SOLAR BATTERY USER MANUAL

Rolls
BATTERY ENGINEERING

Recommended charging, equalization and preventive maintenance procedures for Rolls Solar Batteries.

Rolls

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Manual 605

Rolls Battery has been manufacturing deep cycle lead-acid batteries since 1935. Experience gained has helped us achieve an unmatched reputation along with specific measures to obtain the maximum performance and life from our product. This manual describes the recommended charging, equalization and preventive maintenance procedures for Rolls Solar Batteries in order to maximize battery life.

Equipment Needed

- Goggles, rubber gloves and rubber boots
- Baking soda
- Hydrometer
- Distilled water
- Voltmeter
- Battery charger

Safe Handling Procedure

Always wear acid-resistant clothing, PVC gloves, goggles and rubber boots – especially where there is risk of splashing. Always keep the batteries in an upright position. Always have plenty of water available in case of acid spillage.

Inspection

Upon arrival, check the battery for visible damage (i.e. cracks, dents, deformation and other visible abnormalities). Verify connections, assure that they are clean. If the battery is dirty, or if any minor amount of acid has spilled onto the case, check cleaning section. Any fluid on or around the battery could indicate that the case is not properly sealed. Please verify the polarity of the terminals. Please contact your retailer or Rolls Battery Company Limited to determine if the battery needs replacement.

Installation

Rolls offers batteries for a wide variety of applications. No matter the application, always be certain that the battery is properly secured, free of contaminants and that all connections are in good contact with the terminals. Contact your retailer or Rolls Battery Company Limited for additional information.

Battery Orientation:

Flooded lead acid batteries must be kept in an upright position at all times. Electrolyte in the battery will spill if tilted.

Cable Sizing:

The size of the cables used should be proportionate to the amount of amperage in your system. See Table 1 for maximum current carrying capacity based on cable gauge.

Wire Gauge Size	Amperage
14	25
12	30
10	40
8	55
6	75
4	95
2	130
1	150
00	195
0000	260

Table 1 – Wire gauge sizing

Parallel/Series Connections:

Certain applications demand more voltage or more capacity than one battery's output. By arranging the connection configuration, one is able to increase the output voltage, output capacity or both if needed.

To increase voltage, connect the batteries in series as shown in Figure 1.

Example:

Battery Voltage = 6V each
Battery Capacity = 400 AH each
System Voltage = 12 V
System Capacity = 400 AH

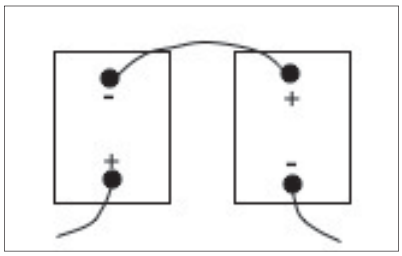

Figure 1 - Voltage Increase

To increase capacity, connect the batteries in parallel as shown in Figure 2.

Example:

Battery Voltage = 6V each
Battery Capacity = 400 AH each
System Voltage = 6 V
System Capacity = 800 AH

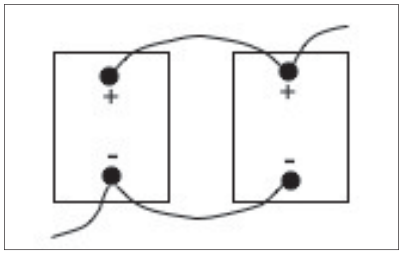

Figure 2 - Capacity Increase

To increase capacity and voltage, connect the batteries in series parallel as shown in Figure 3.

Example:

Battery Voltage = 6V each
Battery Capacity = 400 AH each
System Voltage = 12 V
System Capacity = 800 AH

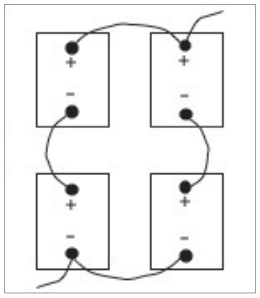

Figure 3 - Voltage/Capacity Increase

Activation of a Dry Battery

Special order batteries can be shipped dry (acid shipped separately). To activate these batteries, start by removing the vent caps. Using approved battery grade electrolyte (1.265), fill each cell half way between the plates and the bottom of the vent well tube. (See Figure 4 on page 5) It is important not to over fill the cells as the acid will expand upon charging. If the cells are too full, the acid will spill out of the top of the cells. Allow electrolyte to saturate into the plates and separators for at least 90 minutes. The temperature of the electrolyte will rise and the specific gravity will drop. Once this is complete, place the batteries on charge at the finishing rate (5% of the 8 or 20 hour rate). The rate may be increased if the battery does not begin to gas. Do not let the cell temperature exceed 115° F (46° C). If the temperature becomes excessive or the cells begin to gas vigorously, reduce the rate of charge. Continue charging until the cell (or cells) reaches within .005 points of the specific gravity of the filling electrolyte corrected for 77° F (25° C). We recommend to continue charging for an additional 60 minutes to insure no further rise in specific gravity.

Top up or remove electrolyte as necessary for proper level. Never add electrolyte (only approved water) after activation. Replace vent caps and remove any spillage of electrolyte. If necessary, clean with bicarbonate of soda and water (100 grams of soda to one liter of water). Rinse with water and wipe dry. Ensure that soda solution does not get into cells.

**Do not place on charge until electrolyte temperature is below 35°C.*

Battery Charging

	Temperature / Volt per cell		Example: 12V (6 cells)
Bulk/Absorption	0°C to 16°C	2.5 Volt	15.0 Volts
	17°C to 27°C	2.4 Volt	14.4 Volts
	28°C to 40°C	2.36 Volt	14.16 Volts
Float	2.19		13.14 Volts
Equalization	2.58-2.67		15.48-16.02 Volts

Table 2 – Charge parameters

Note: The most common type of charge method at present is the three stage plus equalization. This outline is based on this type of charging method. Check with your charger manufacturer for specific settings for their equipment. Please note, if "topping up" with water is required more than once every two (2) months, the voltage settings are too high on your system.

Initial Charge

A battery may not be fully charged when received. The first charge brings the battery to an operational state. Before this charging process, the cell electrolyte level should be checked. Please ensure the electrolyte (liquid) covers the plates. If this isn't the case, add distilled water until all the plates are just submerged. It is important not to over fill because the level will rise during the charging process. Charge voltages are indicated in Table 2.

The electrolyte's specific gravity is the most accurate measurement and it is recommended to verify its value to determine if the cells are in fact fully charged. The specific gravity should be constant for 3 hours for an accurate full charge reading. Check the state of charge as related to specific gravity. Initial charging may take 10 hours. Once the battery is fully charged, verify the electrolyte level in the cell once more. The fluid should be 1/4 - 1/2 inch below the vent tube on each cell as shown in Figure 1. Carefully add distilled water to adjust the level if needed.

% Charge	Specific Gravity* (SG)
100	1.255 – 1.275
75	1.215 – 1.235
50	1.200 – 1.180
25	1.165 – 1.155
0	1.130 – 1.110

Table 3 - Specific Gravity vs State of Charge

* PLEASE NOTE: The Specific Gravity is dependent on the electrolyte temperature. These values are for a temperature of 27°C (80°F). To adjust, add/subtract 0.003 for every 5°C (10°F) decrease/increase.

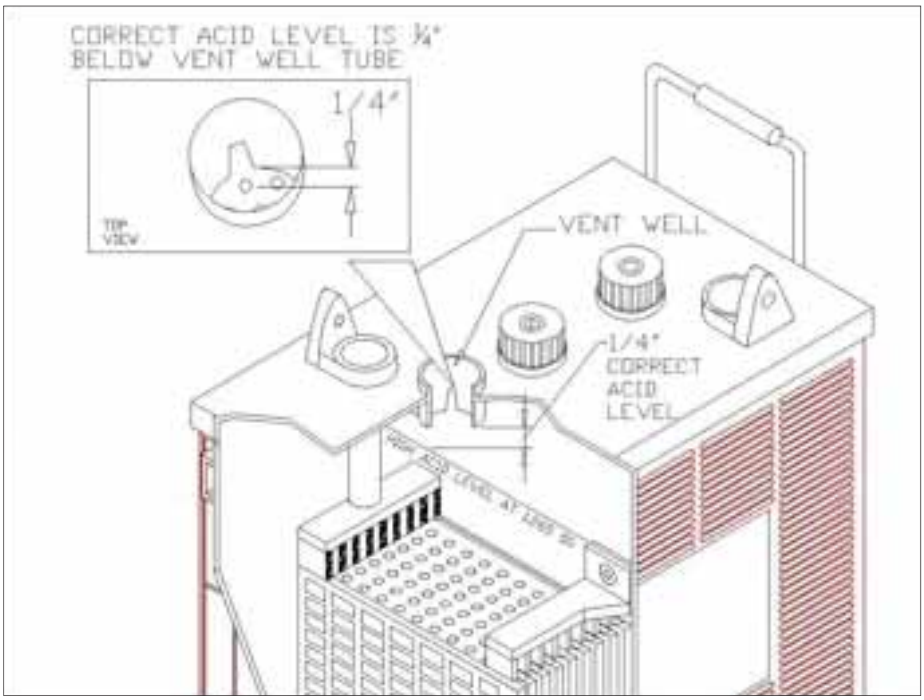

Figure 4 – Electrolyte level

Caution: Do not add water or electrolyte to cells before initial charging. Adjust electrolyte levels only when cells are fully charged. Please contact us if you have any questions or concerns.

Bulk Charge:

The first part of the charging process is the bulk charge; this is when the maximum amount of current flows into the battery bank until a desired voltage is reached. The recommended maximum current is 15% of the AH Capacity of the battery bank based on the 6 hour rate. A lower current can be used but this will prolong the charging time. Bulk charge voltage set points are outlined in Table 3.

Absorption Charge:

Arguably, the most important part of the charge cycle is the absorption charge. Since the bulk charge only recharges the battery bank to an 80% level, the absorption charge completes the charging cycle. Most chargers on the market have a timer that allows the user to adjust the duration for the required time to return the battery to full charge. In order to set the correct time, a simple calculation is required. With the help of the 20 AH capacity, you can figure out the remaining charge required for the battery bank.

As stated previously, the bulk charge brings the bank to an 80% charging level. The remaining 20% of the capacity is a function of time and current. The charger will maintain current level until the bulk set point has been reached, then the charger switches to the absorption timer. The current levels start decreasing as the internal resistance in the battery increases. Assume over the time of the absorption charge that 50% of your maximum charge current will be available (this is factored into the equation).

***Where: **t = 0.42* C/I**

t = Absorption Charge Time
C = 20hr Rated Capacity
I = Charging Current
0.42 = (20%/50%) + 5%. 5% is added due to losses***

Float Charge:

The batteries require a certain amount of voltage in order to maintain full charge when no load is applied. The power supply keeps the batteries at a constant full state of charge. In order to prolong battery life, the float settings on the power supply should be adjusted to the voltage indicated in Table 2.

Note: Multiply the correct cell voltages by the number of cells in your system.

Equalization:

Individual cells will vary slightly in specific gravity after a charging cycle. Equalization or a "controlled overcharge" is required to bring each battery plate to a fully charged condition. This will reduce stratification and sulfating, two circumstances that shorten battery life. Equalization of the battery bank is recommended every 60 to 180 days, depending on the usage of the individual system. To equalize the cells, charge the batteries until the voltage elevates to the "Equalization" voltage shown in Table 2. Charge parameters and maintain for 2 to 3 hours per bank. A constant SG for 30 minutes is a good indication of cell equalization. It is recommended to water the battery cells half way through the equalization. This will assure the water is mixed with the electrolyte.

Frequency:

It is recommended to equalize the batteries before usage. Corrective equalization needs to be performed if symptoms arise such as a constantly running generator (low capacity) or the battery bank will "not hold a charge". These symptoms are typical of a heavily sulfated battery. If a battery is not being fully charged on a regular basis or limited equalization is performed using a generator, sulfating will occur from "deficit" cycling. This undercharge condition can take months before it becomes a major and noticeable problem.

Method

Corrective Equalization can take a very long time depending on the degree of sulfating.

1. If you have a recombination cap, remove during equalization.
2. Set the charging controls to the highest voltage allowable by the charge controller (inverter). Temperature should be monitored very closely and kept below 50°C.
3. Charge at a low DC current (5 A per 100 AH of battery capacity). If grid power is not available, use solar panels or a good DC source when possible. At high voltages, charging with generator can be difficult and hard on the inverter.
4. Once every hour, measure and record the specific gravity and temperature of a test cell. If the temperature rises above 46°C and approaches 52°C, remove the batteries from charge.
5. If severely sulfated, it may take many hours for the specific gravity to rise.
6. Once the specific gravity begins to rise, the bank voltage will most likely drop, or the charging current will increase. The charging current may need to be lowered if temperature approaches 46°C. If the charge controller was bypassed, it should now be used or put back in line.
7. Continue measuring the specific gravity until 1.265 is reached.
8. Charge the batteries for another 2 to 3 hours. Add water to maintain the electrolyte above the plates.
9. Allow bank to cool and check and record the specific gravity of each cell. The gravities should be 1.265 ± 0.005 or lower. Check the cell electrolyte levels and add water if necessary.

It is recommended that a specific gravity reading of one pilot cell is measured and recorded on a regular basis when it is thought that the bank is fully charged. The measurement should be compared to previous readings. If the measurement is lower than the previous reading, a longer absorption time and/or higher voltage setting should be used. The longer the absorption time and the higher the bulk voltage, the more water will be consumed but less equalization will be required.

Note: The Specific Gravity should rise as the cells use water. Look for trends in the specific gravity over a period of time and make small adjustments as necessary.

Temperature Probe:

For additional data and safety, many people choose to install temperature probes inside the battery banks. Regardless of the size of the battery bank, the probe should be installed on the side of one battery, below the liquid level on a battery placed in the center of the bank. The main factor to look for is maximum temperature. The battery bank should not exceed an operating temperature of 50°C.

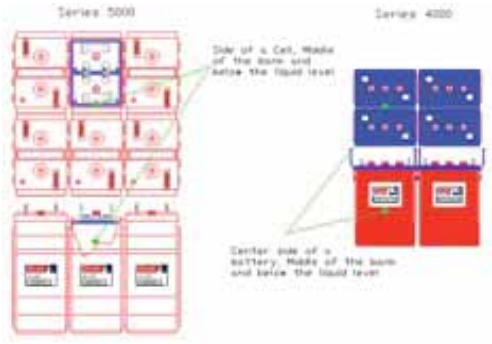

Figure 5 - Temperature Probe

Cleaning:

Batteries should be kept clean at all times. If stored in a dirty area, regular cleaning should be performed. Before doing so, assure that all the vent caps are tightly fastened. Using a solution of water and baking soda (100g per liter), gently wipe the battery and terminals with a damp sponge, then rinse with water.

Pulse Charging:

Pulse Charging has shown that the banks do not get as sulfated as one with the traditional 3-step charging, but will not eliminate the need for controlled, preventive equalization. The benefit of pulse charging is that the bank will need less overcharge and hence less maintenance.

Battery Additives:

Most battery additives are mainly a form of a common preservative, EDTA. These additives help to increase the solubility of the sulfate in the electrolyte (common salt effect). Some additives contain cadmium sulfate, which could cause disposal problems in the future. These additives are not beneficial and are not recommended.

Storage Procedure

Keep the batteries clean and always store in a cool, dry area. Where acid is stored or handled, good ventilation is necessary. Keep the bungs on the containers at all times.

Spillage Procedure

Small spills may be neutralized using water. Spray the spill from a windward location wearing protective equipment. Direct the jet to the outside of the spillage, working your way inward towards the center. Larger spills should be contained using soda ash, sand or dirt and finally washed down with water once absorbed.

Disposal Procedure

Batteries must NEVER be disposed in household waste. To reduce environmental impacts, bring your battery to a certified recycling depot at the end of its life.

Note: Lead-acid batteries are 97-98% recyclable.
Rolls Batteries have >66% recycled lead.

Quick Checklist

Shipping:

- All parts are included
- No acid spill
- No visual damage to the batteries

Installation

- Necessary personal protective gear being worn properly
- All electrical components are turned off
- Acid spill cleanup material at hand

Initial Charge

- Verify electrolyte levels (adjust if needed)
- Measure Specific Gravity
- Set up battery charge voltage/current limits

General

- Safety first!

Warranty

We build one mean battery and we back them with comprehensive warranties that lead the industry in length of coverage. We're confident that our batteries will perform time after time, year after year. But should a problem arise, you can be confident that you're covered better than any other battery warranty in the business.

Rolls, herein referred to as the Company, warrants that batteries sold by it are merchantable and free of defects in workmanship and material at the time they are shipped from the Company's factory.

In the event that the Company makes a drop shipment to a distributor's customer, that customer must be instructed to perform an inspection of the goods BEFORE signing the delivery slip. The Company is not responsible for damaged product reported after shipment has been signed "Received in Good Condition". NOTE: ALL SHIPMENTS SHOULD BE THOROUGHLY INSPECTED FOR DAMAGE BEFORE SIGNING THE DELIVERY SLIP. The Company will replace or, at its option, repair any Rolls Battery sold by it that fails to conform to the warranty stated above on a NO CHARGE BASIS as follows:

SERIES 4000

Failure within 24 months from the date placed in service yields FREE REPLACEMENT, not including freight charges from the factory to the applicable destination. After the first 24 months of service, defective batteries will be adjusted for a period of up to 84 months prorated from the date first in service at prices in effect at time of adjustment.

SERIES 5000

Failure within 36 months from the date placed in service yields FREE REPLACEMENT, not including freight charges from the factory to the applicable destination. After the first 36 months of service, defective batteries will be adjusted for a period of up to 120 months prorated from the date first in service at prices in effect at time of adjustment.

To claim a manufacturing warranty, proof of purchase must be presented, showing the date of purchase and the battery's serial number. The battery must be tested by an Authorized Battery Outlet for actual defect, and upon confirmation of the defect, the warranty will be administered.

The Warranty does not cover shipping damage, cracked covers, cracked cases, bulged cases from heat, freezing or explosion, discharged batteries or the use of undersized batteries damaged from electrical equipment. This warranty covers only manufacturing defects.

The Company makes no warranty with respect to its batteries other than the warranty stated above. All implied warranties of merchantability and all expressed and implied warranties of any other kind are hereby excluded.

Lead Acid Battery Glossary

Absorbed (or Absorptive) Glass Mat
A technique for sealed lead-acid batteries. The electrolyte is absorbed in a matrix of glass fibers, which holds the electrolyte next to the plate and immobilizes it, preventing spills. AGM batteries tend to have good power characteristics, low internal resistance, and good behavior during charging.

Amp, Ampere
Unit of electrical current. Abbreviated "A".

Amp-hour
Unit of electrical energy, one amp of current flowing for one hour. Abbreviated Ah.

Cell
A single battery canister usually grouped together with other cells to form battery packs of different voltages and amperages.
Example: One NiCD cell is 1.20 volts; therefore, six cells packaged together makes a 7.2 volt battery pack.

Cycle
A "cycle" is a somewhat arbitrary term used to describe the process of discharging a fully charged battery down to a particular state of discharge. The term "deep cycle" refers to batteries in which the cycle is from full charge to 80% discharge. A cycle for an automotive battery is about 5%, and for telephone batteries is usually 10%.

Electrolyte
An electrically conductive medium in which current flow is due to the movement of ions. In a lead-acid battery, the electrolyte is a solution of sulfuric acid. In other batteries, the electrolyte may be very different.

Flooded Cell
A design for lead-acid batteries. The electrolyte is an ordinary liquid solution of acid. Flooded cells are prone to making gas while being charged. Flooded cells must be periodically checked for fluid level and water added as necessary. Flooded cells are also typically less expensive than AGM or gel type lead-acid batteries.

Hydrometer
A tool for testing the Specific Gravity of a fluid, such as the electrolyte in a flooded battery. Typically, a squeeze-bulb is used to suck up a sample of the fluid, and a float indicates the specific gravity.

Specific Gravity
The density of a material, expressed as the ratio of the mass of a given volume of the material and the mass of the same volume of water; a specific gravity greater than 1 means heavier than water, less than 1 means lighter than water. The specific gravity of the electrolyte in a battery can be used to measure the state of charge of the battery.

Sulfation
Even though Lead Sulfate is created in the materials of plates during normal discharging, this term is used to describe the generation of a different form (large crystals) of Lead Sulfate which will not readily convert back to normal material when the battery is charged. Sulfation occurs when a battery is stored too long in a discharged condition, if it is never fully charged, or if electrolyte has become abnormally low due to excessive water loss from overcharging and/or evaporation.

Volt
The unit of measurement of electrical potential or "pressure". Most batteries come in 6, 12 and 24 volt. A single cell is 2 volts.

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