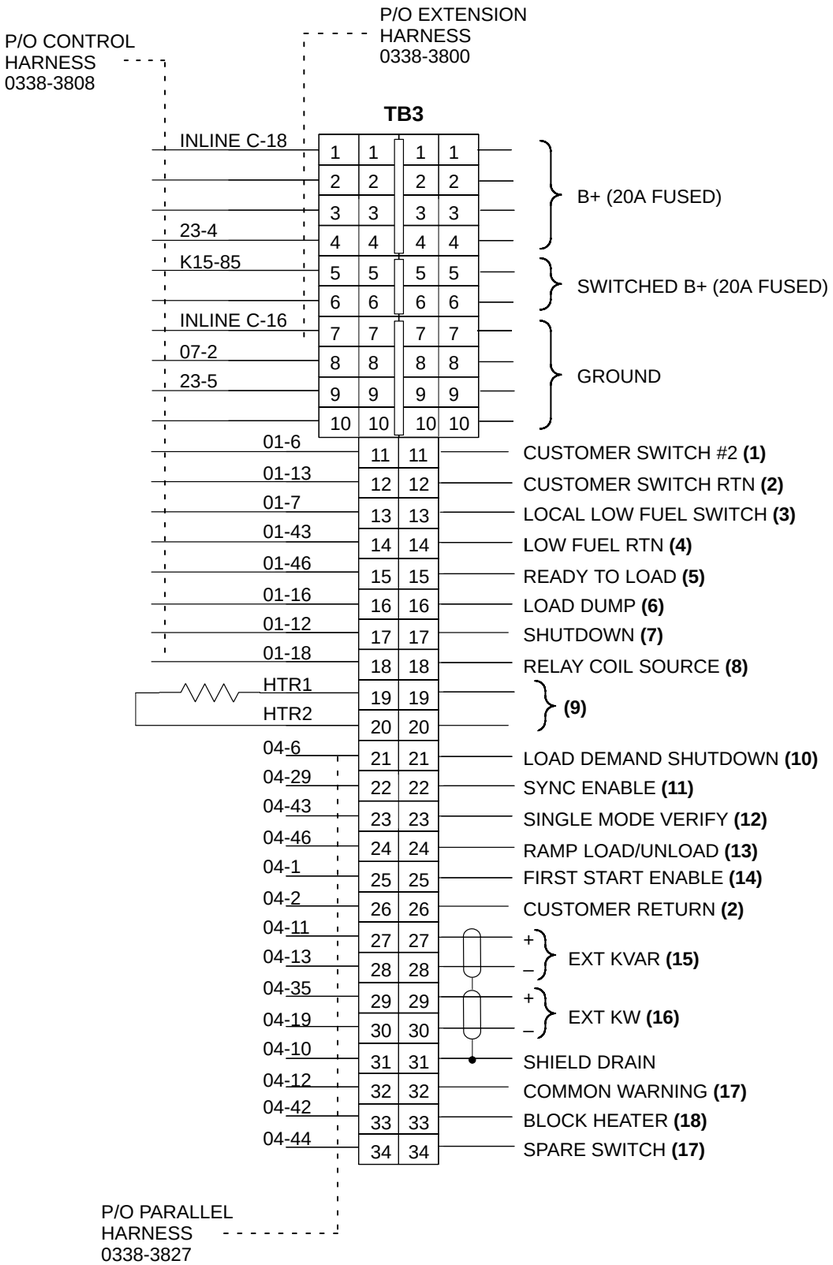

NOTES:

1. CONFIGURABLE CUSTOMER WARNING OR SHUTDOWN SWITCH WITH WAKE-UP CONTROL. APPLY TO CUSTOMER SWITCH RTN TO ACTIVATE.
2. RETURN CONNECTION FOR CUSTOMER SWITCHES.
3. LOCAL LOW FUEL WARNING. APPLY TO LOW FUEL RTN TO ACTIVATE. ACTIVE LOW WITH LESS THAN 50mA CURRENT.
4. RETURN CONNECTION FOR LOCAL LOW FUEL SWITCH AND REMOTE LOW FUEL SWITCH.
5. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) OPERATES WHEN GENERATOR HAS REACHED 90% AC VOLTAGE AND FREQUENCY.
6. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) CONFIGURABLE OPERATION AT UNDER FREQUENCY, OVERLOAD, OR BOTH.
7. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) OPERATES ON GENERATOR SHUTDOWN.
8. RELAY COIL SOURCE HIGH SIDE DRIVER FOR READY TO LOAD, LOAD DUMP, SHUTDOWN, AND MODEM CONTROL RELAY DRIVERS.
9. 120 VAC OR 240 VAC AT 50W.
10. FOR MULTIPLE UNIT OPERATION. APPLY TO CUSTOMER RTN OR GROUND TO SHUTDOWN INDIVIDUAL CAPACITIES AS LOAD DICTATES. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
11. FOR SINGLE / UTILITY PARALLEL MODE. APPLY B+ (24 VDC) TO ENABLE SYNCHRONIZER.
12. FOR SINGLE / UTILITY PARALLEL MODE. APPLY TO CUSTOMER RTN OR GROUND WHEN PARALLEL WITH UTILITY. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
13. APPLY TO CUSTOMER RTN OR GROUND TO LOAD GENSET. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
14. FOR MULTIPLE UNIT OPERATION. APPLY B+ (24 VDC) TO ENABLE FIRST UNIT.
15. ANALOG 0–5 VDC INPUTS TO CONTROL GENERATOR REACTIVE POWER IN UTILITY PARALLELING MODE.
16. ANALOG O–5 VDC INPUTS TO CONTROL GENERATOR REAL POWER IN UTILITY PARALLELING MODE.
17. SELF PROTECTED RELAY DRIVER (200mA @ 24 VDC) OPERATES ON CUSTOMER DEFINED WARNING OR STATUS.
18. SELF PROTECTED RELAY DRIVER (200 mA @ 24 VDC) FOR OPERATING ENGINE BLOCK HEATER.

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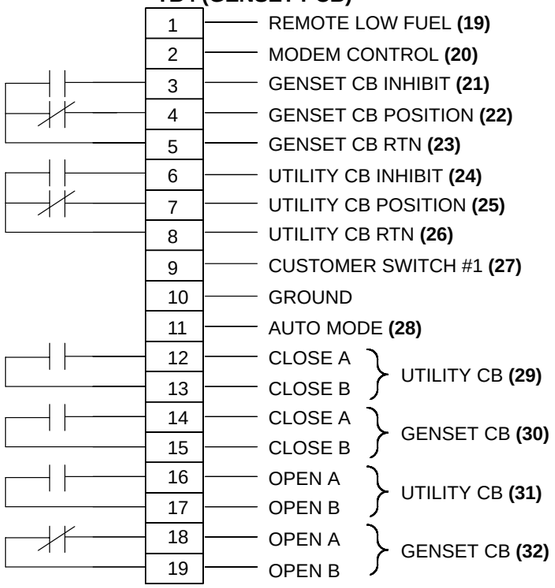
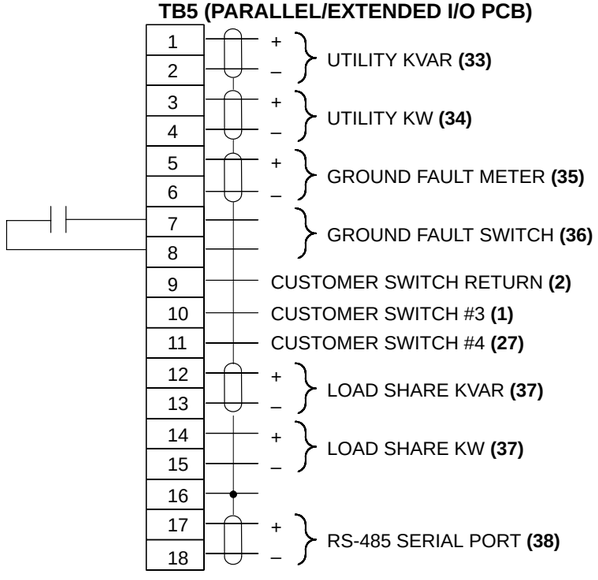
CUSTOMER CONNECTIONS (PAGE 1 OF 2)

TB4 (GENSET PCB)



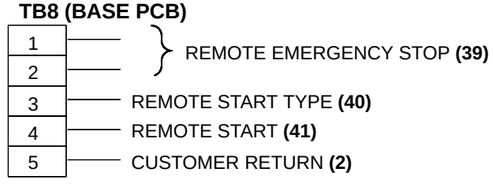
TB5 (PARALLEL/EXTENDED I/O PCB)



NOTES:

19. REMOTE LOW FUEL WARNING. APPLY TO GROUND OR LOW FUEL RTN TO ACTIVATE. ACTIVE LOW WITH LESS THAN 50mA CURRENT.
20. SELF PROTECTED RELAY DRIVER (200mA @ 24 VDC) FOR APPLYING POWER TO MODEM.
21. APPLY TO GENSET CB RETURN TO INHIBIT GENSET CB FROM CLOSING. ACTIVE LOW WITH LESS THAN 50 mA CURRENT.
22. INPUT FROM GENSET CB “B” CONTACT TO INDICATE CB POSITION.
23. RETURN FOR GENSET CB INHIBIT AND POSITION.
24. APPLY TO UTILITY CB RETURN TO INHIBIT UTILITY CB FROM CLOSING. ACTIVE LOW WITH LESS THAN 50mA CURRENT.
25. INPUT FROM UTILITY CB “B” CONTACT TO INDICATE CB POSITION.
26. RETURN FOR UTILITY CB INHIBIT AND POSITION.
27. CONFIGURABLE CUSTOMER WARNING OR SHUTDOWN SWITCH. CONFIGURABLE TO ACTIVATE WHEN EITHER THE CIRCUIT IS OPENED OR CLOSED TO CUSTOMER SWITCH RETURN.
28. INDICATES GENSET IS IN AUTO MODE. ACTIVE HIGH (24 VDC). FUSED AT 5A.
29. CLOSE RELAY CONTACT FOR UTILITY CB. FUSED AT 5A (N/O).
30. CLOSE RELAY CONTACT FOR GENSET CB. FUSED AT 5A (N/O).
31. OPEN RELAY CONTACT FOR UTILITY CB. FUSED AT 5A (N/O).
32. OPEN RELAY CONTACT FOR GENSET CB. FUSED AT 5A (N/C).
33. ANALOG MONITOR SIGNAL (0–5 VDC) FOR UTILITY REACTIVE POWER.
34. ANALOG MONITOR SIGNAL (0–5 VDC) FOR UTILITY REAL POWER.
35. ANALOG INPUT FOR GROUND FAULT CURRENT.
36. APPLY N/O RELAY CONTACT. ACTIVATES ON GROUND FAULT.
37. PARALLEL LOAD SHARE LINES (0–1mA).
38. RS–485 SERIAL PORT CONNECTION.
39. OPEN CONNECTION TO INITIATE EMERGENCY STOP. THESE TERMINALS MUST BE SHORTED TOGETHER IF REMOTE EMERGENCY STOP OPTION NOT USED.
40. DETERMINES REMOTE START TYPE: APPLY TO CUSTOMER RTN FOR NORMAL START SEQUENCE WITH WARM-UP. OPEN = EMERGENCY START SEQUENCE.
41. APPLY TO CUSTOMER RETURN OR GROUND TO INITIATE A REMOTE START. ACTIVE LOW WITH LESS THAN 50mA CURRENT.

TB8 (BASE PCB)



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