

TECHNICAL MANUAL
UNIT, INTERMEDIATE DIRECT
SUPPORT
AND INTERMEDIATE GENERAL
SUPPORT
MAINTENANCE INSTRUCTIONS

**EMERGENCY GENERATOR
SET**

FOR
LANDING CRAFT UTILITY (LCU)
NSN 1905-01-154-1191

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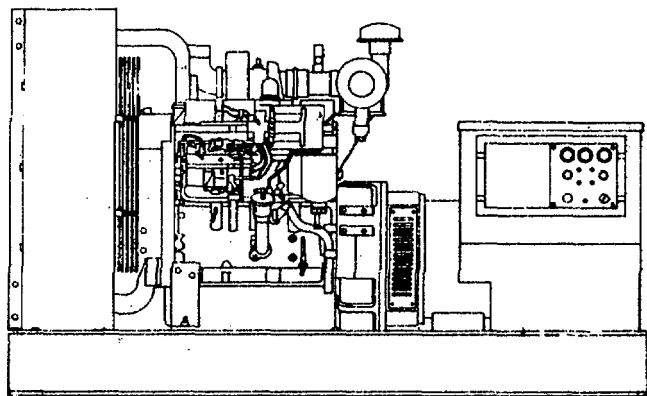
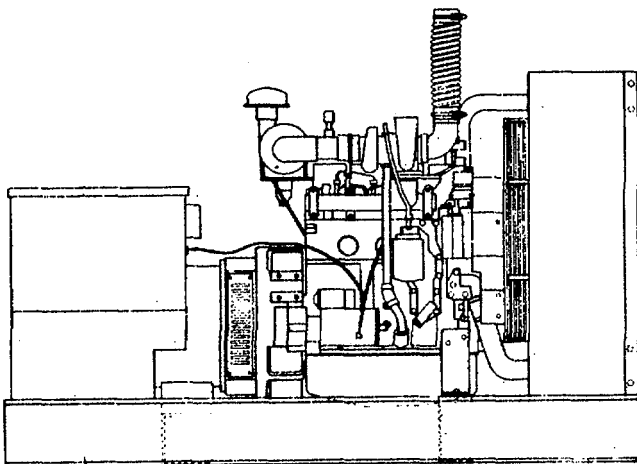
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TECHNICAL MANUAL

No. 55-1905-223-24-4

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 17 January 1989UNIT, INTERMEDIATE DIRECT SUPPORT AND INTERMEDIATE GENERAL SUPPORT
MAINTENANCE INSTRUCTIONSEMERGENCY GENERATOR SET
FOR
LANDING CRAFT UTILITY (LCU)
NSN 1905-01-154-1191**REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS**

You can help improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form) 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Aviation and Troop Command, ATTN: AMSAT-I-MP, 4300 Goodfellow Blvd., St. Louis, MO 63120-1798. A reply will be furnished directly to you.

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CHAPTER 1

INTRODUCTION

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Section I. GENERAL INFORMATION

1-1. **Scope.** The scope of this manual is as follows:

- a. Type of Manual. Unit, intermediate direct support, and intermediate general support maintenance manual.
- b. Model Number and Equipment Name. 4BT3.9CC Emergency Generator.
- c. Purpose of Equipment. Used to supply electric power in the event of normal power failure.

1-2. **Maintenance Forms, Records, and Reports.** Department of the Army forms and procedures used for equipment maintenance are those prescribed by DA Pam 738-750, the Army Maintenance Management System.

1-3. **Destruction of Army Materiel.** Refer to TM 750-244-3 for instructions covering the destruction of Army materiel to prevent enemy use.

1-4. **Reporting Equipment Improvement Recommendations (EIRs).** If your equipment needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell 'us what you don't like about your equipment. Let us know why you don't like the design. Put it on an SF 368 (Quality Deficiency Report). Mail it to: Commander, U.S. Army Troop Support Command; ATTN: AMSTR-QX; 4300 Goodfellow Blvd.; St. Louis, Missouri 63120-1798. We'll send you a reply.

1-5. **Preparation for Storage or Shipment.** Administrative storage of equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the Preventive Maintenance Checks and Services (PMCS) charts before storing. When removing the equipment from administrative storage, the PMCS should be performed to assure operational readiness. Repacking of equipment for shipment or short term storage is covered in paragraph 2-41.

Section II. EQUIPMENT DESCRIPTION AND DATA

1-6. **General Description.** The 4BT3.9GC emergency diesel generator set, illustrated in FIGURE 1-1, is a 4 cycle, 4 cylinder, radiator cooled unit. The generator is direct mounted to the engine for permanent alignment.. The in-line diesel engine covered in this manual is equipped with standard accessories such as water pump, governor, fuel pump etc. Full pressure lubrication is supplied to connecting rod, camshaft bearings and other moving parts. A gear-type pump draws oil from the oil pan and delivers it to the oil filter. Coolant is circulated through the engine by a water pump. This is a closed system with a radiator. Fuel is drawn from the fuel supply by a gear-type fuel pump. A turbocharger on top of the manifold feeds air for combustion in the cylinders. Engine starting is provided by a starter motor which is energized by a storage battery.

1-7. **Characteristics, Capabilities, and Features.** A very broad view of the emergency diesel generator is as follows:

a. Characteristics.

- (1) Transfers mechanical energy, supplied by the engine, into electrical energy.
- (2) Directly mounted to the engine for permanent alignment.
- (3) Has control circuits that shut off the engine if an overspeed, high water temperature, or low oil pressure develops.

b. Capabilities and Features.

- (1) Turbocharger added to increase horsepower, by increasing the air intake into the combustion chambers.
- (2) Provides automatic transfer of electrical load from normal source when power failure occurs.
- (3) Auto control provides one way of starting the engine automatically if power fails.

1-8. **Location and Description of Major Components.** The emergency diesel generator and diesel engine are both on a common chassis sub-base located on the center line of the ship, main deck, aft.

1-9. **Equipment Data.** Characteristics and reference data are provided in Table 1-1. Also see the equipment data given in the operator's manual, TM 55-1905-223-10.

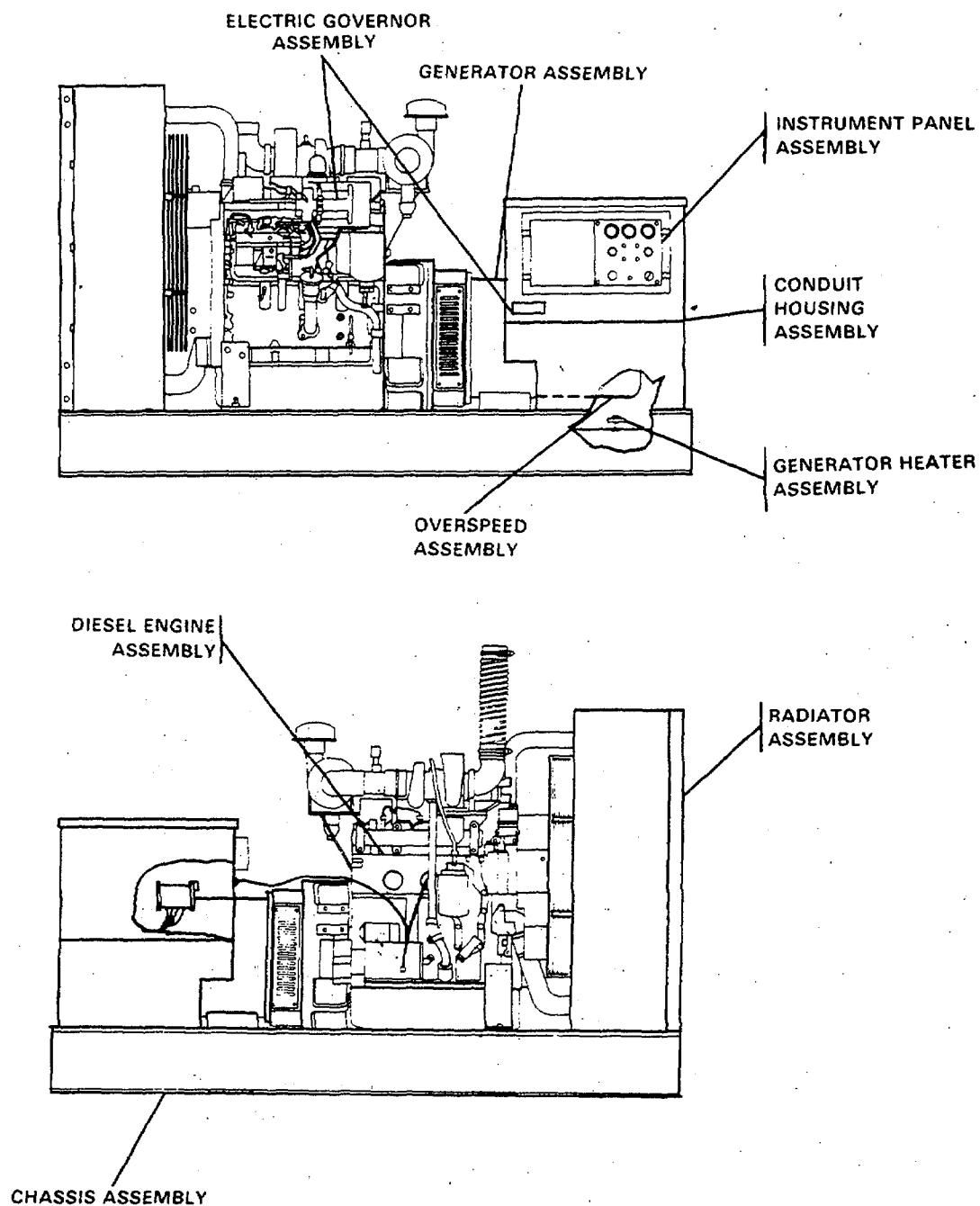


FIGURE 1-1. 4BT3.9GC Emergency Generator Set.

Table 1-1. Equipment Data

Characteristics	Reference Data
Model	4BT3.9GC
Manufacturer	Cummins Engine Co., Inc.
Type	4 cycle, 4 cylinder, diesel
Aspiration	Turbocharged
Rating	60 Hz, 240 V, 40 kW, 3 phase at 1800 rpm
Displacement	3.92 liters (239.3 in ³)
Bore and Stroke	102(4.02) x 120(4.72)
Weight	1514 lbs
Compression Ratio	18.5:1

Section III. PRINCIPLES OF OPERATION

Overview. The principles of operation section will give you overall description of how the emergency generator set works. Keep in mind that proper engine operation depends on two things: 1) compression for ignition, and 2) that fuel be measured and injected into cylinders in the proper quantity at the proper time.

1-10. Generator. The diesel engine is an internal combustion power unit, in which the heat of fuel is converted into work in the cylinder of the engine. Air alone is compressed in the cylinder. After the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition is accomplished by the heat of the compression. The engine is electric started. The starting motor is energized by a storage battery. The generator function is to transform mechanical energy, supplied by the engine, into electrical energy. The following is a brief summary of the main generator components.

a. Right Hand Door Assembly. The right side door assembly of the emergency generator set contains the buttons and indicators necessary for manual operation and monitoring of the set. As conditions are indicated at this assembly, manual intervention of functions or repair may be obtained. This assembly consists of the the following:

- (1) Time totalizing meter. Records the total generator set hours.
- (2) Coolant temperature gauge. Indicates engine coolant temperature.
- (3) Pressure indicator. Indicates engine oil pressure.
- (4) Fault lamp. Lights to indicate a fault condition has occurred.

b. Automatic Transfer Switch. This automatically transfers the electrical load from the normal source of energy to the emergency generator set when power failure occurs. It also transfers the load back when power is returned to normal load.

c. Auto-Control Panel. Provides one way of starting the engine, automatically, if the power fails, or manually, for test and maintenance. In addition, the control circuits provide for shut off of the engine if an overspeed, high water temperature, or low oil pressure develops.

d. Automatic-Voltage Regulator. Controls the generator output voltage at a preset value regardless of the load.

e. Governor. The-governor assembly consists of three main components⁵, the actuator, assembly, the control unit and the magnetic sensor. It maintains the engine at a constant speed during varying loads. The unit contains all solid state electric circuits which sense speed from a magnetic sensor located in the flywheel housing. A pulse from the sensor is directly proportional to the engine speed. It is compared with the control speed set point. It then supplies the appropriate current output to the actuator to control the fuel pump throttle arm. During cranking, the speed control unit causes the actuator to move the fuel pump lever to the full ON position. The actuator will regulate the engine speed once the engine starts.

f. Circuit Breakers. The breakers are used to protect the system during an overload and certain short circuit conditions. They are installed between the voltage regulator and the generator.

1-11. Diesel Engine. The following is a brief summary of the operation of the systems which make up the diesel engine.

a. Combustion System (Diesel Cycle). Diesel Engines are different from spark-ignited engines in a number of ways. Compression ratios are higher, and the charge taken into combustion chamber during the intake stroke consists of air only, with no fuel mixture. Injectors receive low pressure fuel from the fuel pump and deliver it into individual combustion chambers at the proper time, in equal quantity and in an atomized condition for burning. Ignition of fuel is caused by heat of compressed air in the combustion chamber. The four strokes and order in which they occur are shown in FIGURE 1-2 and described in the following paragraphs.

(1) Intake Stroke. During intake stroke, the piston travels downward; intake valve is open, and exhaust valve is closed. The downward travel of the piston allows air from the turbocharger to enter the cylinder.

(2) Compression Stroke. At the end of the intake stroke, intake valve closes and piston starts upward on compression stroke (exhaust valve remains closed). At the end of compression stroke, air in combustion chamber is compressed into a small space causing temperature of the air to rise to a point high enough for ignition of fuel. During last part of compression stroke and early part of power, stroke, a small metered charge of fuel is injected into combustion chamber. Almost immediately after fuel charge is injected into combustion chamber, fuel is ignited by the hot compressed air.

(3) Power Stroke. During the beginning of the power stroke, the piston is pushed downward by the burning and expanding gases; intake and exhaust valves are closed. As more fuel is added and burns, gases get hotter and expand more to further force piston downward and thus add driving force to crankshaft rotation.

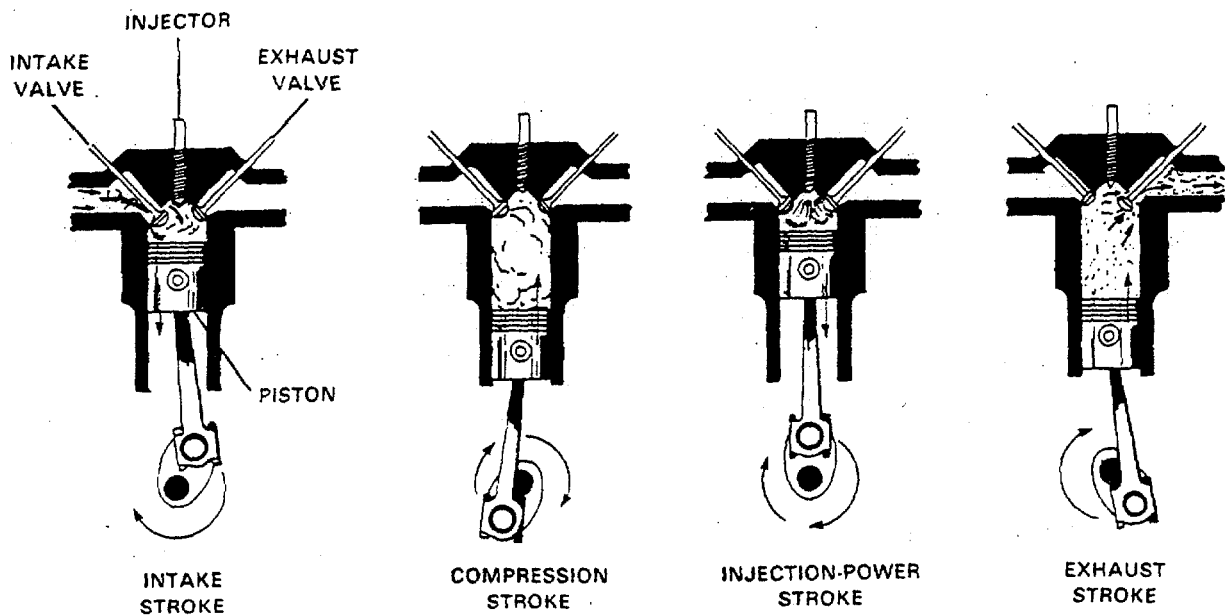


FIGURE 1-2. Four-Stroke Diesel Engine Cycles.

(4) **Exhaust Stroke.** During exhaust stroke, intake valve is closed, exhaust valve open, and piston on upstroke. Upward travel of piston forces burned gases out of combustion chamber through open exhaust valve port and into the exhaust manifold.

b. **Cooling System.** The radiator is filled with a 50% mixture of water and coolant, which is circulated through the engine by a centrifugal-type water pump. Heat is removed from the coolant by the radiator. Control of the temperature is accomplished by a thermostat.

c. **Lubrication System.** The 4BT3.9GC engine is pressure lubricated by a gear-type oil pump at the rear of the engine. The pump is mounted to the block, directly below the crankshaft, and is driven from the rear crankshaft gear. The pump draws the oil from the pan and forces it through the lubrication system in the following sequence:

(1) Oil is drawn from the pan to the oil cooler. A pressure regulating valve controls the oil pressure and passes excess oil back to the pan.

(2) The oil then passes through the oil cooler to the filter. A filter bypass valve ensures a supply of oil in the event the filter becomes plugged.

(3) From the filter, oil flows to the main oil passage in the engine block. This provides lubrication to all moving parts. At the same time oil is routed to the turbocharger through external lines.

(4) Oil is then returned from the turbocharger to the pan.

d. Fuel System. Diesel fuel is drawn in by a gear type fuel lift pump. It is then forced through a fuel water separator/filter to the injector pump which acts as a distributor. At this point excess fuel is returned to the supply. The injector pump supplies fuel to the injectors which spray fuel into the cylinder. The fuel is ignited by the heat of compressed air.

e. Air System. The diesel engine requires several hundred cubic feet of air for every gallon of fuel that burns. For the engine to operate efficiently, it must breathe freely. Air intake and exhaust systems must not be restricted.

(1) Intake air is routed through an air cleaner to the intake air inlet of turbocharger, through air crossover tube. The air then enters the intake manifold to the intake valve. this valve supplies the cylinder with air to be compressed. After fuel ignition the air escapes from the cylinder to the exhaust valve, through the exhaust manifold, enters the turbocharger and exits the turbocharger exhaust outlet.

(2) Turbocharger. The turbocharger forces more air intake into the combustion chambers. This added volume of air causes the engine to burn more fuel, thereby increasing horsepower. Without a turbocharger the engine would be naturally aspirated, supplying less air and producing less power.

CHAPTER 2

UNIT MAINTENANCE INSTRUCTIONS

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Section I. REPAIR PARTS, SPECIAL TOOLS; TEST, MEASUREMENT, AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

2-1. **Common Tools and Equipment.** For authorized common tools and equipment, refer to the Modified Table of Organization and Equipment (MTOE) applicable to your organization.

2-2. **Special Tools, TMDE, and Support Equipment.** Special tools; test, measurement, and diagnostic equipment; and support equipment requirements are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P. These items are also listed in the Maintenance Allocation Chart (MAC), Appendix B of this manual.

2-3. **Repair Parts.** Repair parts are listed and illustrated in the Repair Parts and Special Tools List (RPSTL), TM 55-1905-223-24P.

Section II. SERVICE UPON RECEIPT

2-4. Checking Unpacked Equipment.

- a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged' report the damage in accordance with the instructions of DA Pam 738-750.
- b. Check the equipment against the packing slip to see if the shipment is complete. Report all discrepancies in accordance with the instructions of DA Pam 738-750.
- c. Check to see whether the equipment has been modified.
- d. Remove protective caps, plugs,, inserts, wrappings, and tape when inspection/inventory is completed. Inspect piping openings for damage. Wipe off dirt, grease, or protective films at time of installation.

- e. Remove chocks from resilient mounted components.

2-5. Installation Instructions.

WARNING

DO NOT lift the generator set using only the engine or generator lifting eyes.

NOTE

The approximate weight of the generator set is 1514 lbs (687 Kg).

- a. Position the generator set for good service accessibility on all sides.
- b. Lift the generator set into position by sliding two lifting bars into the base rail holes and connecting them to a spreader bar.
- c. The generator is skid mounted and should be bolted to the deck. The engine comes equipped with resilient mounts.
- d. When the generator set is properly mounted in position proceed as follows:
 - (1) Connect the exhaust outlet connection.
 - (2) Connect the fuel inlet connection.
 - (3) Connect the battery cable to the starter motor.

2-6. Preliminary Servicing and Adjustment. It is important that careful preparation be made before a diesel engine/generator set is started-after long idle periods. It must be ready for immediate use in the event of loss of normal service. Check all pipe connections to ensure that all systems are correctly connected.

- a. Procedural steps to be taken to prepare the generator for starting are:
 - (1) Be sure the radiator has been filled with 50% mixture of water and antifreeze.

2-7. Initial Setup Procedure. Includes operational checks and inspections that are not performed for a routine startup. Direct support maintenance personnel will perform initial setup in accordance with the operator's manual, TM 55-1905-223-10.

2-8. Startup. Refer to Table 2-1, Item 4.

2-9. Shutdown Procedure. Refer to Table 2-1, Item 4.

Section III. UNIT PRIVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-10. **Explanation of PMCS Table.** PMCS is designed to keep the equipment in good working condition. This is accomplished by performing certain tests, inspections, and services. Table 2-1 lists items to be serviced and the procedures needed to accomplish the PMCS. The "Interval" column tells you when to perform a check or service. If needed, PMCS may be performed more frequently than the indicated interval. The "Procedures" column tells you how to perform the required checks and services. If your equipment does not perform as required, see Table 2-2, Troubleshooting. Report any malfunctions or failures on DA Form 2404. In the Item Number column on DA Form 2404, record the appropriate Item Number from the PMCS table.

Table 2-1. Preventive Maintenance Checks and Services (PMCS)

E - Every 20 hours

W - Weekly

Q - Quarterly

S - Semiannually

A - Annually

B - Biennially

ITEM NO.	INTERVAL						ITEMS TO BE INSPECTED/SERVICED	Procedures
	E	W	Q	S	A	B		
1.	•						Oil level	Check the oil level with the dipstick. <u>CAUTION</u> Never operate the engine with the oil level below the "L" (low) mark or above the "H" (high) mark on the dipstick. a. Inspect for leaks. b. Add oil as necessary. Refer to LO 55-1905-223-12 for oil specifications. Check the level of fuel. Check that the fuel valve(s) to the generator are open. NOTE Only good quality climatized diesel fuel should be used. Check coolant level. If low, fill the radiator with required amount of coolant. Use a 50% mixture of water and antifreeze. Inspect the cooling system for leaks. Check the radiator fins for excessive dirt and debris. Run the generator set for 1/2 hour, under load.
2.	•						Fuel tank	
3.	•						Radiator	
4.		•					Generator set	

Table 2-1. Preventive Maintenance Checks and Services (PMCS)-CONT

E - Every 20 hours W - Weekly Q - Quarterly S - Semiannually A - Annually B - Biennially

ITEM NO.	INTERVAL						ITEMS TO BE INSPECTED/SERVICED	Procedures
	E	W	Q	S	A	B		
4 CONT		●					Generator set - CONT	NOTE Operator should remain in attendance. Emergency Generator/Switchboard start Procedure. NOTE: This procedure provides a means to test automatic starting of Emergency Generator and allows the exercise of the Emergency Generator without disturbing the main switchboard. a. Place the Emergency Generator <u>Run-Of-Auto</u> switch to <u>Auto</u>, and the <u>Emergency Stop PB</u> switch is <u>pulled out</u>. b. Place the Emergency Switchboard <u>Mode Switch</u> to <u>Test</u>. This will open P0201 (Main S.B. Bus Tie brkr), while also starting the Emergency Generator and energizing the Emergency Switchboard. Emergency Generator/Switchboard Shutdown Procedures NOTE: a. Place Emergency Switchboard <u>MODE Switch</u> to <u>Man</u> position. b. Place the <u>Emergency Generator Circuit Breaker Switch</u> to momentary <u>TRIP</u> position. The Emergency Generator Circuit Breaker will <u>open</u> and the Emergency Generator will <u>stop</u>. c. <u>Close Main Switchboard Bus Tie Circuit Breaker</u>(PO201). The Emergency Switchboard is now energized by the Main Switchboard.
5.			●				Battery	

Table 2-1. Preventive Maintenance Checks and Services (PMCS)-CONT

E - Every 20 hours

W - Weekly

Q - Quarterly

S - Semiannually

A - Annually

B - Biennially

ITEM NO.	INTERVAL						ITEMS TO BE INSPECTED/SERVICED	Procedures
	E	W	Q	S	A	B		
5. CONT			●				Battery - CONT	d. Place the Emergency Generator Run-Off-Auto Switch to <u>Auto</u>, and insure that the Emergency Stop PB Switch is <u>Pulled out</u> e. Place the Emergency Switchboard Mode Switch to <u>Auto</u>. NOTE: The Emergency System is now ready to energize the Emergency Switchboard in case of a main switchboard power failure. <u>CAUTION</u> When testing, run the generator at 25% to 100% load. Extended operation under very light or no load will result in more frequent maintenance. Check the specific gravity of the battery electrolyte in each cell. Remove the cell caps and check the electrolyte level in each cell. Add distilled water as required to bring the level to the split ring in each cell. Refer to TM 55-1905-223-24-18. Visually inspect the terminals for loose, broken, or corroded connections. a. Repair or replace broken cables or terminals (TM 55-1905-223-24-18). b. On corroded terminals, remove the cables and clean with a battery brush. Connect the cables and tighten.
6.			●				Oil filter	