Chapter 5

Maintenance and Repair Procedures

Regular and systematic maintenance helps ensure that a generator operates as required at all times. Preventive maintenance Is important because it allows the operator to discover and correct defects before they cause serious damage or equipment failure.

This chapter describes the maintenance procedures required for all electric generator sets. Refer to the operator's manual for the PMCS required for a specific generator.

PREVENTIVE MAINTENANCE

Equipment operators must identify and write down all faults or shortcomings they discover. They must stop operating the equipment immediately if the deficiency could endanger personnel or damage the equipment. Operators can repair most of the faults they identify. If they cannot or if replacement parts are required, the operator must record the problem or defective part numbers on a DA Form 2404 and submit the form to organizational maintenance. The use of DA forms is explained in DA Pam 738-750.

Regular PMCS are performed on the following generator systems:

- Lubrication.
- Cooling.
- Fuel.
- Electrical.

Lubrication System

Crankcase and crankcase breather. Inspect for leaks around the crankcase. Replace defective breathers. Ensure the oil in the crankcase is at the proper level.

Oil filter. Inspect the oil filter for loose or missing mounting hardware. Tighten the hardware and replace worn parts. Inspect the oil lines for leaks, breaks, or wear. Service the filter as directed in the lubrication order.

Cooling System

Radiator, grille, and shutter. Inspect the radiator, grille, and shutter for leaks, loose mounting, or obstructions in air passages. Inspect all lines and connections for leaks. Check the hoses for signs of deterioration and loose connections. If antifreeze is used, record the freezing point on the maintenance records. Drain, flush, and refill the cooling system if the coolant is contaminated. Replace defective hoses, lines, and gaskets. Ensure the manual shutter control operates properly.

Water pump, fan, and fan guard. Inspect the water pump for cracks, leaks, loose or missing mounting hardware, or other damage. Inspect the fan and fan guard for loose mounting.

Fan-drive V-belt and pulleys. Inspect the fan–drive V-belt for wear. Replace frayed or worn belts. Check for proper alignment and tension between the pulleys, as prescribed in the technical manual.

Thermostat housing. Inspect the thermostat housing for cracks.

Fuel System

Fuel pump. Inspect the fuel pump for leaks, damage, and loose or missing mounting hardware.

Fuel filters. Inspect the primary and secondary fuel filters for loose or missing mounting hardware, cracks, leaks, or other damage. Service the filters as required in the technical manual.

Fuel supply. Ensure enough clean fuel of each required type is available for the planned period of operation.

Fuel tank, cap, and gasket. Inspect the fuel tank for leaks. Drain sediment from the fuel tank. Inspect the cap and strainer for dirt, wear, and defects. Inspect the chain and gasket for wear. Open or close the cap vent as required.

Fuel lines and fittings. Inspect the fuel lines and fittings for cracks, leaks, and loose or damaged connections.

Electrical System

Batteries. Inspect the batteries for cracks, leaks, dirt, and corroded or damaged cables and terminals. Check the electrolyte level. Refer to page 81 for additional battery checks and services.

Engine generator and starter. Inspect the commutator and brushes for wear, tension, dirt, corrosion, and oil deposits. Ensure the brushes move freely in their holders. Ensure all electrical connections are tight and free of corrosion.

Lights, wiring, and switches. Inspect the panel lights for loose connections, loose mountings, and corrosion. Inspect all electrical leads in the engine and the main generator for looseness, breaks, and damaged or worn insulation. Inspect all switches for signs of excessive wear, failure, or other damage.

Engine generator regulator. Inspect the engine generator regulator for external damage.

Gages. Inspect the fuel gage, thermometer (water temperature gage), and oil pressure gage for loose or missing mounting hardware, cracked or broken glass, or other damage.

Meters. Inspect the battery charge ammeter and hour meter for loose or missing mounting hardware, cracked or broken glass, loose connections, or other damage.

Fault indicator panel. Inspect the indicator lights for damage. Test the lights for proper operation.

Rheostats. Inspect the regulator control rheostat and the crosscurrent compensation rheostat for loose connections or other damage. Turn the knobs to the left and right to ensure they operate freely.

Speed control governor. Inspect the speed control governor for excessive wear, loose mounting, or other damage.

Main generator. Inspect the main generator for damage. Blow dust and dirt from the generator housing with a low-pressure, dry air compressor.

Control panel meters. Inspect the frequency meter, AC ammeter, AC voltmeter, and kilowatt meter for loose mountings, loose connections, cracked or broken glass, or other damage.

EQUIPMENT TESTING

An electric generator set is tested before it begins full operation, periodically during operation, and after parts are repaired or replaced. Tests are made to ensure all parts work properly and will not malfunction under different load conditions. Tests also are made to ensure a generator set can maintain a load. Maintaining a load when the set is in operation reduces carbon buildup in the Internal combustion engine.

Operators may test a generator set using the equipment it was designed to power or using a load bank. The load bank method is preferred because it lets the operator set up and control the power specifications. The load bank should be used to test generators that frequently operate with little or no load.

The load bank is a self-contained test unit mounted within a cabinet. It generates no power. Instead, the load bank operates on an external power source through the system being tested. Cables are required to connect the load bank to the generator. Some load banks are designed to operate automatically. Others are operated manually to maintain a minimum load on the generator.

The load test is made by adding increments of resistive or reactive electrical loads to the generator. Operators can change increment combinations to simulate any electrical loads within the bank's rating. For example, the load bank can test the output of generator sets rated for single-phase, two-wire, 120/240 volts; three–phase, three–wire, 240 volts; and three-phase, four-wire, 120/208 or 240/416 volts. The tests can be applied at frequencies ranging from 50 to 1,000 cycles per second.

WARNING

Store and use the load bank only in an upright position, never upside down or on end. Before use, ground the frame to avoid possible shocks. If excessive vibrations or unusual noises occur during operation, turn the load bank off. Shut down the power source before touching, connecting, or disconnecting any electrical leads or parts. Disconnect the load bank from the power source before removing panels. Stop the *load* bank at once if the motor or other components heat up excessively. Use carbon dioxide to put out all electrical fires. Never use water to put out electrical fires.

COMMON EQUIPMENT MALFUNCTIONS

While preventive maintenance usually keeps an electric generator set operating as required, malfunctions sometimes occur. Operators can correct most equipment failures or unsatisfactory performance by using the following Troubleshooting Guide. It identifies common malfunction symptoms, probable causes, and possible solutions. Report to the next higher level of maintenance if the suggested solution does not correct the malfunction.

NOTE: Operators must report all malfunctions beyond the scope of the operator or the crew to organizational maintenance.

Troubleshooting Guide

Symptom	Probable Cause	Possible Solution
Engine hard to start or fails to start	Fuel tank empty	Fill tank
	Fuel filters clogged	Replace filters
	Fuel pump screen clogged	Clean screen
	Foreign material in fuel	Drain tank and refill with clean fuel
	Air cleaner clogged	Clean or replace filter element
	Overspeed switch tripped	Reset switch
	Battery circuit fuse blown	Replace fuse
	Batteries discharged	Charge or replace batteries
Engine stops suddenly	Fuel tank empty	Fill tank
	Fuel filters clogged	Replace filters
	Fuel pump screen clogged	Clean screen
	Auxiliary fuel hose clogged	Clean hose
	Safety device tripped	Inspect engine oil and coolant levels; reset overspeed switch, and operate unit at proper speed

Engine stops suddenly (Continued)	Engine oil level low	Add oil to proper level
	Coolant level low	Add coolant to proper level
	Engine overheating	Provide proper ventilation
	Cooling system clogged	Flush system
	Fan drive V-belt inoperative	Tighten to proper tension
	Shutter control inoperative	Operate shutter manually and report condition to organizational maintenance
Engine oil pressure low	Oil pressure low	Adjust oil pressure
	Engine oil level low	Add oil to proper level
	Oil filter clogged	Replace filter
	Engine oil diluted	Change oil
Engine exhaust smokes excessively	Engine temperature low due to insufficient warm-up time	Allow sufficient time for engine to warm up before applying load to unit
	Engine temperature low due to defective shutter	Operate the shutter manually and report the condition to organizational maintenance
	Engine oil level too high	Drain oil to proper level
	Air cleaner clogged	Clean or replace filter element
	Fuel grade incorrect	Drain tank and fill with the correct grade of fuel

Symptom	Probable Cause	Possible Solution
Engine lacks power	Air cleaner clogged	Clean or replace filter element
	Fuel filters clogged	Replace filters
	Water in fuel system	Drain tank and refill with clean fuel
	Fuel pump screen clogged	Clean screen
	Fuel grade incorrect	Drain tank and refill with proper grade of fuel
Engine knocks or makes excessive noise	Engine oil level low	Add oil to proper level

CAUTION

Stop the engine immediately if the engine knocks or is noisy when the engine oil is at the proper level. Continued operation may cause serious damage. Report the condition to organizational maintenance.

Starter fails to crank engine	Battery circuit fuse blown	Replace fuse
	Battery circuit breaker tripped	Reset circuit breaker
	Loose or corroded battery cable connections	Tighten and clean connections
	Batteries discharged	Charge or replace batteries
Main generator fails to build up rated voltage	Frequency or voltage too low	Adjust frequency and voltage
	Wiring defective	Inspect wiring; report defective wiring to organizational maintenance

Symptom	Probable Cause	Possible Solution
Main generator voltage too high	Voltage adjusted improperly	Adjust voltage properly
	Frequency adjusted improperly	Adjust frequency properly
Main generator overheats	Generator ventilation doors closed	Open doors
	Generator ventilation screens obstructed	Remove obstructions
	Generator overloaded	Reduce load
Main circuit breaker continues to trip	Generator output voltage too low	Increase output voltage
	Generator wiring defective	Inspect wiring; report defective wiring to organizational maintenance
	Generator overloaded	Reduce load or report condition to organizational maintenance
Frequency drops after increasing generator load	Speed droop adjusted improperly	Adjust droop
Frequency fluctuates	Air cleaner clogged	Clean or replace filter element
	Fuel filters clogged	Replace filters
	Air in fuel system	Prime fuel system
	Governor adjusted improperly	Report to organizational maintenance
Main generator noisy	Object in main generator ventilation screen	Remove object

Symptom	Probable Cause	Possible Solution

CAUTION

Stop operating the equipment immediately if unusual noises are heard. Unusual noises from the main generator usually indicate a part failure. Continued operation may cause additional damage. Report unusual noises to organizational maintenance.

Instruments fail to function properly	Generator controls adjusted improperly	Refer to operator's manual
	Needle stuck on dial gage	Tap gage lightly with finger
Winterization heater fails to ignite or keep burning	Battery circuit fuse blown	Replace fuse
	Heater fuel filters clogged	Replace dirty filters
	Heater fuel pump screen clogged	Clean screen
	Main fuel tank empty	Fill tank
120-volt AC receptacle will not supply current	120-volt AC receptacle fuse blown or circuit breaker off	Replace fuse or reset circuit breaker
24–volt DC receptacle will not supply current	24–volt DC receptacle fuse blown	Replace fuse

ELECTRICAL DISTRIBUTION CABLE REPAIRS

The repair of electrical distribution cables requires special skills and equipment not usually available at the organizational maintenance level. Therefore, equipment operators and crew members are seldom authorized to work on these cables except when tactical conditions require prompt, temporary splicing. The following information describes the types of splices used to repair damaged distribution cables and correct splicing procedures:

WARNING

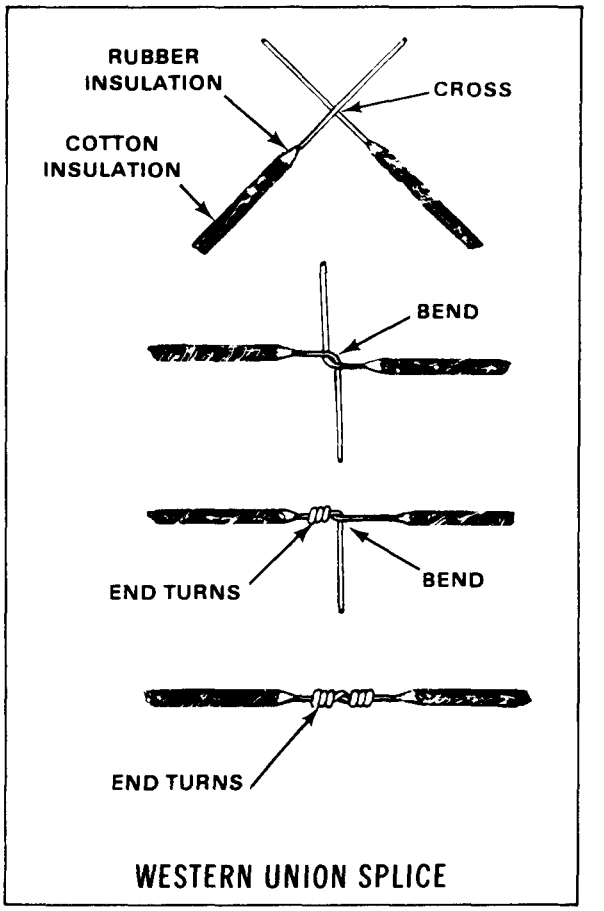
Disconnect the cable from the power source before inspecting or repairing it.

Splices

Western union. Used to repair solid conductors.

Procedure:

1. Remove sufficient insulati on and clean the conductors.
2. Cross the wires and clamp them in the middle with a pair of long-nosed pliers.
3. Grasp the short end of the wire on one side of the pliers, and bend it out and away at a 90-degree angle to the long wire.
4. Wrap the short wire around the long wire using small, tight loops. Make at least three or four loops to ensure a strong connection.
5. Repeat step 4 for the short wire on the other side of the pliers. Wrap the loops in the opposite direction from those on the first wire to add strength to the splice.
6. Crimp down or cut off excess wire on the ends.

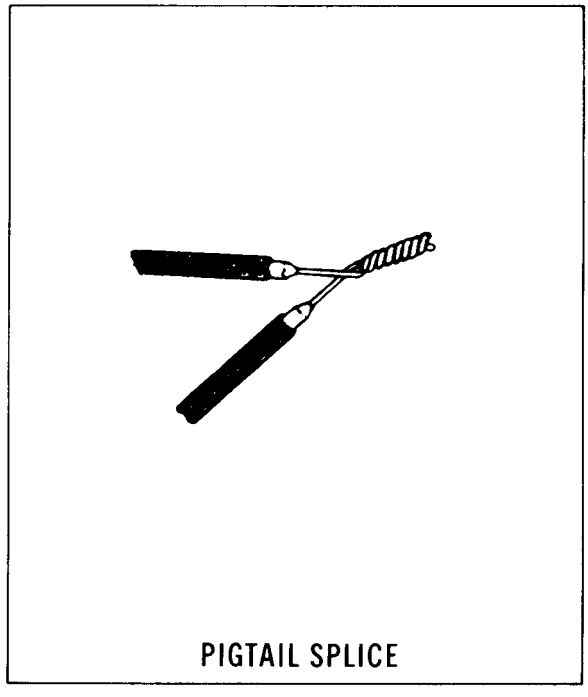


WESTERN UNION SPLICE

Pigtail. Used to add branch circuits on wiring installed in buildings and conduits (steel pipe).

Procedure:

1. Remove sufficient insulation and clean the conductors.
2. Cross the two wires at a 90-degree angle. Allow about 2 inches of overlap.
3. Clamp the wires at the crossing point with a pair of long-nosed pliers.
4. Grasp both short ends between the thumb and first two fingers. Twist the ends to make tight loops. Twist both ends in the same direction.

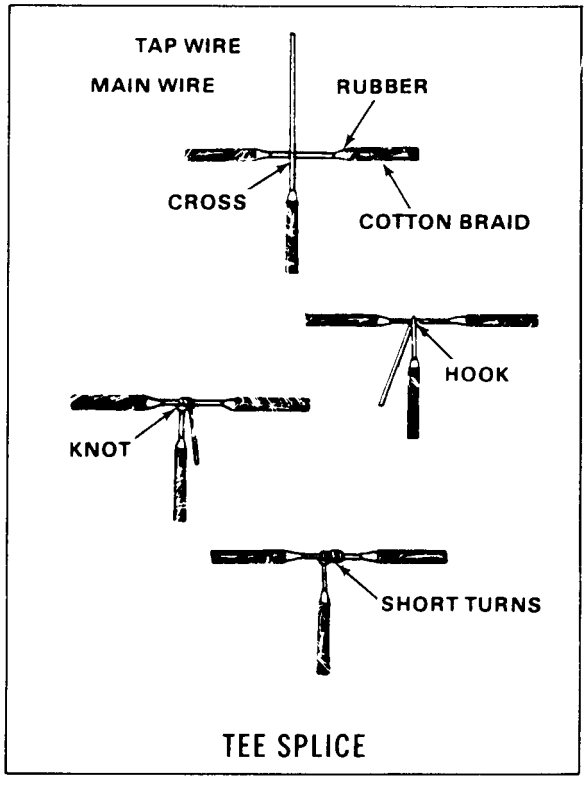


PIGTAIL SPLICE

T (Tee). Used to join a tap (secondary) wire to a main line.

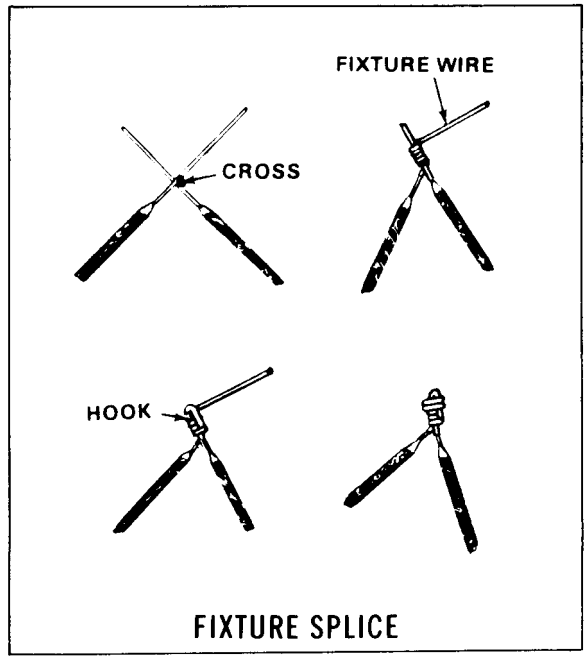
Procedure:

1. Remove sufficient insulation and clean the conductors.
2. Lay the tap wire across the main wire so that about 2 inches overlap at a 90–degree angle.
3. Clamp the wires at the crossing point with a pair of long-nosed pliers.
4. Twist the tap wire around the main wire at least three or four times, using small, tight wraps. The finished connection should look like the letter "T."
5. Crimp down or cut off excess wire on the ends.



TEE SPLICE

Fixture. Used to join a small wire to a large one, or to join a thin wire to a thick one.



FIXTURE SPLICE

Procedure:

1. Remove sufficient insulation and clean the conductors.
2. Overlap the two wires. Wrap the small or thin wire around the solid or heavy one at least three or four times.
3. Bend the end of the large wire over the joint. Wind the rest of the small wire around the large one.

Multiconductor Cable Repairs

Partial repairs to multiconductor cables may be required as a temporary expedient, but they are not authorized. When temporary splices are required, any of those described previously may be used. When more than one conductor is cut simultaneously, rejoin the matching colors (such as red to red or green to green).

Making temporary repairs on a multiconductor cable can be dangerous because moisture sometimes collects between the outer and inner protective coverings. Maintenance personnel must carefully check a multiconductor cable for moisture before working on it. Repair multiconductor cables that contain moisture only if drying equipment is available. Send all moist cables to the direct support unit if proper drying equipment is not available. Complete the following steps in sequence to repair a cut multiconductor cable:

1. Remove sufficient insulation and clean the conductor.
2. Twist the ends of any cut fillers and tie them together.
3. Join the stripped ends of the cable by pushing them together until the wires mesh. At least 1/4 inch of the wires at each end must be meshed together.
4. Solder the wires together.
5. Perform a continuity test, as described on page 80.

6. Insulate the soldered connection using electrical tape. To do this, twist the cable as if wringing out a towel to form a smaller diameter splice. Then apply several layers of electrical tape to the soldered area.

Distribution Cable Inspection

Operators must inspect an electrical distribution cable when it is hooked up initially, before repairs are made, and before the cable is hooked up after repairs. Complete the following steps in sequence to inspect a distribution cable:

WARNING

Disconnect the cable from the power source before starting the inspection.

1. Clean the cable assembly to remove grease, dirt, corrosion-preventive compound, and foreign material.
2. Inspect the cables for cracks, breaks, or burns.
3. Inspect the receptacles and plugs for loose connections or burns.
4. Inspect the conductors and terminals for corrosion, loose connections, or burns.
5. Inspect exposed wires for damage, corrosion, or loose connections.
6. Inspect all painted surfaces for bare spots or scales.
7. Perform a continuity test on each conductor.

Continuity Test

A continuity test is performed on an electric distribution cable to determine if the path for current flow is complete. The test determines if the conductor is broken. It does not determine the current carrying capability of the conductor. Report to support maintenance if additional tests are required.

Use a multimeter and complete the following steps in sequence to perform the continuity test:

1. Prepare the multimeter for testing resistance, as outlined in the multimeter operator's manual.

2. Touch a test lead probe to one end of the conductor; then touch the other test lead probe to the other end of the conductor. Any reading on the multimeter indicates the path for current flow is complete. The reading indicates the resistance of the conductor. For example, a l-mile long, No 6 American wire gage annealed solid copper wire has a resistance reading on the multimeter of 2.13 ohms at 77°F (25°C).

3. Repeat step 2 for all conductors.

BATTERY MAINTENANCE

Batteries must be maintained properly. The checks and services required for batteries, some maintenance problems, and possible solutions follow:

WARNING

Do not smoke or use an open flame near a battery. Batteries generate hydrogen gas, which is highly explosive. Remove all jewelry and use metal tools with care. Metal can cause sparks when it touches battery terminals or exposed wire.

Checks and Services

To ensure the charging system works properly, operators must read the charge indicator each time the generator is started. The indicator shows a low rate of charge immediately, after the engine starts if the battery is fully charged. A partly discharged battery shows a high rate of charge for about 15 minutes.

Operators can correct many battery malfunctions. Some common malfunctions and possible solutions to them follow. Report to the next higher level of maintenance if the suggested solution does not correct the problem.

Problem	Possible Solution
Corroded connections	Clean corrosion from all connectors, terminal lugs, holddowns, and the battery top.
Deformed connectors	Replace or repair deformed connectors and battery ends that touch or almost touch.
Loose connectors	Ensure connectors are all the way down on the battery posts and are fastened securely.
Loose cable terminal lug	Tighten the cable on the connector so that the cable will not move when a reasonable force is exerted.
Loose battery holddowns	Tighten battery holddowns so they will hold the battery in place but not deform the battery, battery case, or battery holddowns.
Loose ground connections	Tighten the ground end of the cable. It must be tight and have a good electrical connection to the engine or the generator frame.

The generator battery must be serviced regularly. The parts to be serviced and maintenance required follow:

Caps. Remove the battery caps and inspect the vent holes. Clean dust from dirty or clogged holes.

Holddowns. Inspect the battery holddowns. Ensure the battery is held tightly in the carrier.

Electrolyte levels. Inspect the electrolyte level and add distilled water as needed. Follow instructions on the filler cap or cell cover. The electrolyte level always must be above the top of the battery plates. Add only distilled water to the battery. If distilled water is not available, use rain or drinking water. Store water for batteries only in glass or plastic containers, not metal containers. Never add contaminants or additives to the battery solution.

WARNING

Handle electrolyte with extreme care. Electrolyte contains sulfuric acid, which severely burns skin, clothing, and paint upon contact. Immediately flush water over any area that comes in contact with electrolyte to wash away all traces of acid.

Serviceability. Check the specific gravity and voltage readings. A voltmeter indicates the battery voltage. A fully charged battery electrolyte has a specific gravity of 1.225 in tropical climates and 1.280 in temperate climates. Charge the battery if the specific gravity is less than 1.180 in tropical climates or 1.225 in temperate climates. Replace the battery with a fully charged one if it cannot be charged in the field.

Terminal connections. Remove corrosion from all battery terminals and clamps. Coat the clean terminals and clamps with a thin layer of corrosion inhibitor or grease. Ensure the clamps have a good electrical connection to the terminal and are fastened securely to the battery.

Cables. Clean corrosion from the terminal lugs, and tighten loose lugs. Clean the cable insulation. Send cables with corrosion under the insulation to organizational maintenance for repair or replacement. Protect cables that pass through holes in metal with grommets. Fasten long sections of cable to a stable object that is away from moving or vibrating parts.

Removal Procedures

Complete the following steps to remove a battery. Be careful when removing the battery from the generator.

1. Turn off all electrical loads.
2. Disconnect the ground or negative cable to reduce sparking.
3. Loosen the clamping nut.
4. Remove the clamps. Spread the clamp ends carefully to avoid damaging the battery posts. Use a small puller or special tool to remove any corroded clamps. Do not pound or beat on the battery terminal.