



STORAGE, COMMISSIONING and MAINTENANCE

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**Power
Generation**

Lead Acid Batteries

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SECTION 1 - SAFETY PRECAUTIONS

1 Safety Precautions

The handling and proper use of lead-acid batteries is not hazardous providing the correct precautions are observed and personnel are trained in their use.

1.1 General Precautions



Never lay tools or metal objects across the top of the battery.



Keep batteries upright.



Use tools with insulated handles.

1.2 Fire Hazard



During the charging of a battery, explosive gases are given off. Keep the battery well ventilated and away from naked flames and sparks. **NO SMOKING.**



Before disconnecting a battery, always remove power from the mains powered battery charger (where fitted) **BEFORE** disconnecting the charger leads.



When putting a battery into service on a generator set, connect the earth lead **LAST**; when removing the battery, disconnect the earth lead **FIRST**.

WARNING: ENSURE THAT BATTERIES ARE CHARGED IN A WELL VENTILATED AREA, AWAY FROM NAKED FLAMES AND SPARKS.

WARNING: BEFORE DISCONNECTING THE BATTERY, ALWAYS REMOVE POWER FROM THE MAINS POWERED BATTERY CHARGER (WHERE FITTED).

1.3 Fluid Hazard



Take care when filling batteries with electrolyte and always wear personal protective equipment

WARNING: NEVER ADD UNDILUTED SULPHURIC ACID TO A BATTERY.

WARNING: ALWAYS WEAR AN ACID-PROOF PROTECTIVE APRON, GOGGLES AND GLOVES WHEN HANDLING ELECTROLYTE. IF ELECTROLYTE IS SPLASHED ON THE SKIN OR IN THE EYES, FLUSH THE AFFECTED AREAS IMMEDIATELY WITH WATER AND SEEK MEDICAL ADVICE.

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SECTION 2 - INTRODUCTION

2 Introduction

Batteries are an essential part of any standby generator system and some 90% of all generator failures are due to batteries.

It is therefore vital that batteries are stored, commissioned and maintained as detailed overleaf. Reference should also be made to the Battery Manufacturer's leaflet.

Batteries are usually supplied with the generator in 'dry-charged' form. In order to commission dry-charged lead-acid batteries, pre-mixed electrolyte of the correct type and specific gravity must be added to the cells of the battery.

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SECTION 3 - STORAGE

3 Storage

Dry-charged batteries should be stored in a cool, dry place, upright and with the vent caps securely in place.

Filled and charged batteries must be stored in a cool, dry, well ventilated place. Ensure that the vent caps are securely screwed down, or pushed home.

Batteries must never be stacked one on top of another and must be protected from the floor by a wooden pallet or suitably thick cardboard sheet.

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SECTION 4 - COMMISSIONING

4 Commissioning

Note: *Commissioning is to be undertaken by suitably trained and qualified service personnel only.*

Lead-acid batteries supplied in dry-charged form are commissioned as follows:

4.1 Pre-Commissioning Procedure

1. Check for any mechanical damage to the battery case or terminals, and ensure that the battery is clean and dry.
2. Smear the battery terminals with petroleum jelly to prevent corrosion.
3. Remove the vent plugs and break any seals (if present), taking care not to damage the plates or separators. The broken seal will fall into the bottom of the chamber and do no harm.

4.2 Filling with Electrolyte

1. Fill each cell of the battery with dilute sulphuric acid (electrolyte) of the correct specific gravity (SG) as shown in Table 6-1, and according to the levels given in Table 8-1. (8.2 litres per standard 655 battery).
2. The filling operation must be completed in one operation.
3. Allow the battery to soak for ten to fifteen minutes. If the electrolyte level has fallen, it should be restored by adding electrolyte of the correct SG to the levels given in Table 8-1.
4. After filling, the battery must be placed on a commissioning charge within **1 hour**. Charging must take place before any load is placed on the battery. (Refer to Section 4.4).

Caution: *Failure to give this commissioning charge may impair the charge capacity and life of the battery.*

4.3 Charging

1. Charge the battery at the current rating given in Table 8-1 for a minimum of four hours in order to ensure that the acid is sufficiently mixed within the battery. The charging period may need to be extended if the battery has been in storage.
2. At the end of the charging process, the electrolyte levels must be checked and restored if necessary by the addition of electrolyte of the correct SG. The vent caps must then be replaced.

Note: *Any further topping-up of the electrolyte must be made using distilled or de-ionised water.*

3. When the generator set is running, check the charge alternator output using an induction ammeter.

4.4 Fitting the battery to the Generator Set

1. A battery must not be fitted to a generator set without charge if the SG of the electrolyte has fallen below 1.240 during storage.
2. Battery hold-down bolts must be tight **but not over tight**.
3. Re-smear the terminals with petroleum jelly, if necessary.
4. Fit the vents firmly in position and ensure that the battery is clean and dry.
5. Ensure correct polarity when connecting the battery to the set. Even momentary incorrect connection can cause damage to the electrical system. Connect the positive generator cable **FIRST**, followed by the negative ground.
6. Terminal connections must be tight **but not over tight**.



SECTION 5 - MAINTENANCE

5 Maintenance

Note: *Maintenance-free batteries are sealed and **do not** require the addition of electrolyte. Some manufacturers of maintenance-free batteries provide an 'eye' or some visible means of telling when the battery is discharged or approaching the end of its useful life.*

Batteries require attention at all times, even when not working. A battery will not last if it is neglected. Maintenance is carried out as follows:

5.1 General

Keep the battery, and the battery area, clean and dry. Ensure that the vent caps are securely screwed down, or pushed home.

To avoid contamination of the battery, only clean it when the vent plugs are in place.

Keep the battery terminals and connections free from corrosion by lightly coating them with petroleum jelly.

Check the condition of the starting batteries (see Figure 6-1) every month or 100 hours whichever occurs first.

WARNING: THOROUGHLY VENTILATE BATTERY AREA BEFORE WORKING ON THE BATTERY. IGNITION OF EXPLOSIVE BATTERY GASES CAN CAUSE SEVERE PERSONAL INJURY. DO NOT SMOKE WHILE SERVICING BATTERIES, OR CAUSE SPARKS OR ARCING THAT MAY IGNITE BATTERY GASES.

Caution: *Always disconnect a battery charger from its AC source before disconnecting the battery leads. Failure to do so can result in voltage spikes high enough to damage the DC control circuits of the generator set.*

WARNING: TO PREVENT DANGEROUS ARCING, ALWAYS DISCONNECT THE NEGATIVE (-) GROUND CABLE FROM THE BATTERY BEFORE WORKING ON ANY PARTS OF THE ELECTRICAL SYSTEM OR THE ENGINE. DISCHARGE STATIC ELECTRICITY FROM BODY BEFORE TOUCHING BATTERIES, BY FIRST TOUCHING A GROUNDED METAL SURFACE.

5.2 Cleaning Batteries

WARNING: ELECTROLYTE IS A DILUTE SULPHURIC ACID THAT IS HARMFUL TO THE SKIN AND EYES. DO NOT GET THE SUBSTANCE IN YOUR EYES OR CONTACT WITH SKIN. WEAR GOGGLES, PROTECTIVE RUBBER GLOVES, AND APRON WHEN SERVICING BATTERIES.

WARNING: IN CASE OF SKIN CONTACT, IMMEDIATELY WASH AFFECTED AREA WITH SOAP AND WATER.
IN CASE OF EYE CONTACT, IMMEDIATELY FLOOD EYES WITH LARGE AMOUNTS OF WATER FOR A MINIMUM OF FIFTEEN MINUTES. IMMEDIATELY CALL A PHYSICIAN.

Prevent a build up of dirt or corrosion by wiping the batteries with a damp cloth. Use a solution consisting of 1/4 lb (0.11kg) of baking soda added to 1 quart (0.96 litres) of water to neutralize any possible acid. Be sure the vent plugs are tight to prevent any cleaning solution from entering the cells.

After cleaning, ensure the battery and surrounding areas are dry.

After making connections, coat the terminals with a light application of petroleum jelly to retard corrosion. Keep the battery terminals clean and tight. A loose connection can reduce battery standby time and cause battery fires.

5.3 Charging

Where generator sets are used infrequently, battery re-charging must take place when the SG drops below 1.220 (or 1.180 in tropical climates) until the SG in all cells rises and remains constant for three hours. In all cases where use is infrequent, batteries must be put on a monthly re-charge schedule to ensure that a fully charged condition is maintained.

Caution: NEVER allow a battery to become completely flat (fully discharged), or to stand in a discharged condition, or damage will result.

1. Remove the vent caps before carrying out charging.
2. Do not put a filled battery into storage without first giving the battery a commissioning charge.
3. Batteries must be given a further charge every six months at the normal initial charge rate until the voltage and SG cease to rise.
4. At the end of the charging process, the electrolyte levels must be checked and restored, if necessary, by the addition of electrolyte of the correct SG. The vent caps must then be replaced.

Note: Any further topping-up of the electrolyte must be made using distilled or de-ionised water.

5.4 Trickle / Boost Charging (Option)

Where a mains-powered battery charger is provided (and switched ON), the battery will automatically receive a 'trickle-charge' to prevent the battery becoming discharged below its optimum charge level.

During trickle-charging, not all cells in the battery receive the same charge; over a period of several months this may affect battery performance. It is therefore good practice to give batteries a regular charge at their **full rate** to return all cells to full capacity. This is referred to as boost-charging, or equalise-charging.

If the charger is fitted with a **Boost Charge** switch, the Boost position should be selected at intervals detailed by the battery manufacturer (normally around every six months).

Caution: *Batteries should not be left on Boost Charge for extended periods as this will result in excessive water consumption, gassing, and may impair battery performance.*

A Boost Charge not exceeding twice the bench charge rate may be used, providing that:



The electrolyte temperature does not exceed 109°F (43°C).



The battery volts do not reach 15V (for a 12V battery)

If either of these situations should arise, reduce the charge rate to the normal bench rate. For tropical climates the temperature must not exceed 120°F (49°C).

Note: *The charge period should be extended:*



To eight hours if the battery has been in storage for three months or more, at temperatures in excess of 86°F (30°C), or if humidity is above 80%



To twelve hours if the battery has been in storage for twelve months or more

At the end of the charging process, the electrolyte levels must be checked and restored if necessary by the addition of electrolyte of the correct SG. The vent caps must then be replaced.

Note: *Any further topping-up of the electrolyte must be made using distilled or de-ionised water.*

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SECTION 6 – ELECTROLYTE - SG & TEMPERATURE

6 Electrolyte - Specific Gravity and Temperature

Note: *Maintenance-free batteries are sealed and **do not** require the addition of electrolyte. Some manufacturers of maintenance-free batteries provide an 'eye' or some visible means of telling when the battery is discharged or approaching the end of its useful life.*

6.1 Checking Electrolyte Level

Caution: *NEVER add tap or well water and NEVER allow the battery electrolyte to drop below the top of the plates.*

Caution: *Do not add water in freezing weather unless the engine will run long enough (two to three hours) to assure a thorough mixing of water and electrolyte.*

Check the level of the electrolyte (acid and water solution) in the batteries at least every month or 100 hours of operation, whichever occurs first. Maintain the electrolyte to the levels indicated in Table 8-1 by the addition of distilled or de-ionised water only and recharge. Replace the vent plugs once filling is completed.

If one cell is low, check case for leaks.

Keep the battery case clean and dry. An accumulation of moisture will lead to a more rapid discharge and battery failure.

6.2 Checking Specific Gravity

Use a battery hydrometer to check the specific gravity of the electrolyte in each battery cell.

Hold the hydrometer vertical and take the reading. A fully charged battery will have a corrected specific gravity of 1.260 at 77°F (25°C). Charge the battery if the reading is below 1.215.

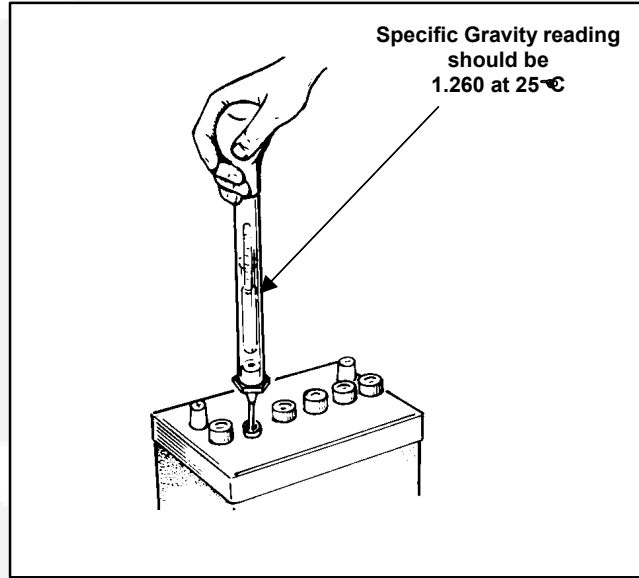


Figure 6-1 Checking Specific Gravity

| SPECIFIC GRAVITY | | |
|--|-----------------------|------------------|
| TEMPERATURE | For Filling New Cells | At end of Charge |
| Ambient temperature normally below 32°C | 1.270 | 1.270 – 1.290 |
| Ambient Temperature frequently above 32°C | 1.240 | 1.240 – 1.260 |
| Maximum permissible temperature of electrolyte during charge | 113°F (45°C) | 113°F (45°C) |

Table 6-1 Specific Gravity

Table 6-1 shows the specific gravity (SG) of electrolyte, corrected to 77°F (25°C). Correct the SG reading for other temperatures by subtracting seven gravity points (0.007) for every 18°F (10°C) the electrolyte temperature is above 80°F (27°C). Apply the correction formula as follows:

1. For every 18°F (10°C) above 77°F (25°C), subtract 0.007 (7 points)
2. For every 18°F (10°C) below 77°F (25°C), add 0.007 (7 points)

For example:

if the Specific Gravity at 77°F (25°C) is 1.260,
 then the Specific Gravity at 59°F (15°C) is 1.267

SECTION 7 – BATTERY REPLACEMENT

7 Battery Replacement

Always replace the starting battery with the same number and type (e.g. vented, lead acid). Properly dispose of battery in accordance with local environmental agency requirements.

WARNING: DO NOT MUTILATE OR BURN THE BATTERY IN A FIRE FOR DISPOSAL. BURNING THE BATTERY MAY CAUSE AN EXPLOSION WHICH CAN RESULT IN SEVERE PERSONAL INJURY OR DEATH. DAMAGE TO CASE WILL RELEASE ELECTROLYTE WHICH IS HARMFUL TO THE SKIN AND EYES AND IS ALSO TOXIC.

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SECTION 8 – ELECTROLYTE LEVELS

8 Electrolyte Levels and Bench Charging Rates

The following table shows the electrolyte level to be expected at a range of bench charging rates:

Table 8-1 Electrolyte Levels

| Battery Type | Electrolyte Level Above Plates (mm) | Bench Charging Rate (A/hour) |
|--------------|-------------------------------------|------------------------------|
| 001 | 8 | 3.0 |
| 007 | 8 | 3.5 |
| 015 | 8 | 4.0 |
| 016 | 8 | 4.0 |
| 017 | 8 | 9.0 |
| 035 | 8 | 3.5 |
| 036 | 8 | 3.5 |
| 037 | 8 | 4.0 |
| 038 | 8 | 4.0 |
| 046 | 8 | 6.0 |
| 047 | 8 | 3.0 |
| 048 | 8 | 4.0 |
| 049 | 8 | 4.0 |
| 063 | 8 | 4.0 |
| 065 | 8 | 5.0 |
| 067 | 8 | 7.0 |
| 068 | 8 | 7.0 |
| 069 | 8 | 7.0 |
| 070 | 8 | 7.0 |
| 071 | 8 | 6.0 |
| 072 | 8 | 8.0 |
| 073 | 8 | 6.0 |
| 074 | 8 | 7.0 |
| 075 | 8 | 7.0 |
| 077 | 8 | 4.0 |
| 078 | 12 | 5.0 |
| 083 | 8 | 3.5 |
| 084 | 8 | 4.0 |
| 085 | 8 | 5.0 |
| 090 | 12 | 7.0 |
| 091 | 8 | 6.0 |
| 092 | 12 | 5.0 |
| 093 | 8 | 6.0 |
| 097 | 8 | 6.0 |
| 154 | 4 | 3.5 |
| 175 | 8 | 7.0 |
| 191 | 6 | 6.0 |

| Battery Type | Electrolyte Level Above Plates (mm) | Bench Charging Rate (A/hour) |
|--------------|-------------------------------------|------------------------------|
| 221 | 8 | 8.0 |
| 222 | 8 | 12.0 |
| 279 | 8 | 6.0 |
| 312 | 8 | 14.0 |
| 313 | 8 | 14.0 |
| 315 | 8 | 14.0 |
| 319 | 8 | 14.0 |
| 320 | 8 | 14.0 |
| 321 | 8 | 14.0 |
| 322 | 8 | 14.0 |
| 324 | 8 | 20.0 |
| 325 | 8 | 20.0 |
| 327 | 8 | 11.0 |
| 328 | 8 | 20.0 |
| 329 | 8 | 20.0 |
| 332 | 8 | 25.0 |
| 333 | 8 | 11.0 |
| 386 | 8 | 6.0 |
| 404 | 8 | 7.0 |
| 414 | 8 | 20.0 |
| 415 | 8 | 20.0 |
| 471 | 8 | 15.0 |
| 484 | 8 | 25.0 |
| 501 | 8 | 9.0 |
| 511 | 8 | 10.0 |
| 521 | 8 | 12.0 |
| 531 | 8 | 13.0 |
| 541 | 8 | 15.0 |
| 543 | 8 | 15.0 |
| 591 | 8 | 14.0 |
| 602 | 8 | 8.0 |
| 612 | 8 | 9.0 |
| 635 | 16 | 12.0 |
| 643 | 16 | 9.0 |
| 644 | 16 | 12.0 |
| 645 | 16 | 9.0 |
| 646 | 16 | 8.0 |
| 647 | 16 | 12.0 |
| 648 | 16 | 12.0 |
| 649 | 16 | 9.0 |

| Battery Type | Electrolyte Level Above Plates (mm) | Bench Charging Rate (A/hour) |
|--------------|-------------------------------------|------------------------------|
| 655 | 16 | 12.0 |
| 656 | 16 | 12.0 |
| 663 | 16 | 9.0 |
| 664 | 16 | 9.0 |
| 665 | 16 | 9.0 |
| 678 | 8 | 6.0 |
| 679 | 16 | 9.0 |
| 701 | 8 | 16.0 |
| 702 | 8 | 20.0 |
| 703 | 8 | 25.0 |
| 711 | 8 | 16.0 |
| 712 | 8 | 20.0 |
| 713 | 8 | 25.0 |
| 721 | 8 | 15.0 |
| 722 | 8 | 20.0 |
| 732 | 8 | 15.0 |
| 733 | 8 | 20.0 |
| 769 | 8 | 45.0 |

Note: 1.If not listed in Table 8-1, use the bench rate given in the catalogue, or charge at a current equal to 10% of the nominal capacity at the twenty hour rate (A/hour), or 5% of the reserve capacity in minutes.

Note: 2.Batteries of the 800 series should be prepared in accordance with the Storage, Commissioning and Maintenance of lead acid batteries with the instructions supplied with each battery.

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SECTION 9 – FAULT FINDING

9 Fault Finding

The following table shows some typical faults, their possible causes and remedies.

Table 9-1 Fault Finding

| SYMPTOM | POSSIBLE FAULT | REMEDY |
|-------------------------------|--|---|
| Battery completely discharged | Poor battery terminal connection | Clean connections, replace and tighten |
| | Charge alternator / alternator connection fault | Check alternator and connections |
| | Mains battery charger / charger connections fault / mains supply fault | Check battery charger, charger mains supply and charger connections |
| | Blown fuse | Replace fuse |
| | Battery fault | Remove and check using specialist equipment |
| Battery low charge | Poor battery connection | Clean connections, replace and tighten |
| | Charge alternator / alternator connection fault | Check alternator and connections |
| | Mains battery charger / charger connections fault | Check battery charger and charger connections |
| | Inequality in cell charge | Boost (equalise) charge required. |
| | Battery fault | Remove and check using specialist equipment |
| Battery overcharged | Charge alternator fault | Check charge alternator |
| | Mains battery charger fault | Check mains battery charger |
| Battery terminals getting hot | Poor battery connection | Clean terminals, reconnect and tighten securely |

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