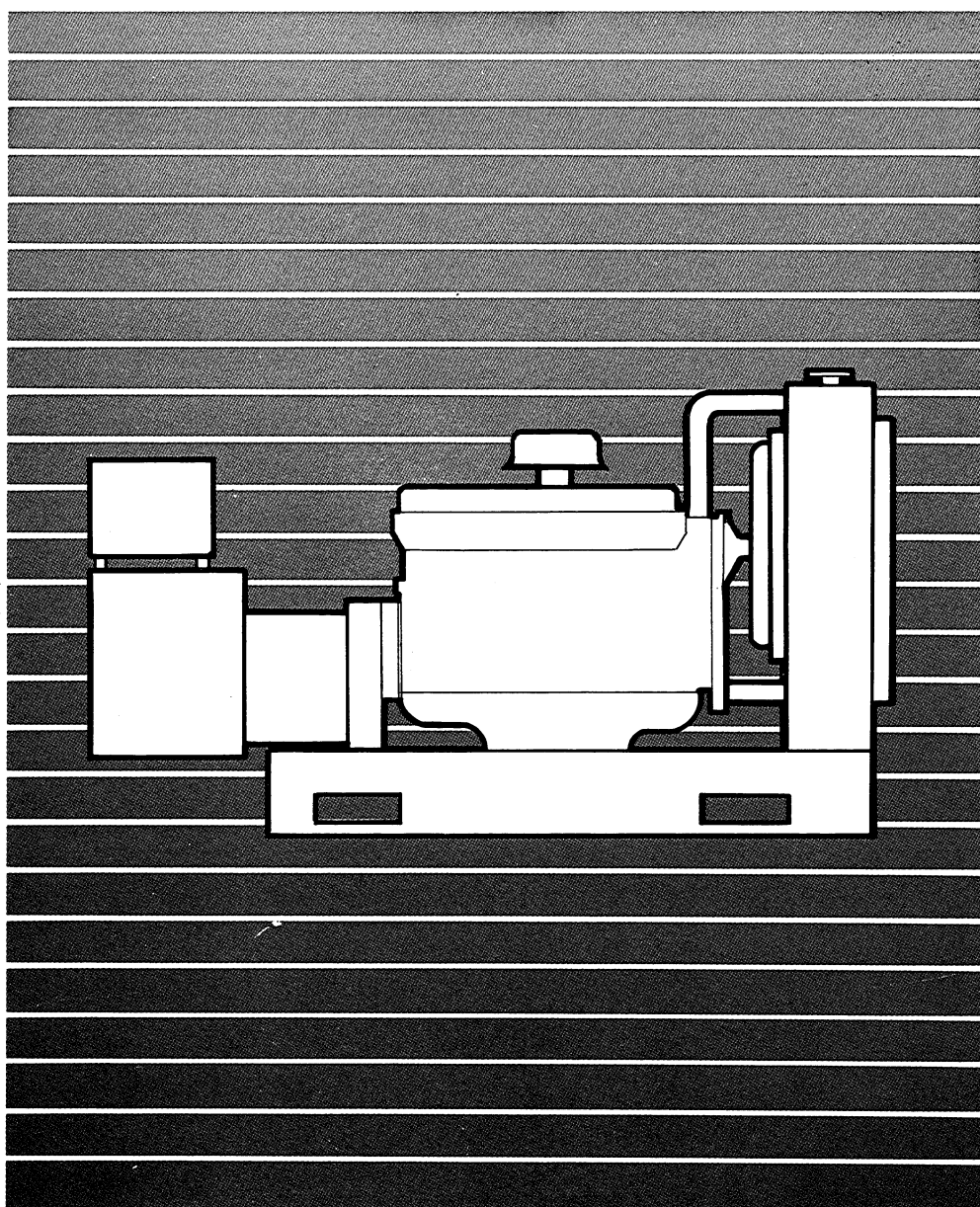




# Cummins Power Systems

# Operation and Maintenance Manual

4A2.3  
6A3.4-GS/GC-1  
6A3.4-GS/GC-2  
6AT3.4-GS/GC  
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.**

# Safety Precautions

**Before operating the generator set**, read the Operation and Maintenance 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.



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



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



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

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

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

**EXHAUST GASES ARE DEADLY**

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

## **Safety Precautions (continued)**

### **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.
- Provide appropriate fire extinguishers and install them in convenient locations. Consult the local fire department for the correct type of fire 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.

# Table of Contents

SECTION TITLE	PAGE
<b>1 INTRODUCTION</b> .....	1-1
About this Manual .....	1-1
How to Obtain Service .....	1-1
Generator Set Overview .....	1-2
Control Panel .....	1-3
<b>2 OPERATION</b> .....	2-1
General .....	2-1
Prestart Checks .....	2-1
Starting .....	2-3
Stopping .....	2-3
Break-In .....	2-3
No-Load Operation .....	2-3
Exercise Period .....	2-3
High/Low Operating Temperatures .....	2-4
Power Rating Factors .....	2-4
<b>3 TROUBLESHOOTING</b> .....	3-1
<b>4 MAINTENANCE</b> .....	4-1
Generator Set Inspection .....	4-2
Lubrication System .....	4-4
Crankcase Breather .....	4-6
Cooling System .....	4-6
Fuel System .....	4-9
Air Cleaner .....	4-11
Fan Belt .....	4-13
Valve Clearance .....	4-13
AC Generator .....	4-13
Batteries .....	4-14
<b>5 INSTALLATION</b> .....	5-1
General .....	5-1
Specifications .....	5-3
Mounting the Generator Set .....	5-4
Mechanical Connections .....	5-5
Electrical Connections .....	5-9
AC Wiring .....	5-10
DC Wiring .....	5-12

# Table of Contents (Continued)

SECTION TITLE	PAGE
<b>6 PRESTART PREPARATIONS</b> .....	6-1
Ventilation .....	6-1
Exhaust System .....	6-1
Mechanical Check .....	6-1
Electrical System .....	6-1
Coolant .....	6-2
Lubrication .....	6-2
Fuel .....	6-2
<b>7 INITIAL START AND CHECKS</b> .....	7-1
Prestart Control Checks .....	7-1
Starting .....	7-1
Engine Gauges .....	7-2
AC Checks .....	7-2
Exhaust System .....	7-3
Fuel System .....	7-3
Mechanical .....	7-3
Stopping .....	7-3
Break-in Procedure .....	7-3

# Section 1. Introduction

## ABOUT THIS MANUAL

This manual contains information for installing, operating, and maintaining the generator set. Study this manual carefully and observe all the warnings and cautions. Using the generator set properly and following a regular maintenance schedule is important to obtain longer unit life, better performance and safer operation.

Included with the generator set literature package is a copy of the engine manual. The engine manual may be used in conjunction with the generator set Operation and Maintenance manual. The operation and maintenance procedures for the complete generator set (including the engine) are covered in this manual. In case of conflicting information this manual takes precedence over the engine manual.

For any operation, maintenance, or troubleshooting information not contained in this manual, contact the distributor.

## HOW TO OBTAIN SERVICE

When the generator set requires servicing, contact your distributor for assistance. Factory trained Parts and Service representatives are ready to handle your service needs.

When contacting your distributor, always give the complete model number and serial number as shown on the generator set data tag (see Figure 1-1). The generator set data tag is located on the side of the AC output box.

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

kw		kva	pf	phase
voltage		amps		
duty		overload		
rpm		hz		
class of insulation		pmg voltage		
field amp max		field voltage max		
generator model no.				
voltage regulator model no.				
ID no.				
generator set serial no.				
BS5000 Part 99		NEMA MG1-22		

3060603  
99 2388

FIGURE 1-1. GENERATOR SET DATA TAG



## GENERATOR SET OVERVIEW

Study the illustrations of the generator set and become familiar with the location of the various components and controls. A more detailed description of the control components follow in this section.

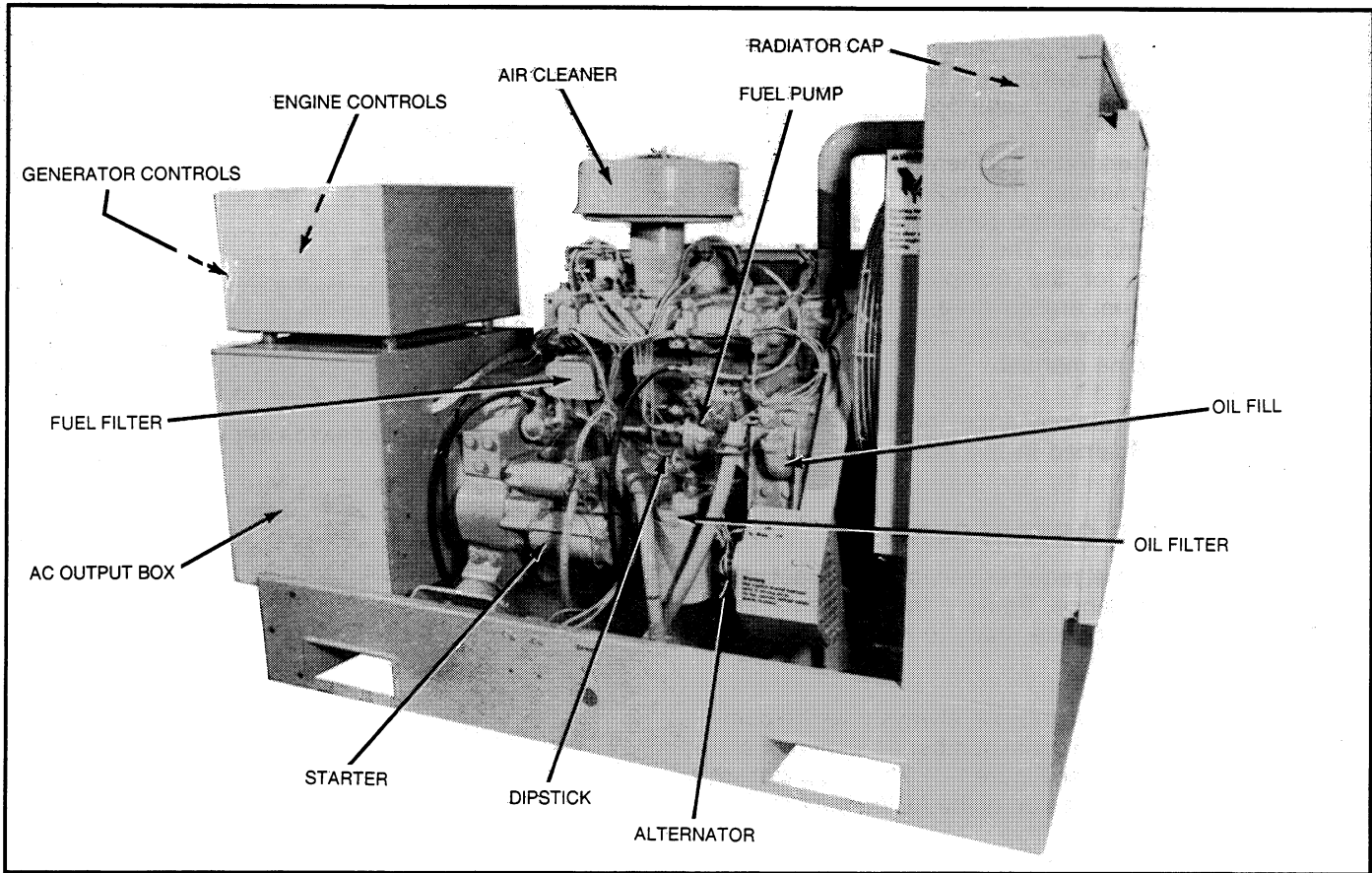


FIGURE 1-2. TYPICAL SET (6A3.4-GS-2 SHOWN FOR REFERENCE)

## CONTROL PANEL

The following section describes the function and operation of the standard Auto-Start 4-light, and the optional 10-light (NFPA 110) generator set monitoring system with options included. All instruments and control switches are located on the face of the control panel. The control panel is separated into two parts; a DC panel on the right for monitoring the engine (Figure 1-4), and an AC panel on the left for monitoring the generator (Figure 1-3).

Review the component descriptions and illustrations and become familiar with their location and operation.

### AC Panel

The following describes the optional AC meter package for on-set control and monitoring of the generator.

**AC Voltmeter:** Dual range instrument indicating generator AC voltage. Measurement range in use shown on the indicator light.

**AC Ammeter:** Dual range instrument indicating generator AC current. Measurement range in use shown on the indicator light.

**Frequency Meter:** Indicates generator output frequency in hertz. It can be used to check engine speed (each hertz equals 30 r/min).

**Wattmeter (optional):** Indicates generator output in kilowatts.

**Voltage Adjust:** Rheostat providing approximately plus or minus five percent adjustment of the rated output voltage.

**Field Breaker:** Provides generator exciter and regulator protection from overheating in the event of certain failure modes of the generator, exciter and voltage regulator.

**Phase Selector Switch:** Selects phases of generator output to be measured by AC voltmeter and AC ammeter.

**Upper and Lower Scale Indicator Lights:** Indicates which scale to use on the AC voltmeter and AC ammeter.

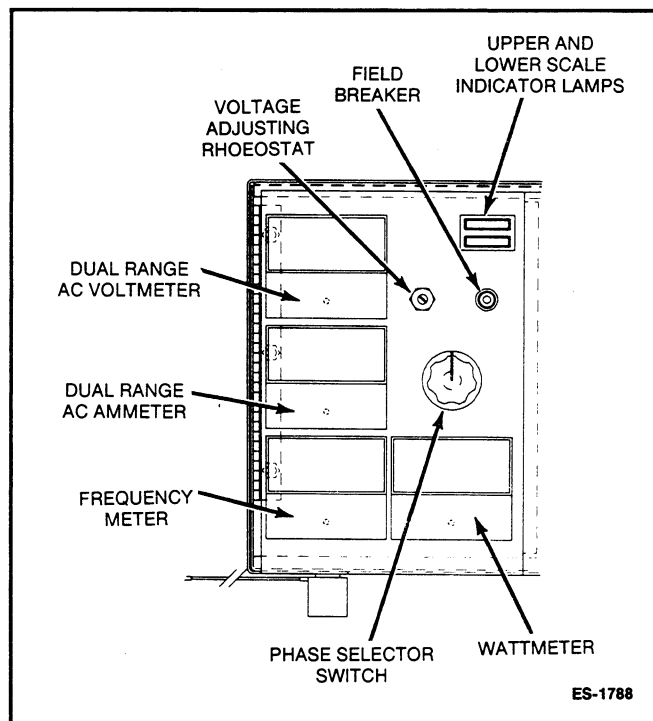


FIGURE 1-3. AC PANEL (WITH OPTIONS)

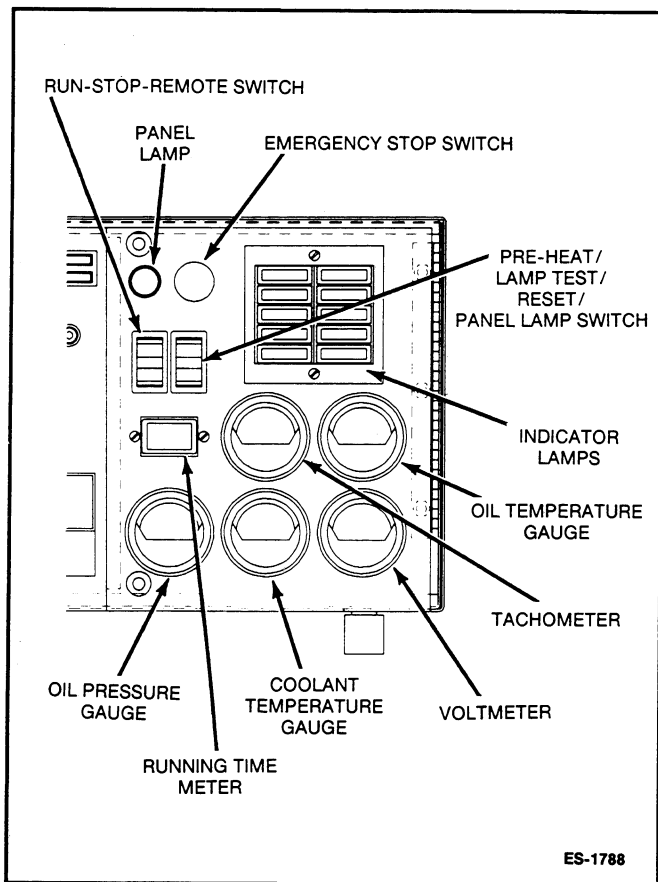


FIGURE 1-4. DC PANEL (WITH OPTIONS)

## DC PANEL

Depending on options ordered, the control groups consist of the standard model Auto-Start 4-light control panel or the optional 10-light (NFPA 110) generator set monitoring system.

The following function and operation descriptions include options. Refer to those applicable to your specific control group. See Figure 1-4.

**Oil Pressure Gauge:** Indicates pressure of lubricating oil in engine (wired to a sensor unit located on the engine).

**Water Temperature Gauge:** Indicates temperature of circulating coolant in engine (wired to a sensor unit located on the engine).

**Battery Charge Rate DC Voltmeter:** Indicates the battery charging voltage.

**Oil Temperature Gauge:** Indicates temperature of lubricating oil in the engine (wired to a sensor unit located on the engine).

**Tachometer:** Provides constant monitoring of engine r/min.

**Speed Adjust Potentiometer:** Operator control for adjusting engine speed (available with optional electronic governor only).

**Run/Stop/Remote Switch:** Starts and stops the unit locally, or from a remote location wired to the engine monitor board.

**Pre-heat, Lamp Test, Reset/Panel Lamp Switch:** Multiple function switch used to provide momentary warm-up of glow plugs, test the fault lamps, and reset the fault circuits when the Run/Stop/Remote switch is in the stop (reset) position. This switch is also used to turn on the control panel lamp.

**Emergency Stop Switch:** Round push-pull switch used to stop the unit locally when pushed in. Pull out to reset.

**Running Time Meter:** Registers the total number of hours that the unit has run. Use it to keep a record for periodic servicing. Time is cumulative; meter cannot be reset.

**Control Panel Lamp:** Convenience light for the operator. Illuminates control panel.

**Indicator Lamps:** Refer to the following control group descriptions.

### Auto-Start 4-Light Control

The standard control panel has four red monitor system indicator lamps. The corresponding fault lamp will come on when an emergency shutdown of the generator set occurs from one of the following conditions:

- Low oil pressure during unit operation
- High engine temperature during unit operation
- Overspeed of engine during unit operation
- Overcrank condition during unit operation

See the following 10-Light Control section for information on the operating parameters of the fault systems.

### 10-Light Control

The optional 10-light (NFPA 110) engine monitor system features indicator lamps for the following:

- RUN (green) lamp comes on when both starter disconnect circuits are opened after unit starting.
- PRE LO OIL PRES (yellow) indicates engine oil pressure is marginally low (20 psi/138 kPa or less). The cause should be found and corrected as soon as possible.
- PRE HI ENG TEMP (yellow) indicates engine temperature is marginally high (coolant temperature above 202°F/94°C). The cause should be found and corrected as soon as possible.
- LO OIL PRES (red) indicates engine has shut down because of critically low oil pressure (below 14 psi/97 kPa). The fault circuit is time delayed 10 seconds following starter disconnect and is inhibited during cranking to allow oil pressure to rise to normal before the electronic control module monitors the system.
- HI ENG TEMP (red) indicates the engine has shut down because of critically high engine temperature (coolant temperature above 222°F/106°C). The fault circuit is time delayed 10 seconds following starter disconnect and is inhibited during cranking. This delay allows coolant in a hot engine time to circulate and return the water jacket temperature to normal before the electronic control module monitors the system.

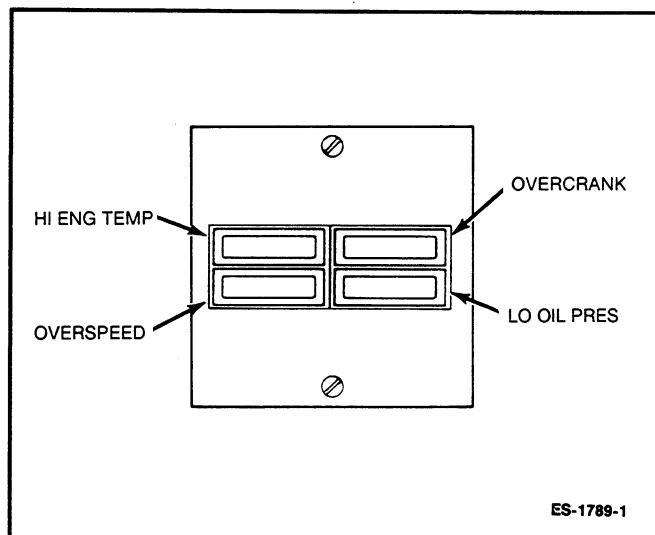


FIGURE 1-5. AUTO-START 4-LIGHT CONTROL

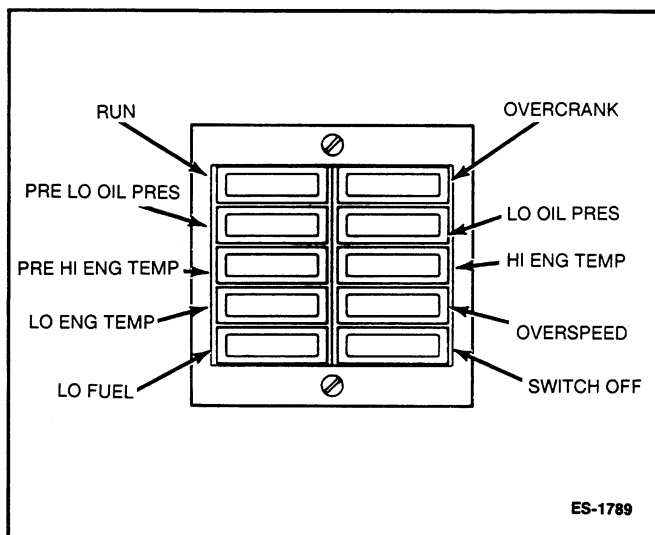


FIGURE 1-6. 10-LIGHT (NFPA 110) CONTROL

- **OVERSPEED (red)** indicates engine has shut down because of excessive speed (60 hertz units over  $2200 \pm 100$  r/min, 50 hertz units over  $1900 \pm 100$  r/min).
- **OVERCRANK (red)** indicates the starter has been locked out because of excessive cranking time (75 seconds). The cycle cranking option allows three 15-second cranking cycles with two 15-second rest periods.
- **LO ENG TEMP (yellow)** engine temperature is marginally low ( $70^{\circ}\text{F}/21^{\circ}\text{C}$  or less). Since the lamp normally goes out after the generator set warms up there should be no cause for alarm.
- **LO FUEL (yellow)** indicates the fuel supply is marginally low. The fuel supply should be replenished as soon as possible.
- **SWITCH OFF (flashing red)** indicates generator set is not in automatic start operation mode.

# Section 2. Operation

## GENERAL

This section covers prestart checks, starting, operating checks, stopping and other operating considerations of the generator set. The operator should read through this entire section before starting the generator set. It is essential that the operator be completely familiar with the generator set for safe operation.

## PRESTART CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation. See Figure 2-1. Refer to the *Maintenance* section for the recommended procedures.

### Lubrication

Check the engine oil level. Keep the oil level near as possible to the dipstick high mark without overfilling.

### Coolant

Check the engine coolant level. The coolant level should be about two inches (51 mm) below the radiator cap opening. Do not check while the coolant is hot.

**⚠ WARNING** *Contact with hot coolant can result in severe burns. Do not bleed hot, pressurized coolant from a closed cooling system.*

### Fuel

Make sure the fuel tanks have sufficient fuel and fuel system is primed. See the *Maintenance* section for recommended fuel.

**⚠ WARNING** *Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep a type ABC fire extinguisher nearby.*

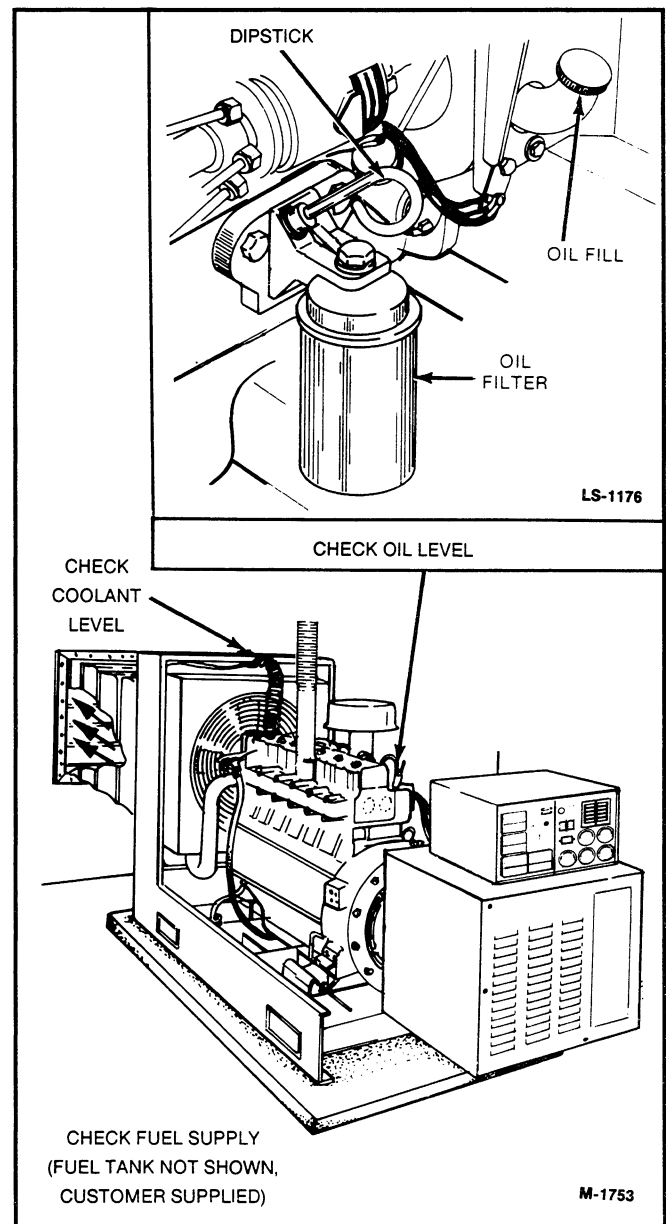
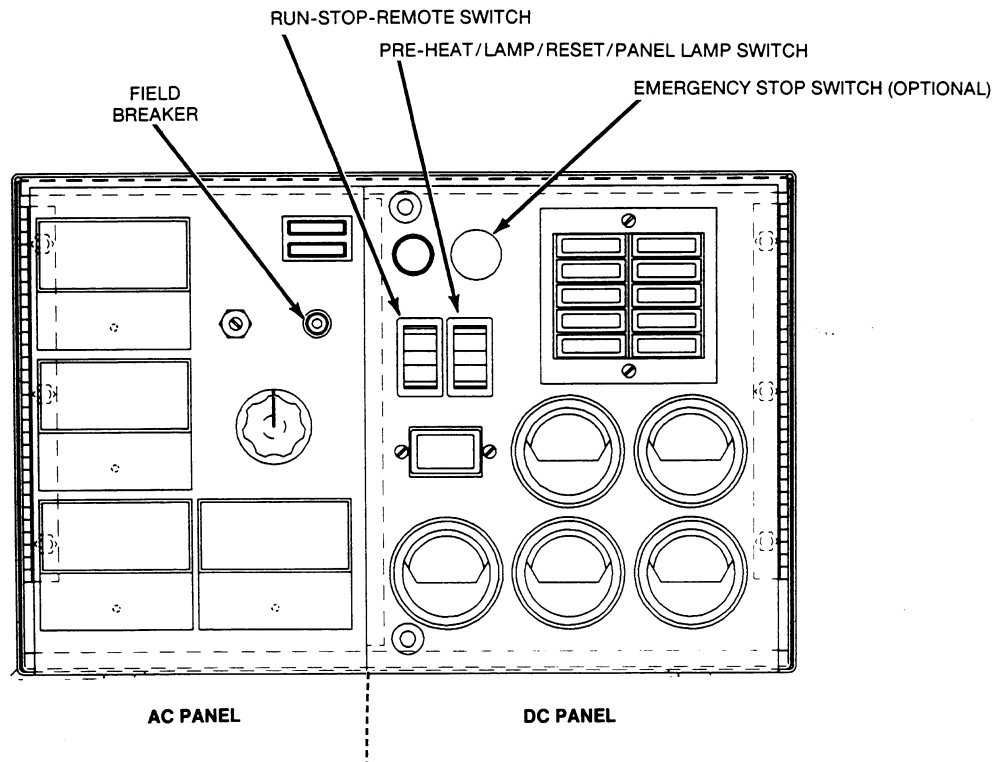


FIGURE 2-1. PRESTART CHECKS



ES-1788

FIGURE 2-2. START CONTROLS

**⚠ WARNING**

**EXHAUST GAS IS DEADLY!**

**Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:**

- Dizziness
- Nausea
- Headache
- Weakness and Sleepiness
- Throbbing in Temples
- Muscular Twitching
- Vomiting
- Inability to Think Coherently

**IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.**

**Protection against carbon monoxide inhalation includes proper installation and regular, frequent visual and audible inspections of the complete exhaust system.**

1-P/EM

## STARTING

The following sections cover the three systems used to start the generator set.

### Starting at Control Panel

If the ambient temperature is below 32°F (0°C), move the Pre-heat, Lamp test, Reset/Panel lamp switch on the DC panel to the PRE-HEAT position for 10 seconds. See Figure 2-2. (Preheating is not necessary if the ambient temperature is above 32°F.)

**⚠ CAUTION** *Do not exceed the 10 second preheat period prior to cranking to prevent heater burn out and conserve the battery. Longer preheating time prior to cranking the engine can ruin the glow plugs.*

Move the Run/Stop/Remote switch on the DC panel (Figure 2-2) to the RUN position. This will activate the engine controls system and the starting system. The starter will begin cranking and after a few seconds the engine should start. The starter will disconnect when the engine reaches a speed of 450 to 570 r/min.

If the engine does not start, the starter will disengage after a specified period of time and the control will indicate an overcrank fault. Generator sets with the standard overcrank control will crank continuously for up to 75 seconds before disengaging the starter. Generator sets with the cycle cranking option will crank for 15 seconds and then stop for 15 seconds until 3 cycles have been completed. To clear an overcrank fault, place the Run/Stop/Remote switch in the STOP position and momentarily depress the Reset switch. Wait two minutes for the starter motor to cool and then repeat the starting procedure. If the engine does not run after a second attempt at starting, refer to the Troubleshooting section.

### Starting From Remote Location

Move the Run/Stop/Remote switch on the generator set DC panel to the REMOTE position. This allows the generator set to be started from a remote switch. Closing the remote switch initiates the starting sequence described in the previous section.

### Automatic Starting

Place the Run/Stop/Remote switch on the generator set DC panel in the REMOTE position if an automatic transfer switch is used. This allows the transfer switch to start the generator set if a power outage occurs and stop it when the power returns.

## STOPPING

### Before Stopping

Run the generator set at no load for three to five minutes before stopping. This allows the lubricating oil and engine coolant to carry heat away from the combustion chamber and bearings.

### To Stop

If the set was started at the set control panel or at a remote control panel, move the Run/Stop/Remote switch or remote starting switch to the STOP position. If the set was started by an automatic transfer switch, the set will automatically stop about 15 minutes after the normal power source returns.

**Emergency Stop:** An optional Emergency Stop switch is available for use at the set control panel. Depress the red emergency stop button (Figure 2-2) to stop set. Switch button must be pulled out to restart set.

## BREAK-IN

Drain and replace the crankcase oil after the first 50 hours of operation on new generator sets. Refer to the *Maintenance* section of this manual for the recommended procedures.

## NO-LOAD OPERATION

Periods of no load operation should be held to a minimum. If it is necessary to keep the engine running for long periods of time when no electric output is required, best engine performance will be obtained by connecting a "dummy" electrical load. Such a load could consist of heater element, etc.

## EXERCISE PERIOD

Generator sets on continuous standby must be able to go from a cold start to being fully operational in a matter of seconds. This can impose a severe burden on engine parts.

Regular exercising keeps engine parts lubricated, prevents oxidation of electrical contacts and in general helps provide reliable engine starting. Exercise the generator set at least once a week for a minimum of 30 minutes with load so the engine reaches normal operating temperatures.

Automatic transfer switches have as an option, an exerciser that can be preset to provide regular exercise periods. Typically the exerciser can be set for time of start, length of run, and day of week.



## HIGH/LOW OPERATING TEMPERATURES

Use a coolant heater if a separate source of power is available. The optional heater will help provide reliable starting under adverse weather conditions. Be sure the voltage of the separate power source is correct for the heater element rating.

### **▲CAUTION**

*To avoid damage to heater, be sure the cooling system is full before applying power to the heater.*

## POWER RATING FACTORS

The generator set power rating applies to sets used in standby applications. The set will operate at the stated rating for the duration of normal utility power interruptions. The rating was established for a standard radiator cooled set running on diesel fuel and operating at an altitude of 300 ft (92 m) with an ambient temperature of 81°F (27°C). For a rating relative to other applications, altitudes, cooling systems, or ambient temperatures, contact a Cummins Distributor.

# Section 3. Troubleshooting

The generator set has a number of sensor units that continuously monitor the engine for abnormal conditions such as low oil pressure or high coolant temperature. If an abnormal condition does occur, the engine monitor will activate a fault lamp and may also stop the engine depending on the condition. If the generator set does shutdown, the operator may be able to restart the set after making certain adjustments or corrections. This section describes the operation of the fault condition system and provides troubleshooting procedures for the operator.

The standard auto-start 4-light control has four red fault lights to indicate malfunctions. The optional 10-light (NFPA 110) control has a single green run light, 4 amber pre-fault lights, and 5 red fault lights. Both controls also have a terminal connection for an external audible alarm that will sound when a fault occurs.

## Safety Considerations

High voltages are present within the control box and generator output box when the generator is running. Do not open the control box or generator output box while set is running.

**⚠ WARNING** *Contacting high voltage components can cause severe personal injury or death. Keep control and output box covers in place during troubleshooting.*

Generator set installations are normally designed for automatic starting or remote starting. When troubleshooting a set that is shut down, make certain the generator set cannot be accidentally restarted. Place the Run/Stop/Remote switch in the STOP position and remove the negative battery cable from the set starting battery.

**⚠ WARNING** *Accidental starting of the generator set during troubleshooting can cause severe personal injury or death. Disable the generator set before troubleshooting.*

When a fault condition occurs, follow the troubleshooting charts in this section to locate and correct the problem.

## Resetting the Control

The external alarm and fault lamp can be deactivated by placing the Run/Stop/Remote switch in the STOP position and pressing the Reset-Lamp Test switch. Locate the problem and make the necessary corrections before restarting the generator set. While pressing the Reset-Lamp Test switch, observe that all lamps light.

## Line Circuit Breaker (Optional)

The optional line circuit breaker mounts on the generator output box. If the load exceeds the generator current rating, the line circuit breaker will open to prevent the generator from being overloaded. If the circuit breaker trips, locate the source of the overload and correct as required. Manually reset the breaker to reconnect the load to the generator.

**TABLE 3-1. TROUBLESHOOTING**

**⚠ WARNING** *Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages i and ii.*

SYMPTOM	CORRECTIVE ACTION
1. Green RUN lamp lights following engine start-up.	1. Indicates all engine systems are normal. No corrective action required.
2. PRE HI ENGINE TEMP lamp lights. Engine continues to operate.	2. Indicates engine has begun to overheat and engine temperature has risen to approximately 202°F (94°C). If generator is powering non-critical and critical loads and cannot be shutdown, use the following: <ul style="list-style-type: none"> <li>a. Reduce load if possible by turning off non-critical loads.</li> <li>b. Check air inlets and outlets and remove any obstructions to airflow.</li> <li>c. Open doors or windows in generator area to increase ventilation.</li> </ul> If engine can be stopped, follow procedure in step 3.
*3. HI ENG TEMP lamp lights. Engine shuts down.	3. Indicates engine has overheated (engine temperature has risen above 222°F/106°C) or coolant level is low (sets with coolant level sensor). Allow engine to cool down completely before proceeding with the following checks: <ul style="list-style-type: none"> <li>a. Check coolant level and replenish if low. Look for possible coolant leakage points and repair if necessary.</li> <li>b. Check for obstructions to cooling airflow and correct as necessary.</li> <li>c. Check for a slipping fan belt and tighten if loose.</li> <li>d. Reset control and restart after locating and correcting problem. Contact a Cummins Dealer or Distributor if none of the above.</li> </ul>
4. PRE LO OIL PRES lamp lights. Engine continues to operate.	4. Indicates engine oil pressure has dropped to 20 psi (138 kPa). If generator is powering critical loads and cannot be shut down, wait until next shutdown period and then follow step 5 procedure. If engine can be stopped, follow procedures in step 5.
*5. LO OIL PRES lamp lights. Engine shuts down NOTE: See also step 6.	5. Indicates engine oil pressure has dropped to 14 psi (97 kPa). Check oil level, lines and filters. If oil system is okay but oil level is low, replenish. Reset control and restart. Contact a Cummins Dealer or Distributor if oil pressure is not in the range of 35 to 55 psi (241 to 379 kPa).

\*Use these steps when troubleshooting the standard 4-light control panel

Run Lamp - See Steps 1 and 16

Fault Lamp - See Steps 3, 4, 6, 7, and 12

Other Faults - See Steps 13, 14, and 15

**TABLE 3-1. TROUBLESHOOTING (Continued)**



**WARNING** *Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages i and ii.*

SYMPTOM	CORRECTIVE ACTION
<p>*6. OVERCRANK lamp lights and engine stops cranking.</p> <p>or</p> <p>Engine runs, shuts down, and LO OIL PRES lamp lights.</p>	<p>6. Indicates possible fuel system problem.</p> <ol style="list-style-type: none"> <li>Check for empty fuel tank, fuel leaks, or plugged fuel lines and correct as required.</li> <li>Check for dirty fuel filter and replace if necessary (see <i>Maintenance</i> section).</li> <li>Check for dirty or plugged air filter and replace if necessary (see <i>Maintenance</i> section).</li> <li>Refer to Step 5.</li> <li>Reset the control and restart after correcting the problem. Contact a Cummins Dealer for service if none of the above.</li> </ol>
<p>*7. Engine runs and then shuts down, OVERSPEED lamp lights.</p>	<p>7. Indicates engine has exceeded normal operating speed. Contact a Cummins Dealer for service.</p>
<p>8. SWITCH OFF lamp flashes.</p>	<p>8. Indicates Run/Stop/Remote switch is in the Stop position which will prevent automatic starting if an automatic transfer switch is used. Move the Run/Stop/Remote switch to the Remote position for automatic starting.</p>
<p>9. LO FUEL lamp lights. Engine continues to run.</p>	<p>9. Indicates diesel fuel supply is running low. Check fuel supply and replenish as required.</p>
<p>10. LO FUEL lamp lights. Engine shuts down and LO OIL PRES lamp lights.</p>	<p>10. Indicates engine has run out of fuel. Check fuel level and replenish as required.</p>
<p>11. LO ENG TEMP lamp lights. Set is in standby mode but is not operating.</p> <p>(Lamp lights when engine coolant temperature is 70°F (21°C) or lower. Since the lamp goes out after the engine warms up, there should be no cause for alarm even during initial generator set operation.)</p>	<p>11. Indicates engine coolant heater is not operating or is not circulating coolant. Check for the following conditions:</p> <ol style="list-style-type: none"> <li>Coolant heater not connected to power supply. Check for blown fuse or disconnected heater cord and correct as required.</li> <li>Check for low coolant level and replenish if required. Look for possible coolant leakage points and repair as required.</li> <li>Contact a Cummins Dealer if none of the above.</li> </ol>

\*Use these steps when troubleshooting the standard 4-light control panel

Run Lamp - See Steps 1 and 16

Fault Lamp - See Steps 3, 4, 6, 7, and 12

Other Faults - See Steps 13, 14, and 15

**TABLE 3-1. TROUBLESHOOTING (Continued)**

**WARNING** Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on pages i and ii.

SYMPTOM	CORRECTIVE ACTION
*12. Fault lamp lights but no fault exists. Engine gauges show oil pressure, engine temperature, and frequency (speed) are within normal limits.	12. The monitor board or a sensor may be at fault. Contact a Cummins Dealer or Distributor for service.
*13. Engine starts from generator control panel but will not start automatically or from a remote panel. (Note: The Run/Stop/Remote switch must be in the Remote position for automatic or remote starting).	13. Remote circuit breaker is tripped. Reset breaker and restart. Contact a Cummins Dealer if breaker trips after resetting.
*14 Engine will not crank.	14. Indicates possible fault with control or starting system. Check for the following conditions: a. Fault lamp on. Correct fault and reset control. b. Poor battery cable connections. Clean the battery cable terminals and tighten all connections. c. Discharged or defective battery. Recharge or replace the battery. d. Contact a Cummins Dealer or Distributor for assistance if none of the above.
*15. No AC output voltage.	15. Field breaker is tripped. Reset breaker. Contact a Cummins Dealer or Distributor if voltage build up causes breaker to trip.
16. Green RUN lamp does not light following engine start-up.	16. Indicates possible Start/Disconnect relay failure. Contact a Cummins Dealer or Distributor for assistance.

\*Use these steps when troubleshooting the standard 4-light control panel

Run Lamp - See Steps 1 and 16

Fault Lamp - See Steps 3, 4, 6, 7, and 12

Other Faults - See Steps 13, 14, and 15

# Section 4. Maintenance

Establish and adhere to a definite schedule for maintenance and service based on the application and severity of the environment. Table 4-1 covers the recommended service intervals for a generator set on standby service. If the set will be subjected to extreme operating conditions, the service intervals should be reduced accordingly. Some of the factors that can effect the maintenance are the following:

- Use for continuous duty (prime power)
- Extremes in ambient temperature
- Exposure to elements
- Exposure to salt water
- Exposure to windblown dust or sand

Consult with your distributor if the generator set will be subjected to any extreme operating conditions and determine a suitable schedule of maintenance. Use the running time meter to keep an accurate log of all service performed for warranty support. Perform all service at the time period indicated or after the number of operating hours indicated, whichever occurs first. Use Table 4-1 to determine the maintenance required and then refer to the sections that follow for the correct service procedures.

## ⚠ WARNING

**Accidental starting of the generator set can cause severe personal injury or death. Disconnect the negative battery cable before repairs are made to the engine, controls or generator.**

**TABLE 4-1. MAINTENANCE SCHEDULE**

MAINTENANCE CHECKS	SERVICE TIME				
	Daily or after 8 hours	Weekly or after 50 hours	Monthly or after 100 hours	6 Months or after 200 hours	12 Months or after 400 hours
Inspect Generator Set	x <sup>1</sup>				
Check Oil Level	x				
Check Fan Belt	x				
Check Coolant Level	x				
Check Coolant Heater (if equipped)	x				
Check Air Cleaner		x <sup>2</sup>			
Check Battery Charging System		x			
Drain Water and Sediment from Fuel Tanks		x <sup>6</sup>			
Exercise Standby Sets		See Note 8			
Check Anti-freeze Concentration			x		
Drain Exhaust Condensate Trap			x		
Check Fuel Level			x		
Change Crankcase Oil and Filter (Turbo)		See Note 3	x <sup>2,3</sup>		
Change Crankcase Oil and Filter (Non-Turbo)		See Note 3		x <sup>2,3,4</sup>	
Check Battery Condition				x	
Change Air Cleaner Element (Standard)				x	
Clean Generator Assembly				x	
Change Air Cleaner Element (Heavy Duty)					x
Clean Crankcase Breather Cap (Turbo)					x
Change Fuel Filter					x <sup>2,5</sup>
Check Valve Lash Clearance		See Note 3			x <sup>3,7</sup>

- 1 - Check for oil, fuel, cooling, and exhaust system leaks. Check exhaust system audibly and visually with set running. Shut unit down and repair any leaks immediately.
- 2 - Perform more often in extremely dusty conditions.
- 3 - Perform after first 50 hours of operation on new sets.
- 4 - Perform every 200 hours or 6 months, whichever comes first.
- 5 - Perform every 400 hours or 12 months, whichever comes first.
- 6 - Drain 1 cup or more of fuel to remove water and sediment.
- 7 - Contact an authorized service center for service.
- 8 - Exercise standby sets weekly. Refer to Operation section.

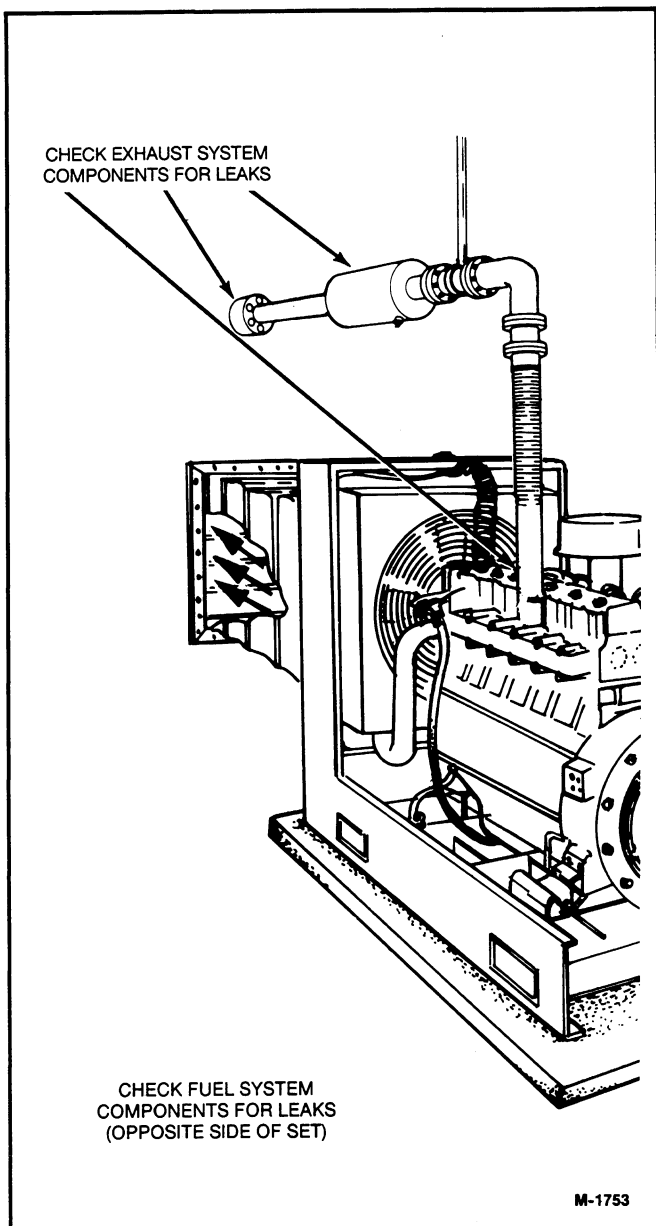


FIGURE 4-1.EXHAUST AND FUEL SYSTEM CHECKS

## GENERATOR SET INSPECTION

During operation, be alert for problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected to provide continued safe operation.

### Exhaust System

With the generator set operating, inspect the entire exhaust system visually and audibly (see Figure 4-1) including the exhaust manifold, turbocharger (if equipped), muffler, and exhaust pipe. Check for leaks at all connections, welds, gaskets, and joints and also make sure that exhaust pipes are not heating surrounding areas excessively. If any leaks are detected, shut down the generator set and have leaks corrected immediately.

#### **⚠ WARNING**

*Inhalation of exhaust gases can result in severe personal injury or death. Be sure deadly exhaust gas is piped outside and away from windows, doors or other inlets to building.*

### Fuel System

With the generator set operating, inspect the fuel supply lines, return lines, filters, and fittings for leaks (see Figure 4-1). Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage. If any leaks are detected, have them corrected immediately.

#### **⚠ WARNING**

*Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep a type ABC fire extinguisher nearby.*

## AC Electrical System

Check the following while the generator set is operating; otherwise measure load lines L1, L2, and L3 using the appropriate AC meter.

**Frequency Meter:** The generator frequency should be stable and the reading should be the same as the data tag rating (50 or 60 Hz). See Figure 4-2.

**AC Voltmeter:** Turn the phase selector switch to each line-to-line phase selection shown on the volts scale (L1-L2 on single phase sets; L1-L2, L2-L3, and L3-L1 on three phase sets). Read the AC voltmeter using the upper or lower scale as indicated by the scale indicator light. The line-to-line voltage(s) should be the same as the set data tag rating (see Figure 4-2).

**AC Ammeter:** Turn the phase selector switch to each phase selection shown on the amp scale (L1 and L2 on single phase sets; L1, L2 and L3 on three phase sets). Read the ammeter using the upper or lower scale as indicated by the scale indicator light. At no-load, the current readings should be zero. With a load applied, each line current should be about the same (See Figure 4-2).

## DC Electrical System

Check the following while the generator set is not operating.

**Fault Lamps:** With the generator set stopped (Run / Stop / Remote switch in STOP position), actuate the Lamp Test switch. Verify that all indicator lamps are on and then place switch at Panel Lamp (see Figure 4-3).

**Starting Battery:** Check the terminals on the battery for clean and tight connections. Loose or corroded connections create resistance which can hinder starting. Clean and reconnect the battery cables if loose. Always disconnect both ends of the negative battery cable. Reconnect one end of the cable to the negative battery terminal and the other end to ground. This will make sure that any arcing will be away from the battery and less likely to ignite explosive battery gases (See Figure 4-4).



**WARNING** Ignition of explosive battery gases can cause severe personal injury. Do not smoke or cause any spark or flame while servicing batteries.

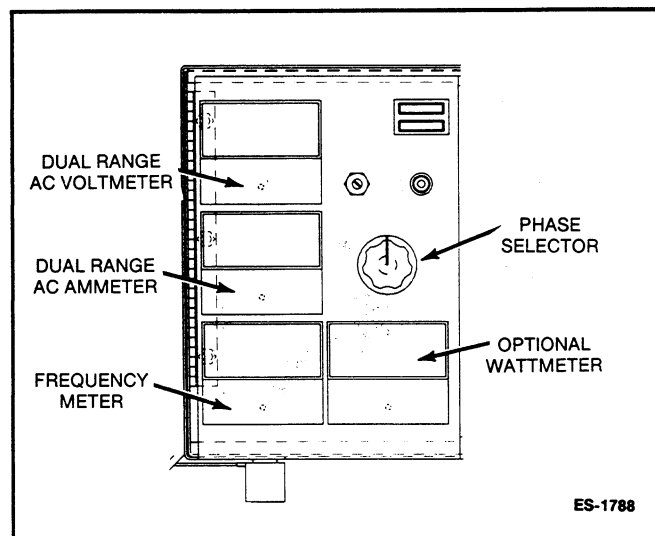


FIGURE 4-2. AC ELECTRICAL CHECKS

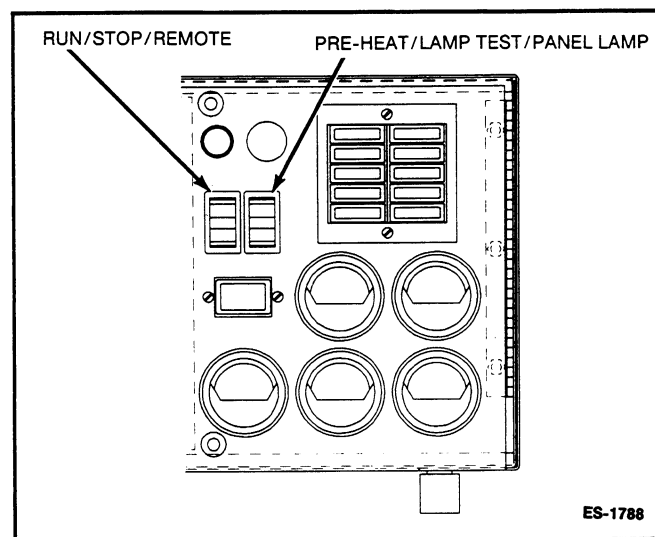


FIGURE 4-3. FAULT LAMP CHECKS

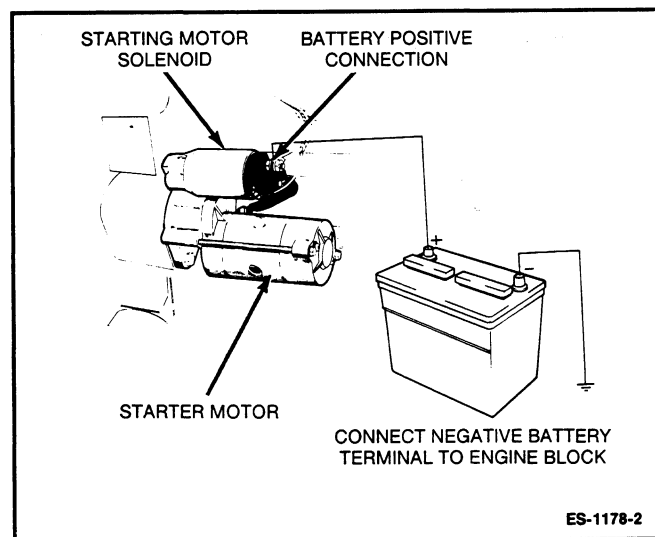


FIGURE 4-4. BATTERY CONNECTIONS



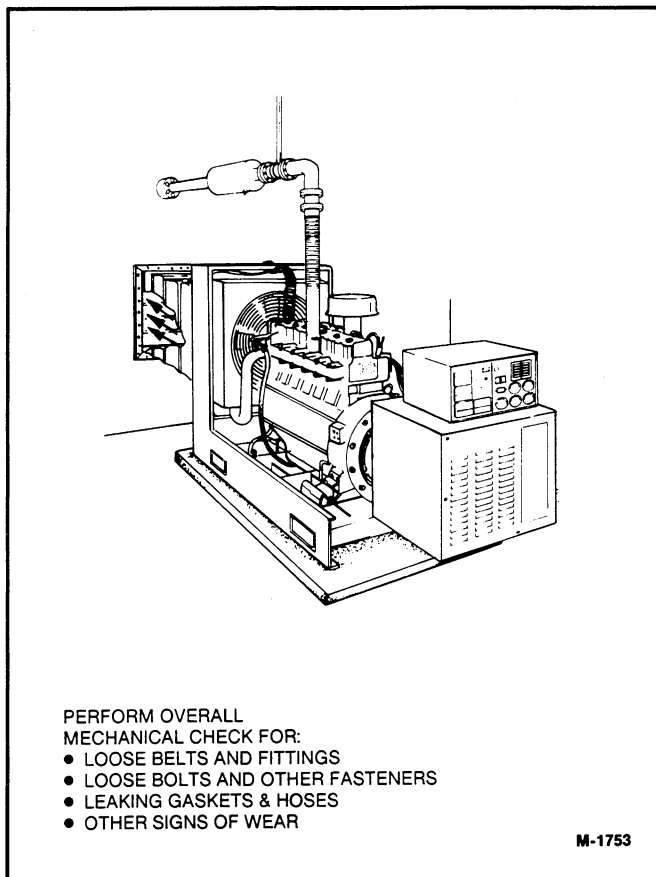
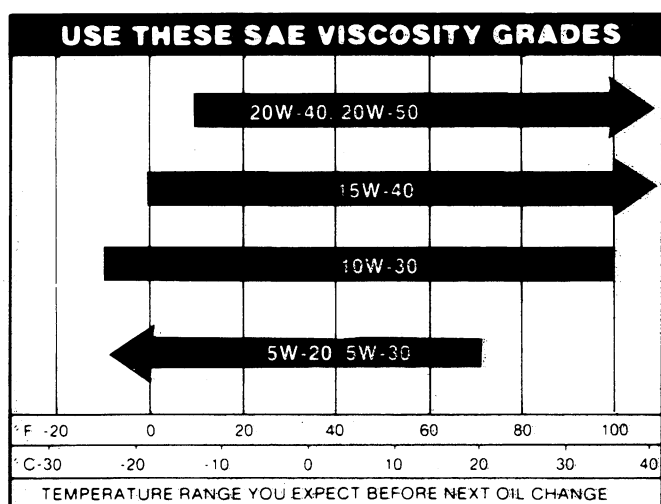


FIGURE 4-5. MECHANICAL CONNECTIONS

TABLE 4-2. OIL VISCOSITY GRADE SELECTION



LS-1177

## Mechanical

Follow warning below before proceeding. With the generator set stopped, check for loose belts and fittings, leaking gaskets and hoses, or any signs of mechanical damage (see Figure 4-5). If any problems are found, have them corrected immediately. With the set running, listen for any unusual noises that may indicate mechanical problems and check the oil pressure frequently. Investigate anything that indicates possible mechanical problems.

### ⚠ WARNING

**Accidental starting of the generator set can cause severe personal injury or death. Place the Automatic Start switch to OFF position and disconnect the negative (-) battery cable before inspecting generator set.**

## LUBRICATION SYSTEM

The lubrication system must be primed and filled with oil of the recommended classification and viscosity. Refer to the SPECIFICATIONS section for lubricating oil capacity.

## Oil Recommendations

Use multigrade lubricating oils with the American Petroleum Institute (API) classification CD/SF or CE/SF. Table 4-2 shows preferred oil grades for ambient temperatures indicated.

When selecting the oil viscosity, pick the grade that is right for the LOWEST temperature expected. Oil that is too thick can result in a lack of lubrication when engine is started.

Single grade oils can be substituted for short durations until the recommended multigrade is procured.

## Engine Oil Level

Check the engine oil level during engine shutdown periods at the intervals specified in Table 4-1. The oil dipstick and oil filter are located on the same side of the engine (see Figure 4-6). The dipstick is stamped with FULL and ADD marks to indicate the level of oil in the crankcase. For accurate readings, shut off the engine and wait approximately 15 minutes before checking the oil level. This allows oil in the upper portion of the engine to drain back into the crankcase.

### **⚠ WARNING**

**Crankcase pressure can blow out hot oil and cause serious burns. Do NOT check oil while the generator is operating.**

Keep the oil level as near as possible to the high mark on the dipstick. Remove the oil fill cap and add oil of the same API classification and brand when necessary. Check unit log book to confirm oil viscosity to use.

### **⚠ CAUTION**

**Do not operate the engine with the oil level below the ADD mark or above the FULL mark. Overfilling causes foaming or aeration of the oil, while operation below the ADD mark causes loss of oil pressure.**

## Oil and Filter Change

Change the oil and filter at the intervals recommended in Table 4-1. Use oil that meets the API Classification and viscosity requirements.

1. Start the generator set and allow engine to warm up to operating temperature and then shut generator set off. Make sure that Run/Stop/Remote switch is at STOP, and the negative (-) battery cable is disconnected to avoid accidental start-up during this procedure.
2. Remove the oil drain plug or open the drain valve and collect the engine oil in a suitable size waste container. When the crankcase is drained, replace the oil drain plug or close the drain valve. Torque the oil drain plug to 60-70 ft-lb (81-95 N•m).
3. Unscrew the oil filter and discard (see Figure 4-6). Thoroughly clean filter mounting surface.
4. Apply a light coat of oil to the gasket sealing surface of the new filter and fill filter with clean, new oil.
5. Install filter and tighten 1/4 to 1/2 turn by hand after the seal touches the sealing surface of the bracket. Do not overtighten.

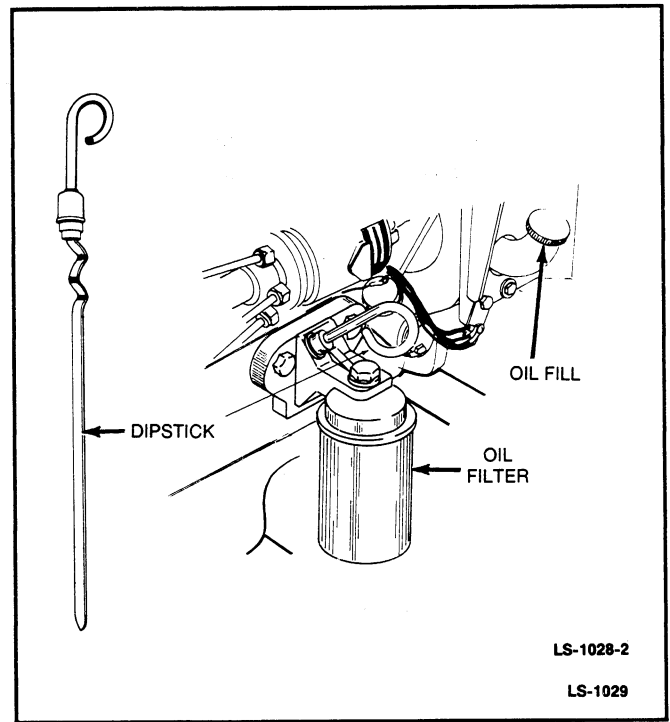


FIGURE 4-6. DIPSTICK, OIL FILTER, AND FILL CAP

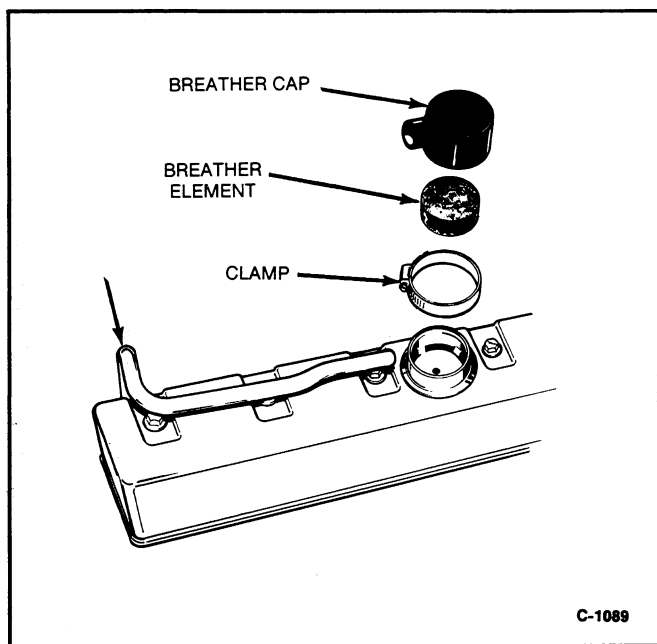


FIGURE 4-7. CRANKCASE BREATHER

6. Fill the crankcase with the amount of oil to achieve reading at FULL mark of dipstick.
7. Reconnect the negative (-) starting battery cable, start the engine and check for oil leaks.
8. Shut off the engine, wait 15 minutes, and then check the oil level. Add oil if required.

**⚠ WARNING** *Crankcase pressure can blow out hot oil and cause serious burns. Do NOT check oil while the generator set is operating.*

### CRANKCASE BREATHER (Turbocharged Engines)

Remove and clean the crankcase breather at the interval specified in Table 4-1.

**To Service:** See Figure 4-7.

1. Remove breather cap and lift out the breather element.
2. Clean breather cap and element in cleaning solvent. Dry thoroughly with low pressure air, under 35 psi (241 kPa).
3. Install a clean or new breather element in the valve cover. Do not pack element into valve cover.
4. Install clamp, breather cap, and connect breather tube.

**⚠ CAUTION** *Overtightening of the clamp will tear breather cap.*

### COOLING SYSTEM

The cooling system must be full before being operated. Capacity of the standard unit with set-mounted radiator is shown on the Specifications page of the Installation Section.

**⚠ CAUTION** *The coolant heater (if so equipped) must not be operated while the cooling system is empty or when the engine is running or damage to the heater will occur.*

### Coolant Level

Check the coolant level during shutdown periods at the intervals specified in Table 4-1. Remove the radiator cap after allowing the engine to cool and, if necessary, add coolant until the level is near the top of the radiator (see Figure 4-8). Use a coolant solution that meets the engine coolant requirements.

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

**⚠ CAUTION** *The high engine temperature shutdown system will not operate if the coolant level is too low. The high engine temperature sensor monitors coolant temperature. Loss of coolant will prevent sensor operation and allow the engine to overheat causing severe engine damage. Therefore, maintain adequate coolant level for proper operation of the high engine temperature shutdown system.*

### Filling the Cooling System

Verify that all drain cocks are closed and all hose clamps secure. Remove the cooling system with the recommended coolant. Limit the fill rate to 3 gallons/minute to allow the engine block to fill completely with coolant.

**⚠ CAUTION** *Exceeding the recommended fill rate may cause incomplete filling of the engine block which can result in possible engine damage during warm-up. Always follow the recommended fill procedure.*

When the engine is first started, remove the pressure cap and monitor the coolant level. As trapped air is expelled from the system, the coolant level will drop and additional coolant should be added. Replace the pressure cap when the coolant level is stable.

### Cleaning and Flushing the Cooling System

The cooling system must be clean and free of rust and scale if it is to perform properly. Use only coolant that meets the engine requirements.

### Chemical Cleaning

Thoroughly clean the cooling system if rust and scale have collected on the engine water jacket or in the radiator. Rust and scale slow down heat transfer and can block the coolant flow. Use a good cooling system cleaner such as sodium bisulphate or oxalic acid and follow the instructions provided by the supplier. Follow up by neutralizing and flushing with clean water.

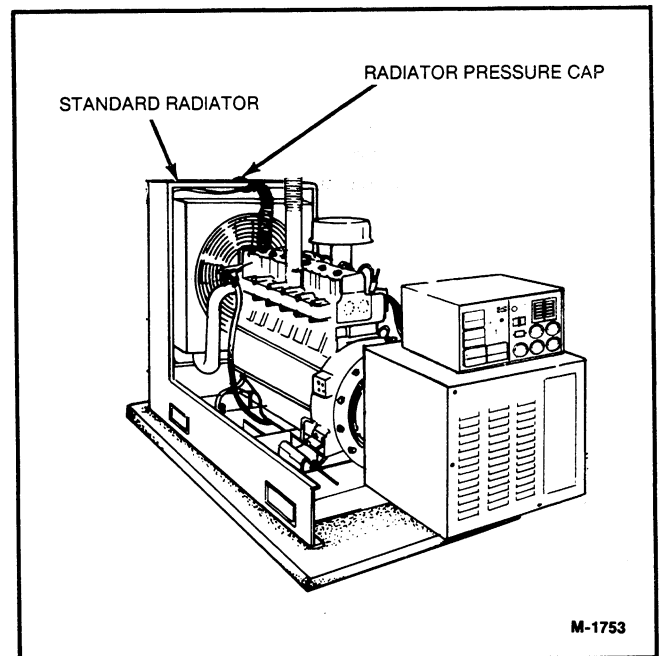


FIGURE 4-8. STANDARD SET MOUNTED RADIATOR

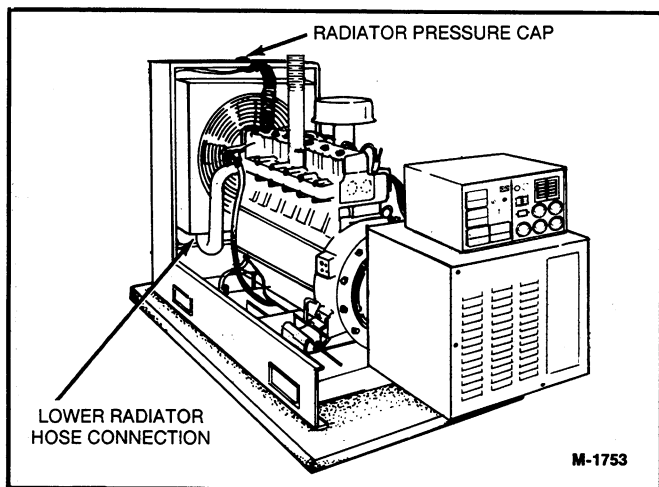


FIGURE 4-9. RADIATOR DRAINING

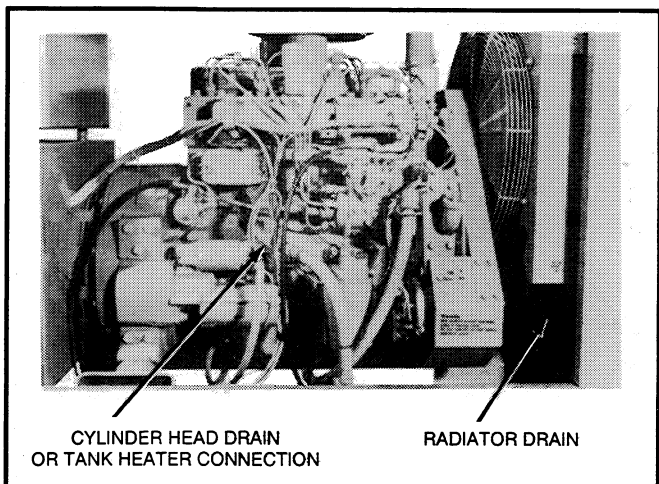


FIGURE 4-10. COOLANT SYSTEM DRAINS

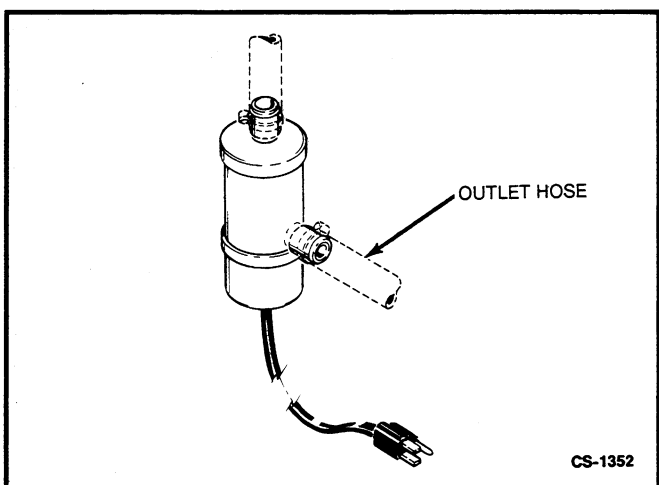


FIGURE 4-11. TANK TYPE COOLANT HEATER

## Draining and Flushing

Flush the radiator and block after cleaning or before refilling the system with new coolant as follows: (refer to Figures 4-9 and 4-10)

### 1. Drain Cooling System.

- A. Disconnect coolant heater from AC power source, if so equipped.
- B. Allow system to cool.
- C. Remove radiator pressure cap.
- D. Open radiator drain cock and disconnect lower radiator hose from radiator.
- E. Remove drain plug from cylinder block (or disconnect tank heater at that location, if so equipped).
- F. Allow system to drain completely.
- G. Reinstall cylinder block drain plug or reconnect tank heater.
- H. Close the radiator drain cock, and reconnect the lower radiator hose.

### 2. Flush Cooling System

- A. Fill cooling system with clean water. Do not install radiator cap.
- B. Operate engine for 5 minutes with the coolant temperature above 194°F (90°C).
- C. Shut off engine and drain cooling system (see Drain Cooling System) Note: If the water being drained is still dirty, the system must be flushed again until the water is clean.
- D. When flushing water is clean, drain completely, then refer to Filling the Cooling System in this section.

## Coolant Heater

Check the operation of the optional coolant heater by verifying that hot coolant is being discharged from the outlet hose (see Figure 4-11).

## Coolant Requirements

A satisfactory engine coolant inhibits corrosion and protects against freezing. A solution of ethylene glycol anti-freeze (permanent type) and water is recommended for normal operation and storage periods. Choose only a reliable brand of anti-freeze that contains a rust and corrosion inhibitor but does not contain a stop-leak additive.

**▲CAUTION** *Do not use antifreeze with an anti-leak formula. The stop leak element can prevent or retard the coolant flow through the filter thereby eliminating the filtering completely.*

**▲WARNING** *Contact with hot coolant can result in serious burns. Do not bleed hot, pressurized coolant from a closed cooling system.*

The water used for engine coolant should be clean, low in mineral content, and free of any corrosive chemicals such as chloride, sulphate, or acid. Use soft water whenever available. Well water often contains lime and other minerals which eventually may clog the radiator core and reduce the cooling efficiency.

Use a 50/50 mixture of antifreeze and clean water to provide adequate corrosion protection. Be sure the antifreeze solution will protect the cooling system during the coldest winter weather.

## **FUEL SYSTEM**

The engine has been primarily designed to operate on No. 2 diesel fuel since such fuels have a higher energy content and are generally lower in cost. The engine will also operate satisfactorily on No. 1 fuel or other similar fuels if they meet certain specifications. Refer to the engine manual or consult the distributor for the specific requirements if using a non-standard fuel.

### **Fuel Handling Precautions**

Take appropriate precautions to prevent the entrance of dirt, water, or other contaminants into the fuel system. Filter or strain the fuel as the tank is filled.

**▲WARNING** *Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep an ABC type fire extinguisher nearby.*

To avoid condensation problems, keep fuel supply tanks as full as possible by filling up each time the engine is used. In cold weather, warm fuel returning from the injectors heats the fuel in the supply tank. If the fuel level is low, the upper portion of the tank tends to form condensation. In warm weather, both the fuel and the tank will be warm during the daytime. At night, cool air tends to lower the temperature of the tank more rapidly than the temperature of the fuel. If the fuel level is low, the upper portion of the tank will cool more rapidly and tend to form condensation.

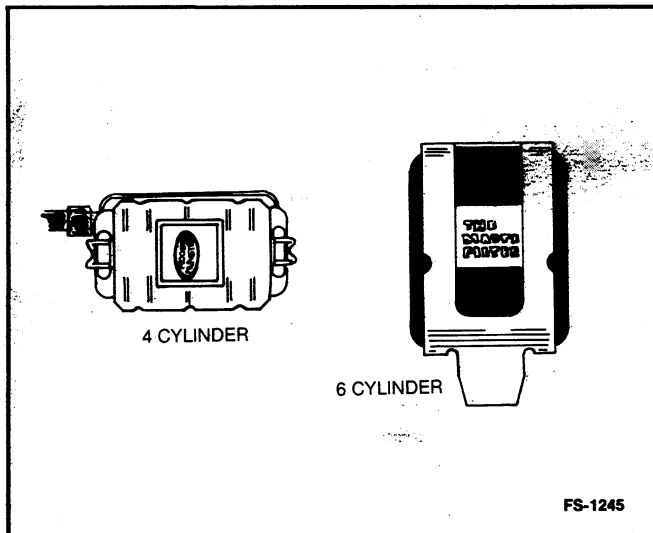


FIGURE 4-12. FUEL FILTERS

Condensation (water) can cause fuel pump and injector problems, clogging of fuel filters as well as freezing problems. In addition, water mixing with the sulphur in the fuel forms an acid which can corrode and damage engine parts.

### Fuel Filter

The combination primary and secondary fuel filter is a disposable type. Any dirt that passes through the primary section is trapped by the secondary section. This prevents dirt from entering fuel injection pump.

The filter replacement interval will vary according to the fuel quality and cleanliness. Using the wrong fuel or dirty fuel will shorten the service life of the filter. At interval recommended in Table 4-1, remove the fuel filter and discard it (see Figure 4-12) according to the following procedure:

1. Close the fuel tank shut-off valve.
2. Clean all dirt from around filter, filter base and surrounding area.
3. Remove filter retaining clip or clips from fuel filter.
4. Remove old filter and dispose of it properly.

### CAUTION

**Take special precautions to keep the fuel clean and free of water. Due to the precise tolerances of diesel injection systems, dirt or water in the fuel might cause severe damage to both the injection pump and injector nozzles.**

5. Install new fuel filter and prime the fuel system.

### WARNING

**Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep an ABC type fire extinguisher nearby.**

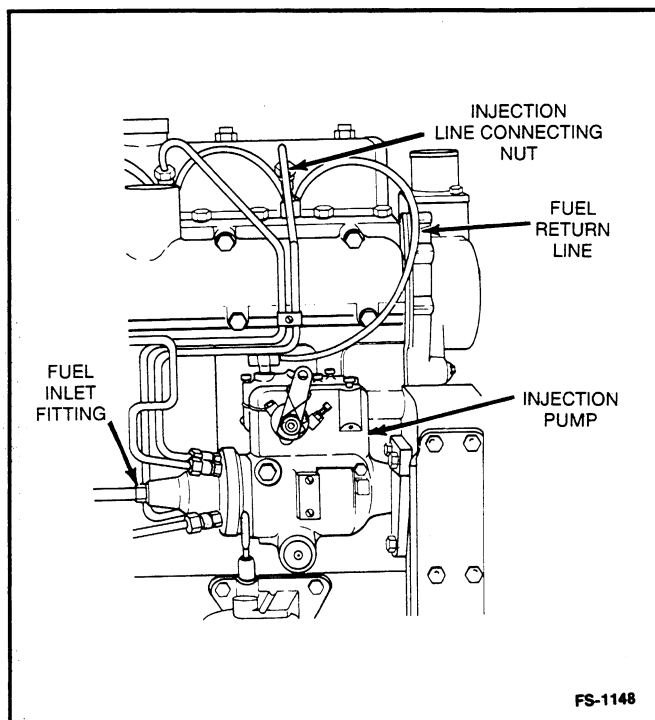


FIGURE 4-13. FUEL INJECTION PUMP

### Priming the Fuel System

The fuel system must be primed prior to initial start up or after engine has run out of fuel.

### Low Pressure Fuel System

The transfer pump, fuel filter and injection pump housing comprise the low-pressure fuel system. Use the following procedure to remove the trapped air from the system.

1. Check fuel level in fuel tank and open shut-off valve.
2. Loosen the fuel filter to injection pump line at the injection pump fuel inlet fitting (see Figure 4-13).

3. Actuate the priming lever on the side of the transfer pump until fuel flows from the fitting (see Figure 4-14). If the camshaft transfer pump lobe is up, turn engine one revolution to permit hand priming.
4. Tighten fuel line at the injection pump inlet.

### High Pressure Fuel System

The injection pump, fuel injection lines and fuel injectors comprise the high-pressure fuel system. This part of the system is usually self-priming since any trapped air is usually forced out through the injection nozzles. However, if the engine has run out of fuel, been shut down for an extended period of time or has had the injection lines removed, it may be necessary to prime. Use the following procedure:

1. Loosen the fuel injection line connecting nut attaching each line to corresponding nozzle holder (see Figure 4-13).
2. Energize the starting motor by placing the Run/Stop/Remote switch in the Run position.
3. After 30 seconds, place the Run/Stop/Remote switch in the Stop position and pause for two minutes to permit the starter motor to cool.
4. Discontinue priming when fuel flows from the end of all high pressure fuel injection lines. Tighten connection nuts and torque to 18 ft-lbs (24 N•m).

**⚠ WARNING** *The fuel is under extremely high pressure and presents the hazard of penetrating the skin, causing blood poisoning or skin infection. Protective gloves and a face mask should be worn during this procedure.*

**⚠ WARNING** *Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep an ABC type fire extinguisher nearby.*

### AIR CLEANER

The engine air intake components should be checked at the interval indicated in Table 4-1. The frequency of cleaning or replacing air cleaner filter elements is primarily determined by the conditions that the generator set operates in. The standard air cleaner is a disposable type. The optional heavy duty air cleaner contains a paper cartridge filter element which can be cleaned and reused if not damaged, or discarded and replaced.

**⚠ CAUTION** *Filters should be handled with care to prevent damage. If the filter does become damaged, install the recommended replacement part.*

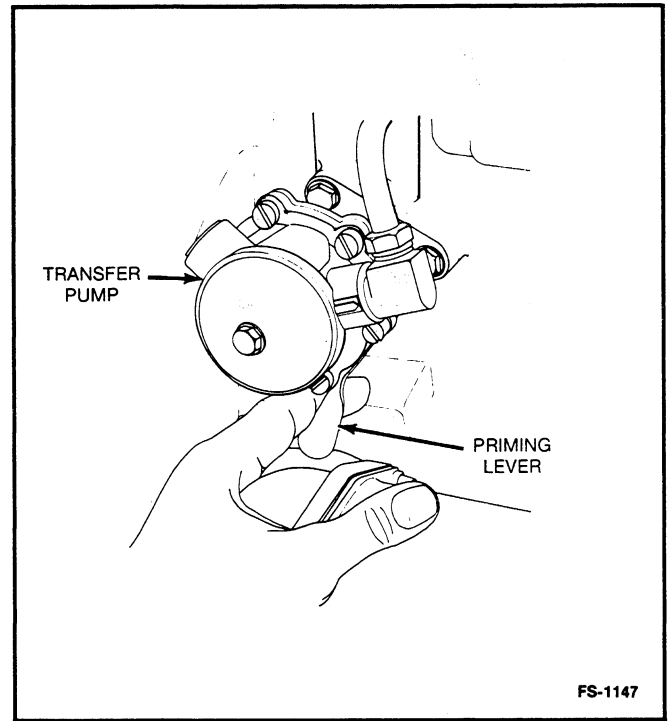


FIGURE 4-14. FUEL TRANSFER PUMP



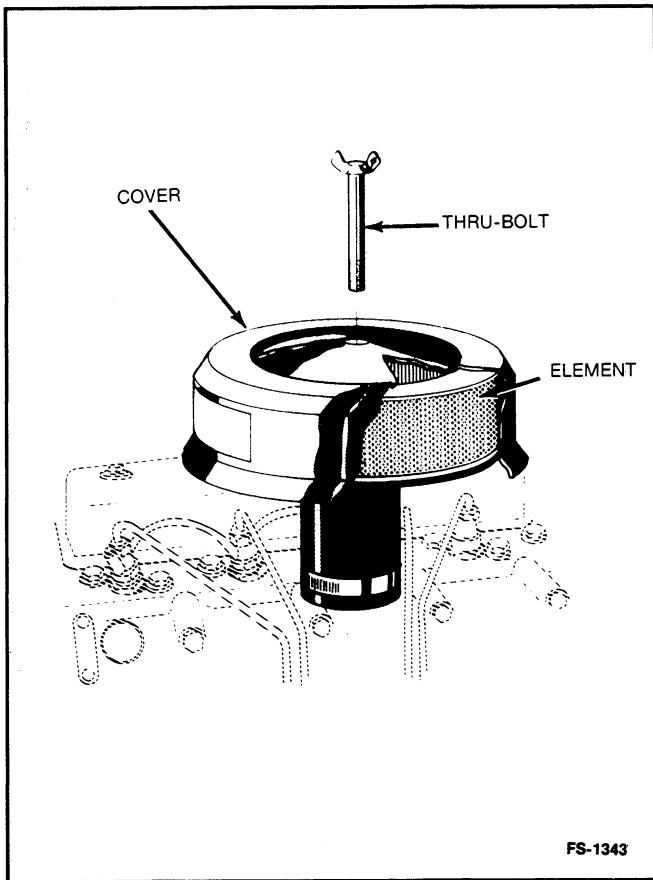


FIGURE 4-15. STANDARD AIR CLEANER

**To Replace the Standard Air Cleaner:** See Figure 4-15.

1. Remove the thru-bolt.
2. Lift off Air Cleaner Cover.
3. Lift off Air Cleaner Element.
4. Install new Air Cleaner Element, after cleaning the cover of dust and debris.

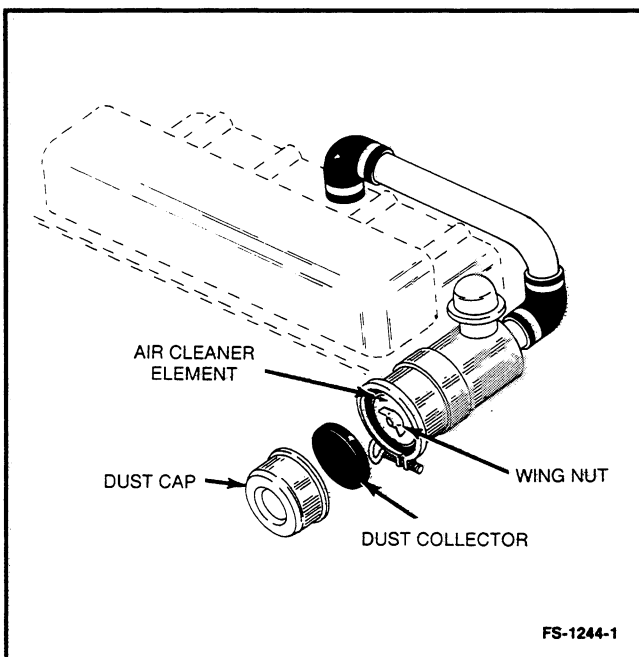


FIGURE 4-16. HEAVY DUTY AIR CLEANER

**To Service the Optional, Heavy-Duty Air Cleaner:** See Figure 4-16.

1. Remove the Dust Cap.
2. Clean dust and debris from the rubber dust collector in the cap.
3. Remove the wing nut and air filter element.
4. Clean by directing dry, clean, low-pressure air (30 psi/207 kPa) up and down the pleats on the inside of the element. If the element is extremely dirty, it can be washed by soaking in a mild detergent and water. Soak for 15 minutes and then rinse thoroughly with clean water.
5. Air dry the element for a minimum of 24 hours. Do not dry with compressed air or at temperatures greater than 150°F (66°C).
6. Reassemble, making certain the dust cap side marked "TOP" is facing out.

**⚠ CAUTION** *Do not reuse the element more than twice. If element has even a small hole, replace it to prevent engine damage from dirt.*

## FAN BELT

To adjust, loosen alternator bolt that passes through elongated slot in mounting bracket. Slide alternator until a fan belt tension of 60 lbs. (267 N) is obtained. Tighten alternator mounting bolt to lock alternator in place. Check tension and repeat if necessary. See Figure 4-17.

## VALVE CLEARANCE

Because of the high compression developed by diesel engines, correct valve clearance is very important. Incorrect valve clearance will cause loss of compression, misfiring, noise and eventually may lead to damaged engine components. At interval recommended in Table 4-1, contact your authorized Cummins service center.

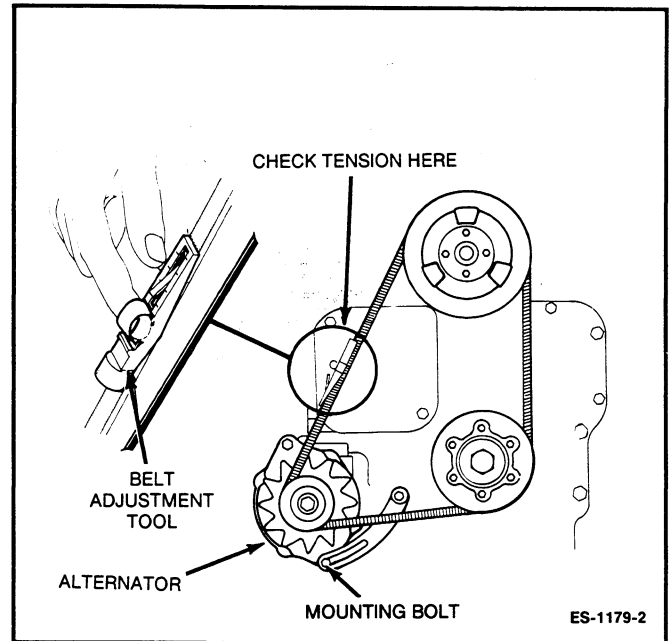


FIGURE 4-17. FAN BELT ADJUSTMENT

## AC GENERATOR

### General

These generators require very little servicing. Periodic inspections, to coincide with engine oil changes, will help provide good performance.

Remove the generator output box cover and inspect front and back sides of the intake slots for obstructions such as debris, dirt and dust. Clean as necessary (see Figure 4-18).

Inspect the Rotating Rectifier assembly to make sure the diodes are free of dust, dirt and grease (see Figure 4-19). Excessive foreign matter on these diodes and heat sinks will cause the diodes to overheat and fail. Blow out the assembly periodically with filtered low-pressure air.

**CAUTION** *Excessive foreign matter on diodes and heat sinks will cause overheating and possible failure.*

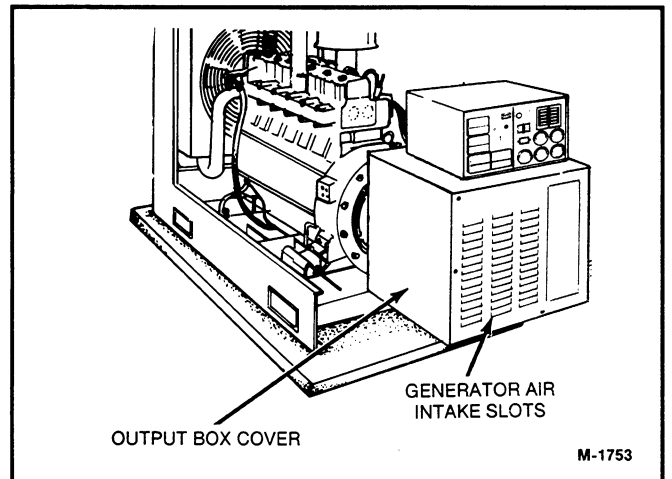


FIGURE 4-18. GENERATOR OUTPUT BOX

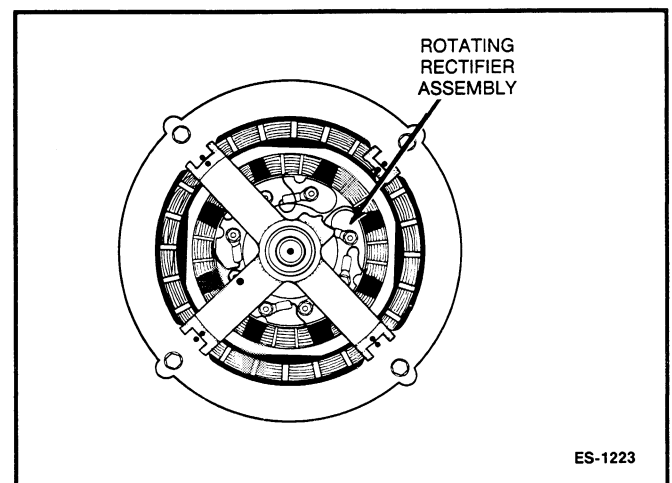


FIGURE 4-19. GENERATOR END VIEW

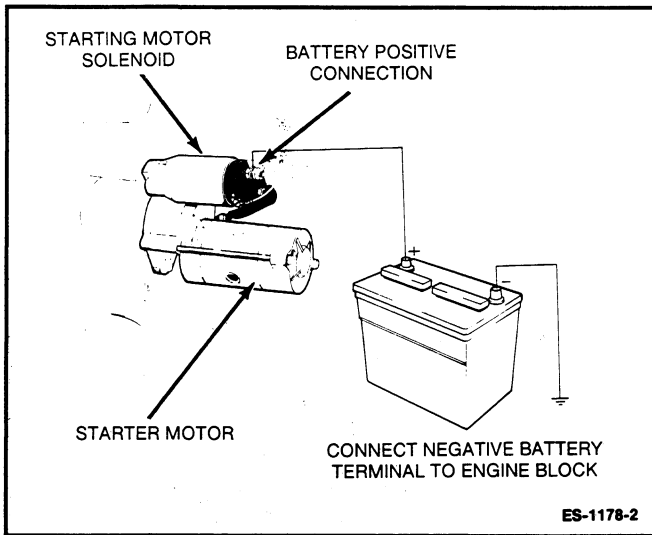


FIGURE 4-20. STARTING BATTERY

## BATTERIES

Check the condition of the starting batteries at the interval specified in Table 4-1. See that connections are clean and tight (Figure 4-20). A light coating of non-conductive grease will retard corrosion at terminals. Keep the electrolyte at the proper level above the plates by adding distilled water. Check specific gravity and recharge if below 1.260.

If the generator set is operated in an area where the ambient temperature is consistently above 95°F (35°C), a specific gravity of 1.225 is recommended to reduce electrolyte loss.

**⚠ WARNING** *Ignition of explosive battery gases can cause severe personal injury. Do not smoke while servicing batteries. Wear protective apron and goggles when checking specific gravity and adding distilled water.*

# Section 5. Installation

## GENERAL

This section of the manual provides the following generator set installation instructions:

- Mounting — Recommendations for fastening generator set to base and space requirements for normal operation and service.
- Mechanical Connections—Connection points for fuel, exhaust, ventilation, and cooling.
- Electrical Connections—Location of electrical connection points for the control, generator, and starting system.

### Installation Overview

The installation recommendations in this section apply to typical generator set installations with standard model generator sets (See Figure 5-1). 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 your distributor for assistance.

### Power Rating Factors

The standard generator set power rating applies to sets used in standby applications. The set will operate at the stated rating for the duration of normal utility power interruptions. The rating was established for a standard radiator cooled generator set running on diesel fuel and operating at the reference Product Data Sheet conditions.

Cummins also has published ratings for optional prime power sets, sets without fans and sets with short stack generators. All Generator Set Data Tags will show such ratings for sets built with these options.

For a rating relative to other applications, altitudes, cooling systems, or ambient temperatures, contact your distributor.

## Application and Installation

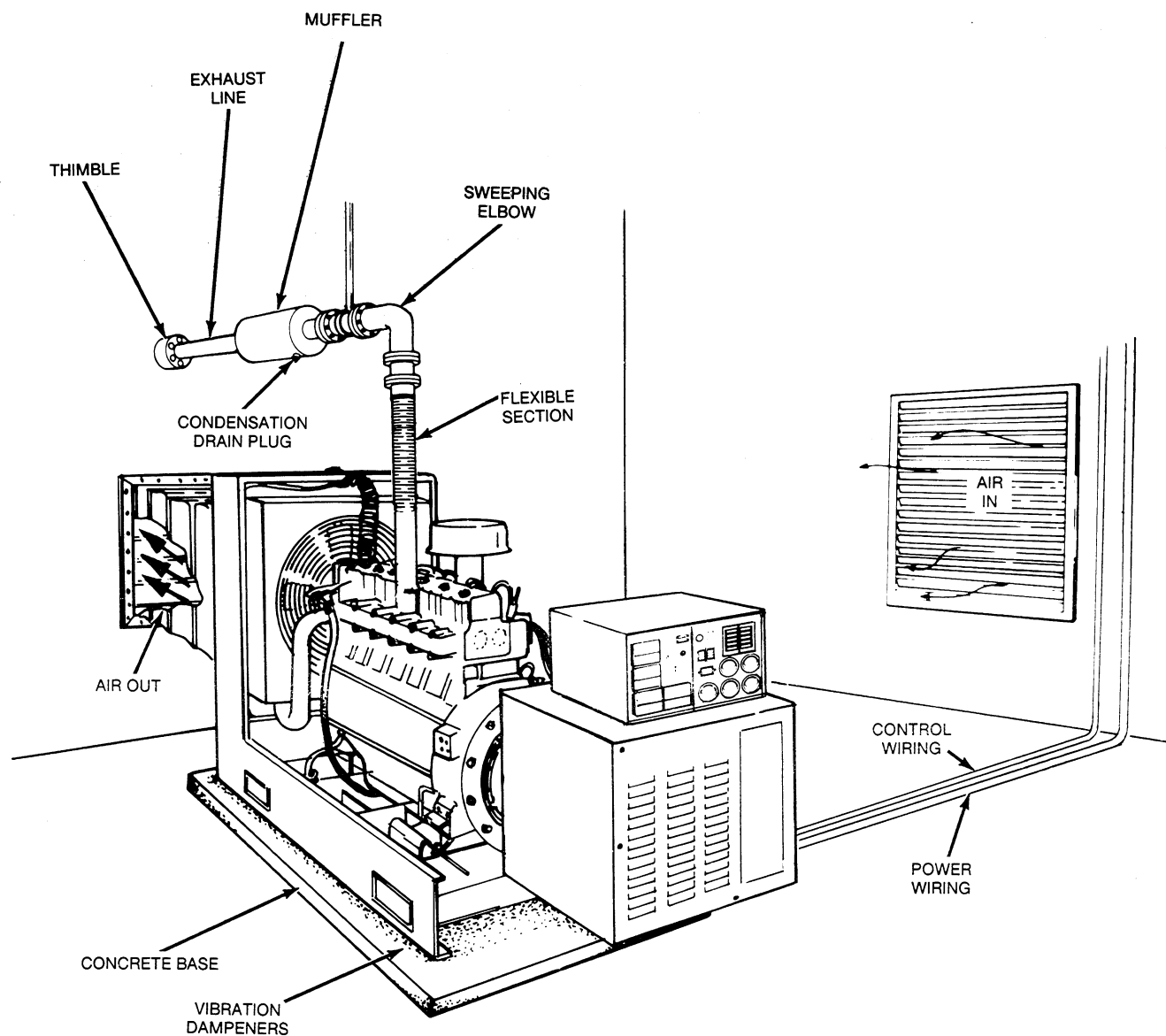
An electrical power system must be carefully planned and correctly installed to provide proper operation. This involves two essential elements: application and installation.

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 sheetmetal workers to properly complete the various segments of the installation. Refer to the Typical Installation figure and Specifications table that follow while reviewing this section.

### 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.



**IMPORTANT!**

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

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

M-1753

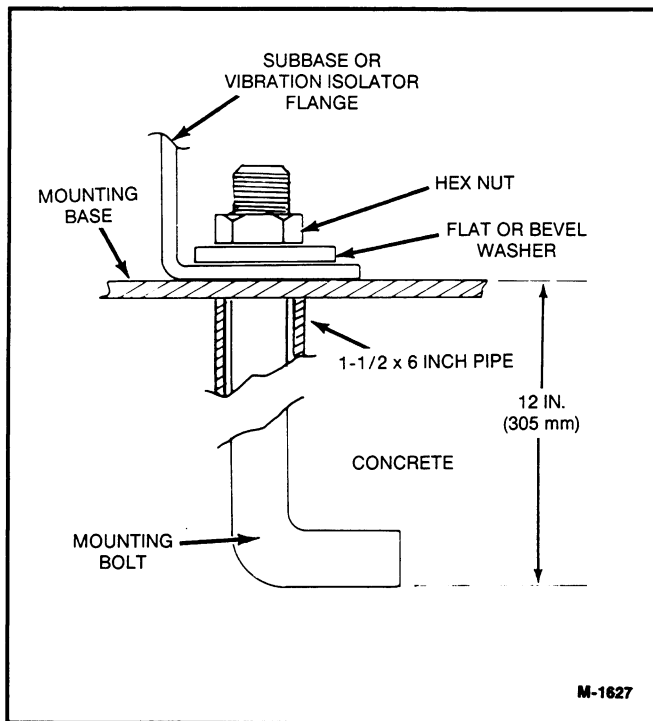
FIGURE 5-1. TYPICAL INSTALLATION

**TABLE 5-1. SPECIFICATIONS**

	GENERATOR SET MODEL			
SYSTEM	4A2.3-GS/GC	6A3.4-GS/GC-1	6A3.4-GS/GC-2	6AT3.4-GS/GC
<b>ENGINE</b>				
Cummins Model	4A2.3	6A3.4	6A3.4	6AT3.4
Coolant Capacity Engine and Radiator	12.2 Qt. (11.5 L)	17.8 Qt. (16.8 L)	17.8 Qt. (16.8 L)	18.5 Qt. (17.5 L)
Oil Capacity	6 Qt. (5.7 L)	9 Qt. (8.5 L)	9 Qt. (8.5 L)	12 Qt. (11.4 L)
Fuel Pump				
Inlet Thread Size	1/4 NPTF	1/4 NPTF	1/4 NPTF	1/4 NPTF
Outlet Thread Size	1/8 NPTF	1/8 NPTF	1/8 NPTF	1/8 NPTF
Maximum Lift	6 ft. (1.8 m)	6 ft. (1.8 m)	6 ft. (1.8 m)	6 ft. (1.8 m)
Exhaust				
Outlet Size	2 in. NPT external	2 in. NPT external	2 in. NPT external	3 in. NPT external
Maximum Allowable Back Pressure	41 in. H <sub>2</sub> O 3 in. Hg	41 in. H <sub>2</sub> O 3 in. Hg	41 in. H <sub>2</sub> O 3 in. Hg	40 in. H <sub>2</sub> O 2.9 in. Hg
Starting System				
Voltage DC	12	12	12	12
Battery Requirements				
BCI Group	31	31	31	31
Cold Cranking Amps	530	625	625	625
Quantity Required	1	1	1	1

**⚠ WARNING**

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



**FIGURE 5-2. TYPICAL ANCHOR BOLT DIAGRAM**

## 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 5-1):

- 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 (305mm) 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. Mount the generator set on a substantial and level base such as a concrete pad. For most installations, vibration isolators between the subbase and foundation are required. Contact your distributor.

Typically 3/4 inch diameter, anchored mounting bolts are used to secure the generator set subbase to the floor to prevent movement. Secure the subbase/vibration isolators using flat or bevel washer and hexagon nut for each bolt. 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 unit. For convenience in general servicing such as the radiator, fan belt, and changing the crankcase oil; the surface of the mounting base should be at least 6 inches (152 mm) above the floor.

## MECHANICAL CONNECTIONS

### General

The generator set mechanical system installation includes connecting the fuel, exhaust, ventilation and cooling systems (see Figure 5-1). Before starting any type of fuel installation, all pertinent state and local codes must be complied with and the installation must be inspected before the unit is put in service.

### Fuel System

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

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

Use only compatible metal fuel lines to avoid electrolysis when fuel lines must be buried. Use a flexible section of tubing between the engine and fuel supply line to provide vibration isolation. Refer to your generator set outline drawing for sizes and locations.

**▲ 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 shutoff valve in the supply line is recommended for all installations and required for indoor automatic or remote starting installations. Connect the solenoid wires to the battery ignition circuit to open the valve during generator set operation.

### Supply Tank

Locate the fuel tank as close as possible to the generator set and within the 5 foot (1.5 metre) lift capacity of the fuel pump if possible. Install a fuel tank that has sufficient capacity to keep the generator set operating continuously at full load for at least 36 hours.

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

If the main fuel tank is installed below the lift capabilities of the standard fuel transfer pump, a transfer tank and auxiliary pump will also be required. If an overhead 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 Transfer Tank and Figure 5-3, following.



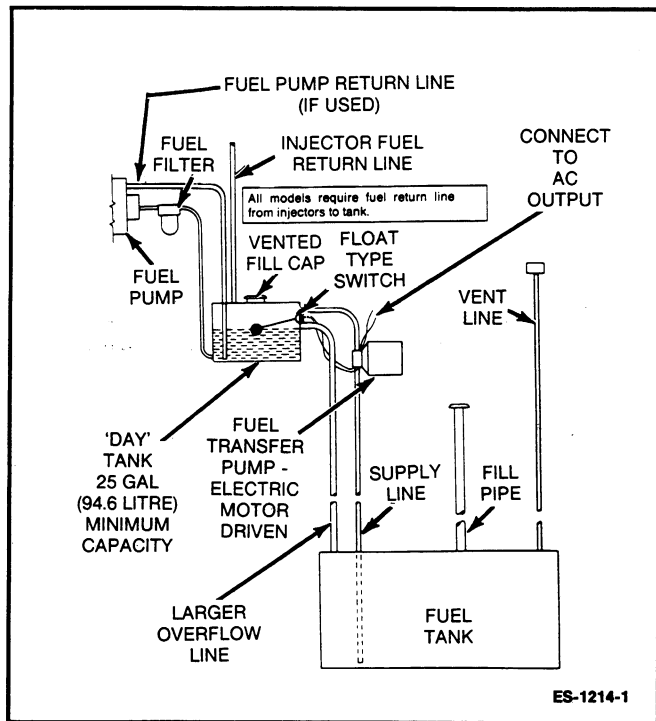


FIGURE 5-3. TYPICAL FUEL SUPPLY INSTALLATION

### Transfer Tank (If Used)

Fuel transfer 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 transfer 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 transfer tank. A float switch in the transfer tank controls operation of the auxiliary fuel pump.

The supply tank top must be below the transfer tank top to prevent siphoning from the fuel supply tank to the transfer tank.

Provide a return line from the engine injection system return connection to the transfer tank (near the top). Provide a transfer 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 transfer tank.*

**Supply Tank Higher Than Engine:** Install the transfer 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 transfer tank.

Include a shutoff solenoid in the fuel line between the fuel supply tank and the transfer tank. It stops fuel flow when the generator set is off.

### Engine Fuel Connections

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

## Exhaust System

Pipe exhaust gases to the outside of any enclosure. Locate the exhaust outlet away from any air inlets to avoid exhaust gases re-entering the enclosure. Exhaust installations are subject to various detrimental conditions such as extreme heat, infrequent operation, hanging loads, etc. Regularly inspect the exhaust system both visually and audibly to 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.*

Use an approved thimble, or other refractory insulation system, where exhaust pipes pass through walls or partitions (see Figure 5-4). Build according to all applicable code requirements.

**⚠ 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 5-5).

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

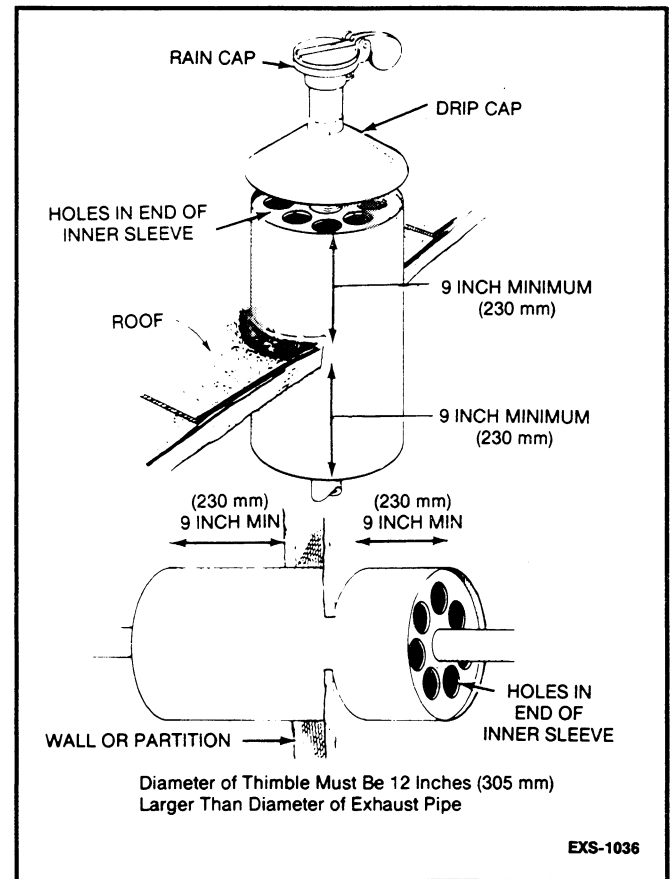


FIGURE 5-4. MOUNTING EXHAUST THIMBLE THROUGH ROOF OR WALL

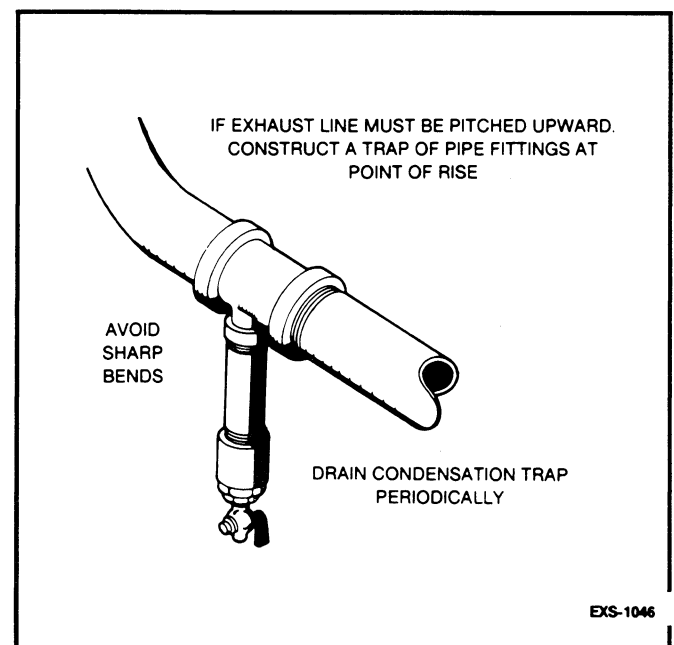


FIGURE 5-5. EXHAUST CONDENSATION TRAP

## Ventilation System

Generator sets create considerable 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 5-6), 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.

## Cooling System

A set-mounted radiator with engine-driven fan is standard (see Figure 5-6). Air is pulled from the generator end of the set across the engine and then forced through the radiator. An air duct adapter flange surrounds the radiator grill to allow mounting of the air discharge duct.

Locate the air inlet to the rear of set and near the floor. Make the air inlet vent opening 1.5 to 2 times larger than the radiator opening.

Locate the air outlet directly in front of the radiator and as close as possible. The effective opening area should be at least as large as the radiator area. Length and shape of the air outlet duct should offer minimum restriction to airflow. Use a duct of canvas or sheet metal between the radiator and the air outlet opening to prevent recirculation of heated air and provide for flexible connection. The outlet opening size must be increased proportionate to any added restriction caused by ducting louvers.

Refer to *Specifications* in this section for standard Cooling system capacities, and *Maintenance—Cooling System* section for further setup procedures.

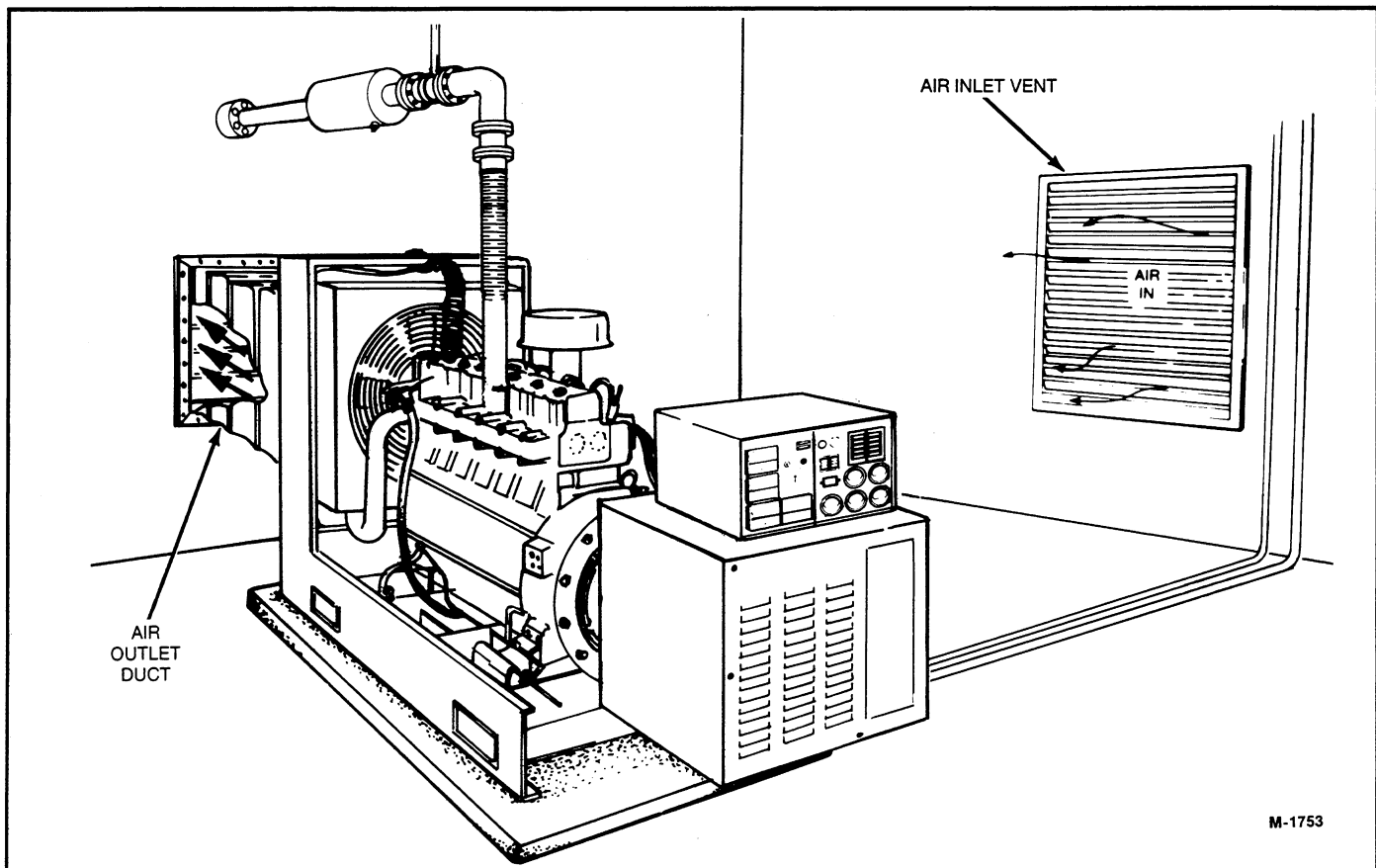


FIGURE 5-6. VENTILATION SYSTEM

### Coolant Heater (Optional)

A coolant heater is used to keep engine coolant warm when the engine is shut down (see Figure 5-7). It heats and circulates the coolant within the engine. This reduces start-up time and lessens engine wear caused by cold starts. It is electrically operated and thermostatically controlled.

**⚠CAUTION** *The heater must not be operated while the cooling system is empty or when the generator set is operating or damage to the heater will occur.*

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

## 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.

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

**⚠WARNING** *Improper wiring 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 5-8). 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 distributor can supply transfer switches matched to the generator rating.

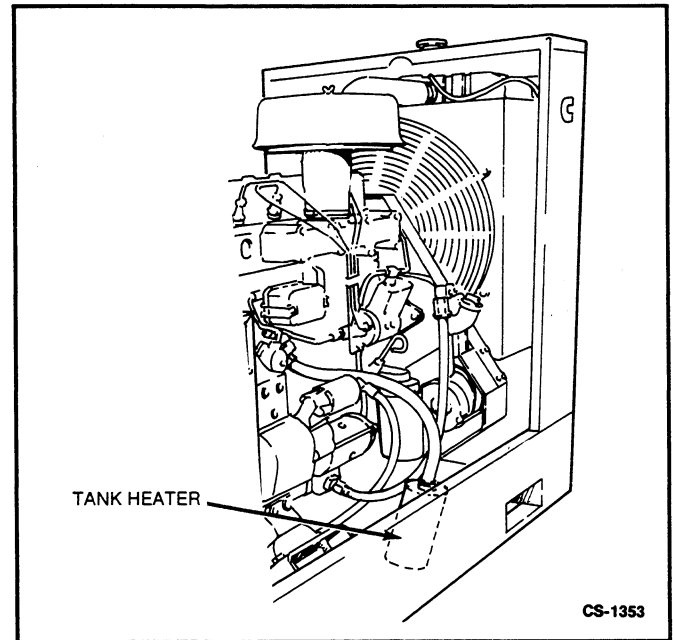


FIGURE 5-7. TYPICAL COOLANT HEATER (TANK TYPE)

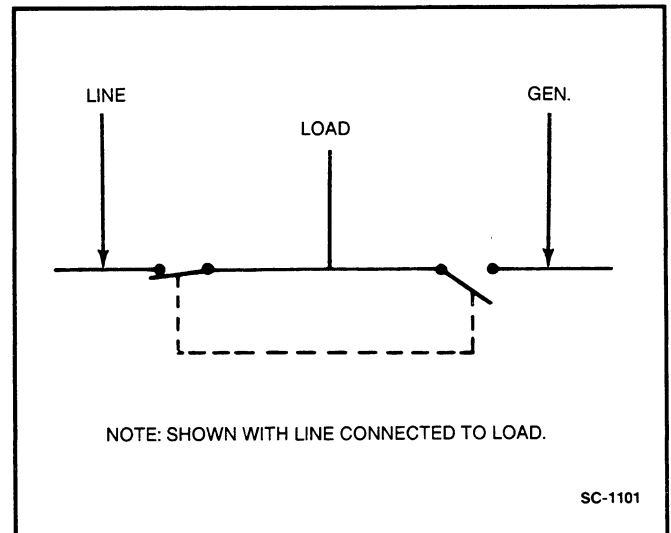


FIGURE 5-8. TYPICAL LOAD TRANSFER SWITCH

## AC WIRING

### Generator Voltage Connections

The generator output voltage and maximum current rating are specified on the generator set data tag. Line-to-neutral voltage is always the lower voltage shown on the data tag and line-to-line voltage is the higher rating. These generators can be configured for the voltages shown in the Reconnection Diagram (see Figure 5-9). 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.

Refer to Reconnection Diagram (see Figure 5-9) when reviewing the voltage connection information; and use the electrical schematic supplied with your generator set when actually performing load connections.

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

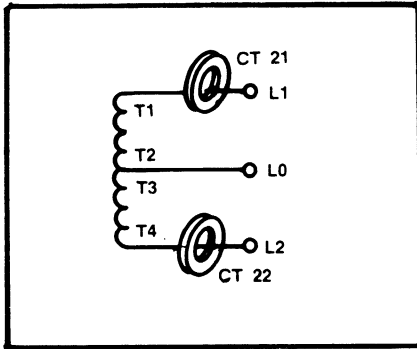
### Load Connections

The load is connected to the generator set by bolting the load wires to the appropriate generator lead wires in the output box. The generator lead wires are marked T1, T2, etc. for identification.

Use a section of flexible conduit at the output box to permit movement.

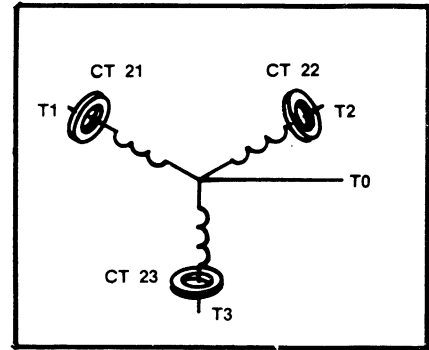
When installing sets with the optional AC ammeter, the generator output leads must be routed through the current transformers for proper meter operation (see Figure 5-10). The current transformers are identified as CT21, CT22, and CT23 (3 phase only) on the wiring diagrams and electrical schematics. Refer to the appropriate generator connection diagram (see Figures 5-9) to identify the output leads that must be routed through each current transformer.

120/240 VOLT, 3 PHASE, 60 HERTZ



SECONDARY CURRENT TRANSFORMER CONN. 1-3

220/380 VOLT, 3 PHASE, 60 HERTZ  
347/600 VOLT, 3 PHASE, 60 HERTZ



SECONDARY CURRENT TRANSFORMER CONN. 1-2

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

ES-1791

FIGURE 5-9. GENERATOR VOLTAGE CONNECTIONS

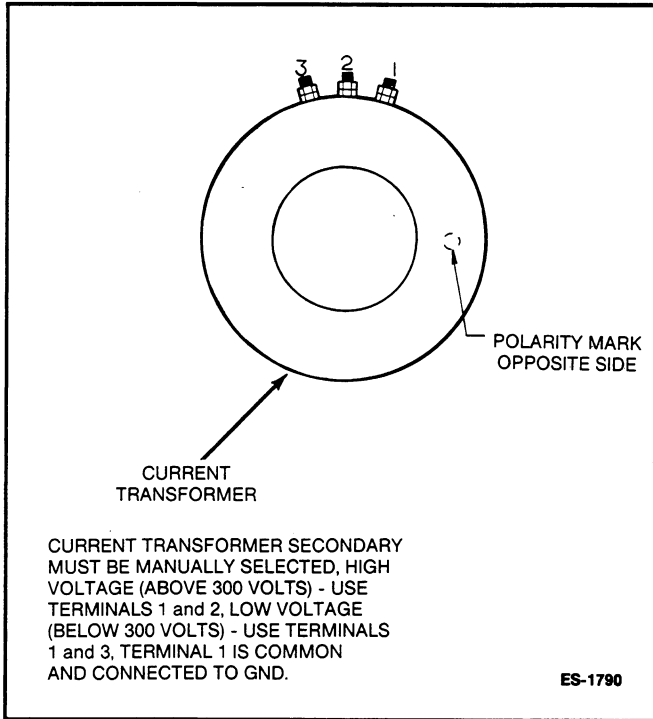


FIGURE 5-10. CURRENT TRANSFORMERS

## Load Balancing

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

## Grounding

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

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

Typical requirements for bonding and grounding are given in the National Electrical Code, 1981, Article 250. All connections, wire sizes, etc. must conform to the requirements of the electrical codes in effect at the installation site.

## 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 5-11).

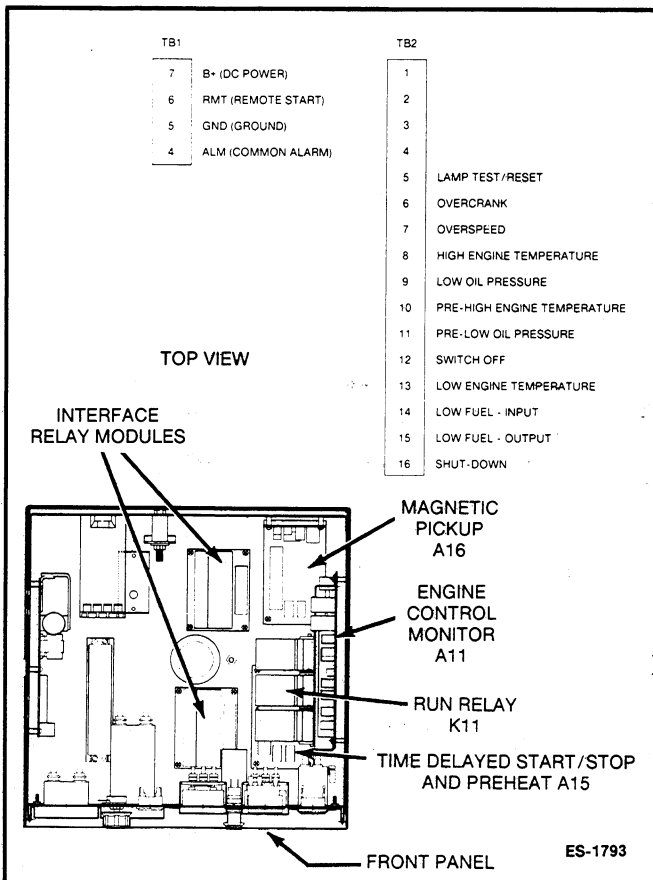


FIGURE 5-11. REMOTE CONTROL AND REMOTE MONITOR CONNECTIONS

If the distance between the set and remote station is less than 1000 feet (305m), 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 10-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.**

### Battery Connections

Use one 12 volt battery for a normal installation (see Specifications). Connect battery as shown in Figure 5-12. Battery cables are included on the unit. Connect battery positive before connecting battery negative to prevent arcing.

Service the battery as necessary. Infrequent set use (as in emergency standby service) may allow the battery to self-discharge to the point where it cannot start the set. If an automatic transfer switch is installed that has no built-in charge circuit, connect a separate trickle charger.

If the battery is installed outside the skid base, use battery cables that are of sufficient size to handle high current loads during cranking. Refer to Table 5-2 for recommended cable dimensions.

#### ⚠ 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.**

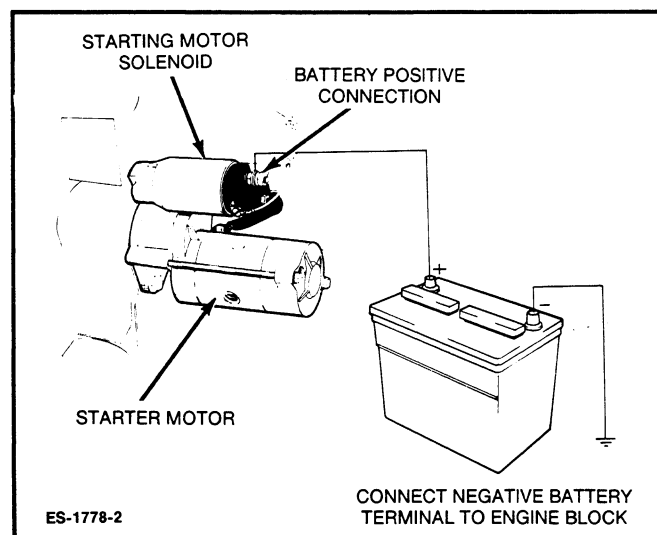


FIGURE 5-12. BATTERY CONNECTIONS

TABLE 5-2. BATTERY CABLE SIZE

MM	6.5	7.3	8.3	9.3	10.5	11.6
INCH	0.258	0.289	0.325	0.365	0.410	0.460
WIRE SIZE	2	1	0	00	000	0000
LOOP	4 ft. 1.24 m	5 ft. 1.55 m	7 ft. 2.17 m	9 ft. 2.79 m	11 ft. 3.41 m	14 ft. 4.34 m





# Section 6. Prestart Preparation

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

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

## 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 one 12-volt battery for a normal installation. Connect the negative (-) battery cable last to reduce the chance of arcing.

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

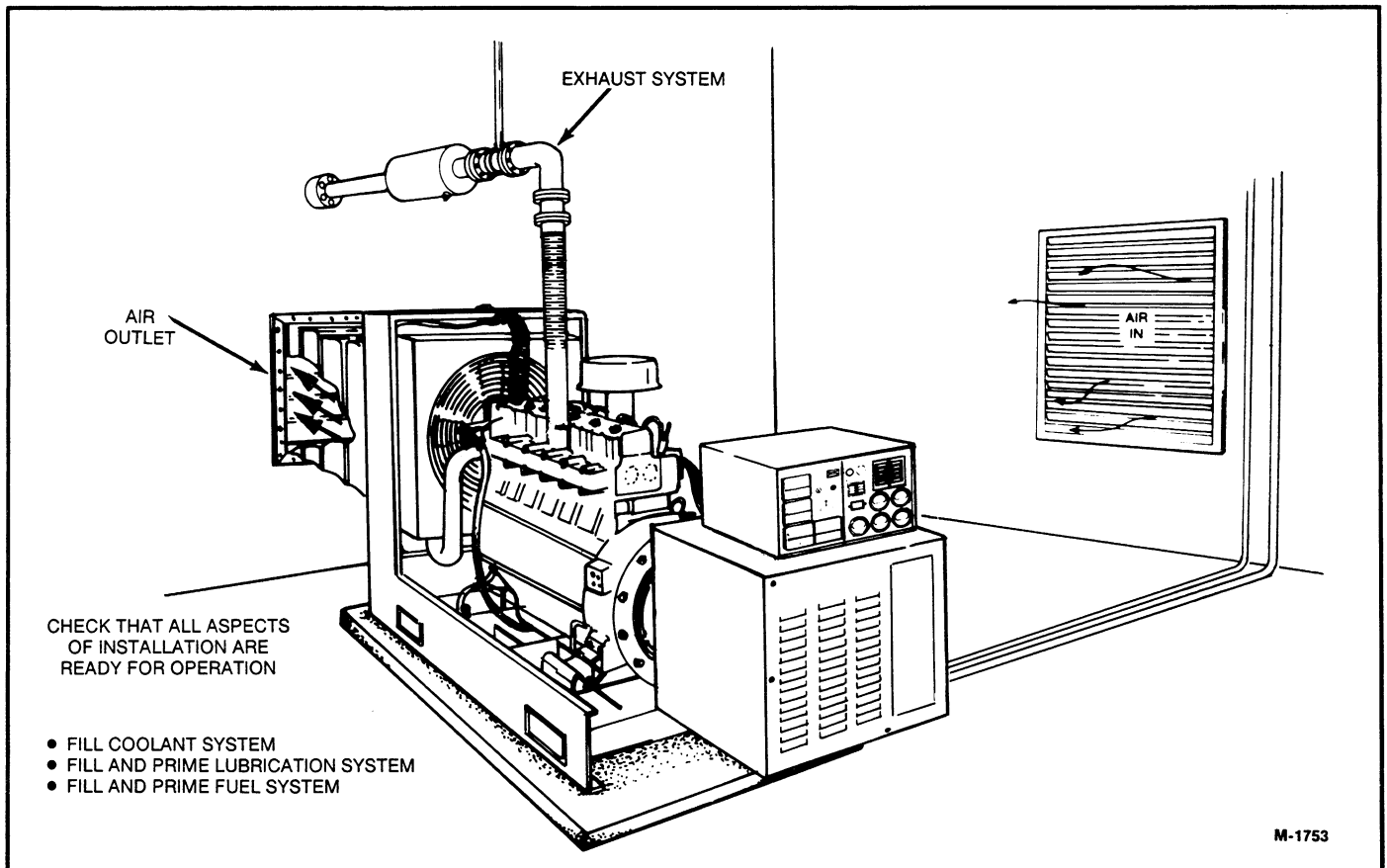


FIGURE 6-1. TYPICAL INSTALLATION

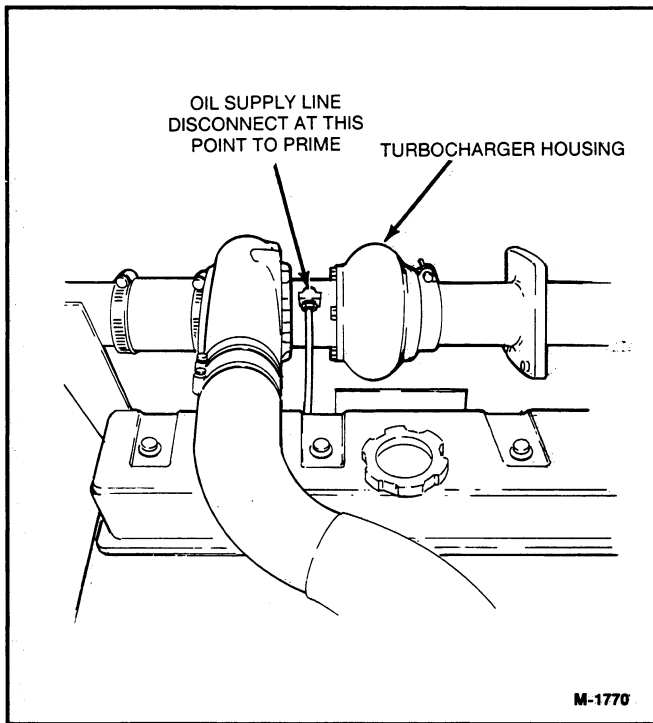


FIGURE 6-2. PRIMING TURBOCHARGER

## COOLANT

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

## LUBRICATION

Engine oil is drained prior to shipment. Before starting, fill the crankcase with the recommended oil. Refer to *Maintenance* section for the Procedure.

### **Prime Turbocharger (Turbocharged Model Only):**

1. Remove oil inlet line from turbocharger housing (Figure 6-2).
2. Fill bearing housing with clean engine lubricating oil. Replace oil inlet line and secure.

## FUEL

Fill the fuel tanks with the recommended fuel and prime the fuel system. All manual shutoff valves should be turned open.

1. Prime the transfer pump, fuel filter, and injection pump housing as follows:

### **⚠ 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.*

- A. Loosen low pressure injection pump line at injection pump fitting (Figure 4-13).
- B. Actuate the priming lever on the side of the transfer pump until fuel flows from the fitting (Figure 4-14).

**If resistance is not felt when operating priming lever the camshaft transfer pump lobe is up. Turn engine one revolution to permit hand priming.**

- C. Tighten fuel line at injection pump inlet.

## 2. Priming High Pressure Fuel System

This part of the system is usually self-priming since any air trapped in injection lines is usually forced out through injection nozzles. If the engine has run out of fuel, been shut down for an extended period, or has had fuel injection lines removed, it may be necessary to prime as follows:

- A. Loosen fuel injection line connecting nut, attaching each line to corresponding nozzle holder.
- B. Place speed control in high speed position and stop control in RUN Position.
- C. Energize starting motor. (Do not operate starting motor for more than 30 seconds at a time without pausing two minutes to permit starter to cool).
- D. When fuel flows from the end of all high pressure fuel injection lines, stop starting motor and tighten connection nuts.

**▲WARNING** *Keep hands and face away from spray. The discharge pressure can penetrate the skin and can cause blood poisoning or a serious skin infection.*

**▲WARNING** *Fuel presents the hazard of fire or explosion which can cause severe personal injury or death. Do not permit any flame, spark, pilot light, cigarette, or other ignition source near the fuel system. Keep an ABC type fire extinguisher nearby.*



# Section 7. Initial Start and Checks

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

## Mechanical

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 Preheat/Lamp Test/Reset/Panel Lamp switch at LAMP TEST. All indicator lamps will illuminate. Place the switch at PANEL LAMP.

## STARTING

- If the ambient temperature is below 32°F (0°C), place the Preheat/Lamp Test/Reset/Panel Lamp switch at PREHEAT for 10 seconds.

**⚠ CAUTION** *Do not exceed the 10 second preheat period prior to cranking to prevent heater burn out and conserve the battery. Longer preheating time prior to cranking the engine can ruin the glow plugs.*

- 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.

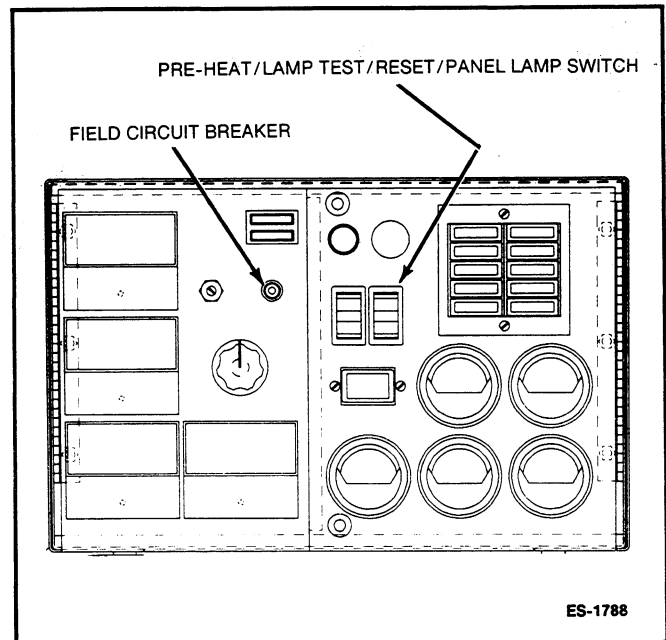


FIGURE 7-1. PRESTART CONTROL CHECKS

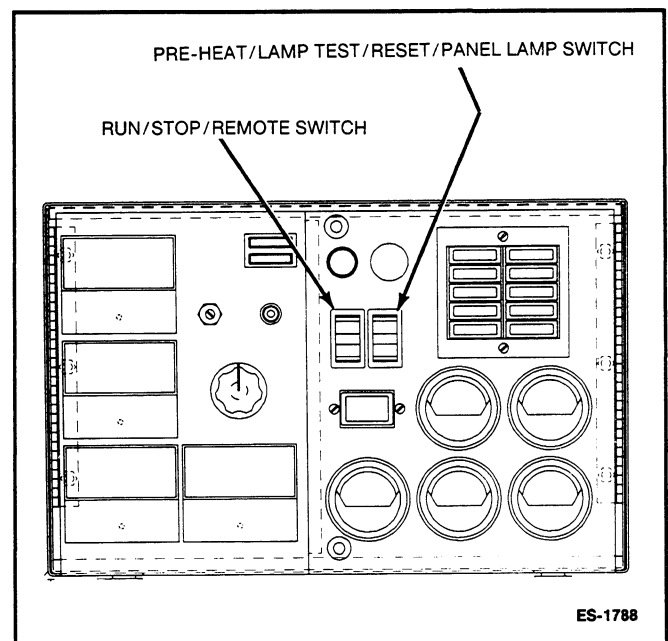


FIGURE 7-2. INITIAL MANUAL START

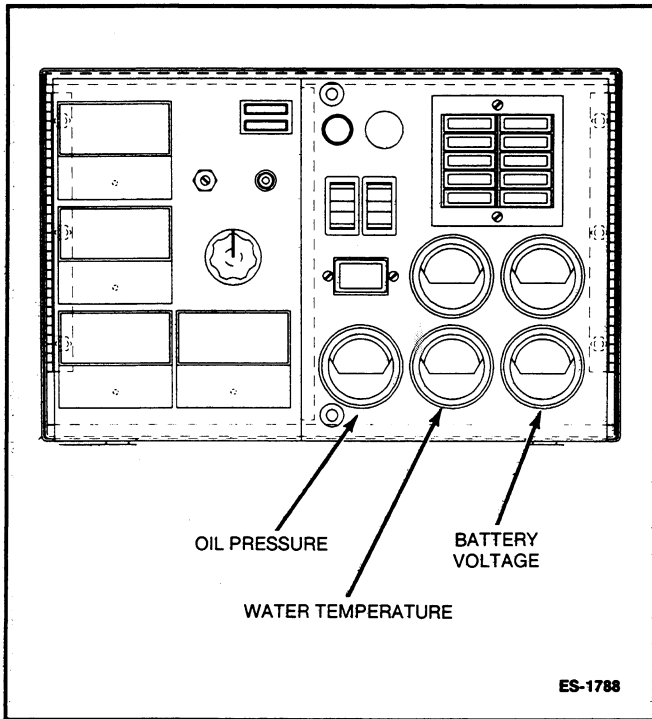


FIGURE 7-3. ENGINE GAUGES

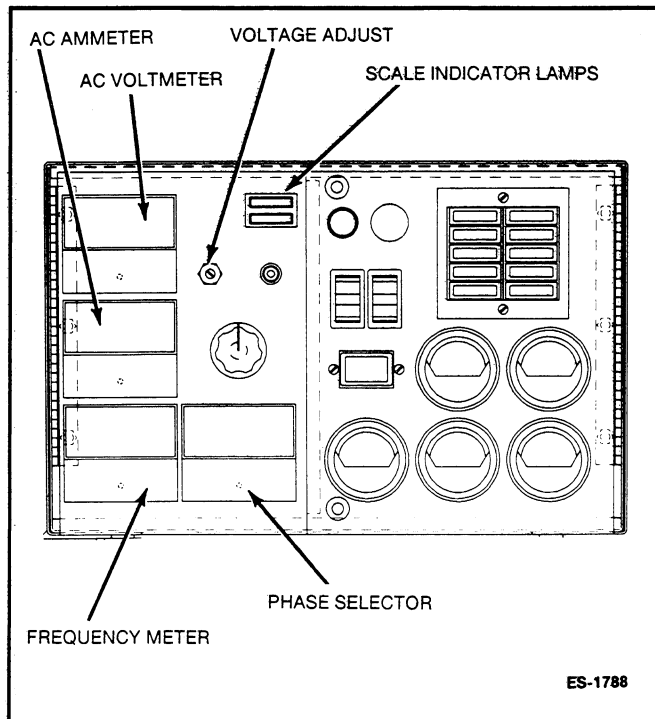


FIGURE 7-4. AC CHECKS

## ENGINE GAUGES

Check the following while the generator set is operating (see Figure 7-3):

### Oil Pressure Gauge

The oil pressure gauge should be in the range of 30 to 55 psi (207 to 380 kPa) when the engine is at operating 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 12 to 14 volts while set is running. If reading is high or low, check batteries and the battery charger circuit.

### 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.

## 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 7-4.

### 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 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. (See Figure 7-5).

**⚠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. (Reference Figure 7-5).

**⚠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

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 (Reference Figure 7-5).

## STOPPING

Stop the generator set by moving the Run/Stop/Remote switch to STOP (see Figure 7-6). Refer to *Operation* section 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 Hour Meter (see Figure 7-6.) Refer to the *Maintenance* section, table 4-1.

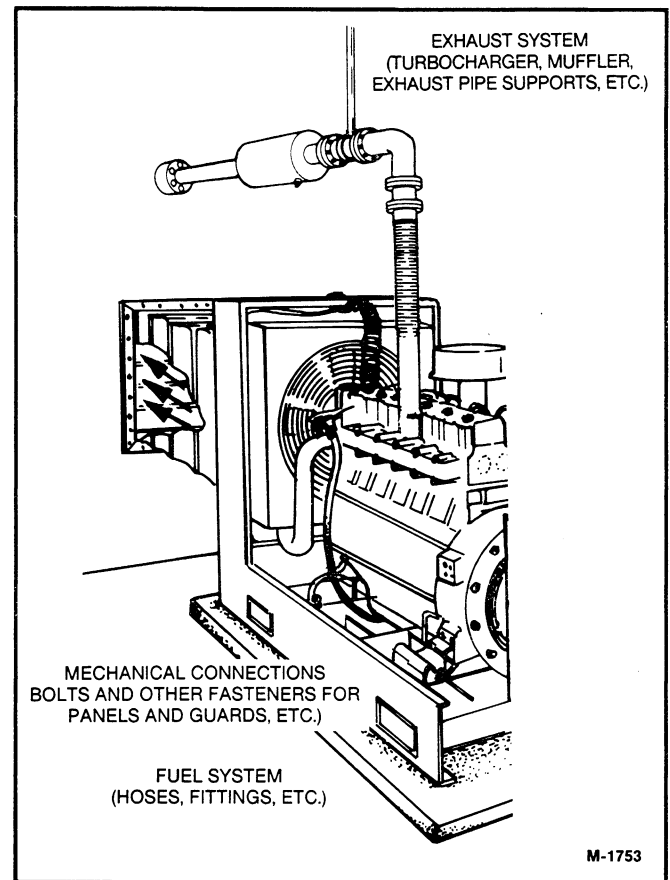


FIGURE 7-5. GENERATOR SET INSPECTION

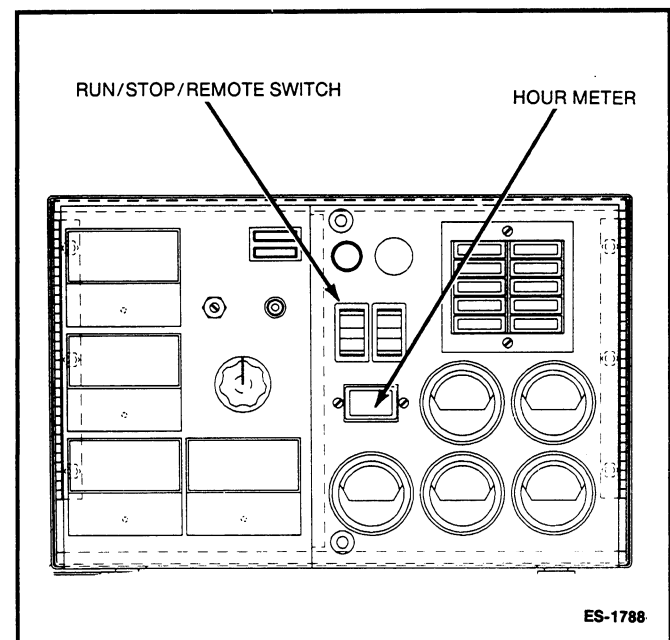


FIGURE 7-6. DC CONTROL PANEL









**Cummins Power Systems**  
**1400 73rd Avenue N.E.**  
**Minneapolis, Minnesota**  
**55432**

904-0132

Printed in U.S.A.  
7/88