

**CARE AND MAINTENANCE OF  
RENEWABLE ENERGY SYSTEM BATTERIES**



***Rolls***  
BATTERY ENGINEERING

Recommended charging, equalization and preventative  
maintenance procedures for Rolls Solar Batteries

## Contacts:

SURRETTE BATTERY COMPANY, LTD.  
P.O. Box 2020, I Station Road  
Springhill, Nova Scotia  
B0M 1X0  
Canada

Toll-free 1-800-681-9914  
Phone (902) 597-3767  
Fax (902) 597-8447  
Toll-free Fax 1-800-681-9915

### Customer Service

Mary Holbourne  
(902) 597-4005  
mary@surrette.com

### Quality Assurance

Pascal Ferron  
(902) 597-4003  
pascal@surrette.com

### Technical Service

(902) 597-3767  
1-800-681-9914  
support@rollsbattery.com

This booklet was compiled by Renewable Energy Systems of information from the following Surrette Battery Company Publications:

Solar Battery User Manual  
Surrette Bulletins #605, 606, 607, 609, & 612



145 W Dimond Blvd, Anchorage, AK 99515  
Phone 907-561-7941 Fax 907-561-7946  
info@renewableenergysys.com

[www.renewableenergysys.com](http://www.renewableenergysys.com)

# Care and Maintenance of Renewable Energy System Batteries

<b>Equipment and Supplies for Working with Batteries</b>	<b>2</b>
Equipment and supplies needed	
<b>Emergency Acid Spillage Procedure</b>	<b>2</b>
Cleaning up an acid spill	
<b>Lead Acid Safety</b>	<b>2</b>
Important cautions and basic safety principles	
<b>Before Using Your Batteries for the First Time</b>	<b>3</b>
Inspection, acid levels, voltage, charging, specific gravity levels and record keeping	
<b>Preventative Maintenance</b>	<b>4</b>
Monthly, quarterly, semiannual	
<b>Charging</b>	<b>5</b>
Charge voltage settings, bulk charge, absorption charge, float charge	
<b>Equalization</b>	<b>6</b>
Frequency, method	
<b>Tools for Measuring Specific Gravity and Determining State of Charge</b>	<b>7</b>
Using a refractometer, hydrometer, voltmeter; correcting readings for temperature	
<b>Determining State of Charge</b>	<b>9</b>
Measuring state of charge using specific gravity readings, Measuring state of charge using voltage readings	
<b>Storage</b>	<b>10</b>
Preparing batteries for winter storage	
<b>Cleaning and Disposal</b>	<b>11</b>
<b>Warranty Information</b>	<b>12</b>
Warranty, Rolls warranty claim form, Rolls warranty claim procedure	
<b>Lead Acid Battery Glossary</b>	<b>15</b>
<b>Battery Inspection Record</b>	<b>16</b>

## Equipment and Supplies for Working with Batteries

### You will need:

- Protective eyewear, rubber gloves
- Distilled water
- Baking soda
- Refractometer or Hydrometer
- Voltmeter
- Battery charger

Always wear acid-resistant clothing, PVC gloves, and protective eyewear—especially where there is risk of splashing. Always keep the batteries in an upright position as electrolyte in the battery will spill if tilted. Always have plenty of water and baking soda available in case of acid spillage.

## Emergency Acid Spillage Procedure

**Large or continuous battery acid spills should be treated as an emergency** as sulphuric acid is a hazardous material. **Safety precautions should be taken and protective clothing worn.**

Small spills may be neutralized using baking soda and water. Sprinkle the acid with baking soda until the acid is neutralized and stops bubbling or fizzing. Spray the spill with water wearing protective clothing and eyewear. Direct the jet to the outside of the spillage, working inward towards the center.

Larger spills should be contained using baking soda, sand, or dirt, and finally washed down with baking soda and water once absorbed.

## Lead Acid Safety

Batteries store electrical energy chemically and can be used and operated safely but caution and some basic principals should be kept in mind:

1. Batteries can cause **ELECTRICAL SHOCK**. Do not lay tools, wires or conducting materials across the tops of the batteries such that the positive and negative post or connectors can make an electrical short circuit. Always replace removed safety shrouds on batteries with external connectors.
2. Battery acid can cause **SEVERE ACID BURNS**. At a minimum, always wear approved safety glasses and rubber gloves.
3. Lead acid batteries produce hydrogen, which can cause **EXPLOSIONS**. Never smoke or allow open flame around a battery on charge. Proper charge settings and procedures must be used and followed. Batteries should be vented when charging.
4. Lead acid batteries are extremely heavy and proper lifting procedures must be used to avoid personal **INJURY**. It is recommended steel toe shoes be worn when working around a battery.
5. Only fill batteries with distilled water. Fill to original level. **NEVER** fill batteries with seawater, as **DEADLY CHLORINE GAS** will be liberated.
6. If you have questions, comments or concerns please call Renewable Energy Systems at (907) 561-7941 or Surette Battery Company at 1-800-681-9914 for assistance. MSDS's are available on request.

## Before Using Your Batteries for the First Time

### 1. Inspect the Batteries

Before first use, check each battery for visible damage (i.e. cracks, dents, deformation and other visible abnormalities). Check that the battery is properly secured, free of contaminants and that all connections are clean and in good contact with the terminals. Verify the polarity of the terminals.

If the battery is dirty, or if any minor amount of acid has spilled onto the case, clean it with a weak solution of household baking soda and water (100 g per liter or 4 oz per pint). Make sure the vent caps are securely tightened and NO soda solution gets into the battery cells.

Any fluid on or around the battery could indicate that the case is not properly sealed. Contact Surette Battery Company or Renewable Energy Systems to determine if the battery should be replaced.

### 2. Check initial acid levels.

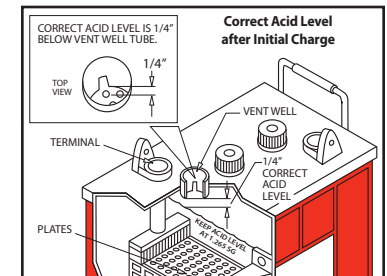
When a battery is first acquired and before charging, the cell acid levels should be checked. The electrolyte (liquid) level should always be at least 1/2" above the plates. If this isn't the case, add distilled water until the level is correct. Never leave the plates exposed. Never take acid out of the battery, except the small amounts needed for testing.

### 3. Check the battery voltage.

With a voltmeter, measure each battery's open load voltage. It is important to measure each battery individually rather than as a bank, both for increased precision and so that any undercharged batteries can be identified. Compare voltage readings to Table 1 on page 5. If voltage is below minimums, the battery will need to be charged.

### 4. Charge the battery (if needed).

If the charge voltages are low initially, put the battery on charge. The first charge brings the battery to an operational state and will take longer than subsequent charging. Once the battery is fully charged, verify the electrolyte level in the cell once more. The fluid should be 1/4 inch below the vent well tube on each cell. See page 5 for more about charging.



### 5. Check specific gravity levels and begin record keeping.

After removing from charge, the specific gravity readings of each cell should be recorded and kept for the life of the battery. **Good record keeping** is vital as review of these records can help to determine the health of the battery and can prove invaluable if system problems develop. If you are working with multiple batteries, it is useful to number the batteries and the cells of each battery, starting with the positive cell and moving from cell to cell towards the negative terminal.

**When the bank is first put into service** a pilot cell should be monitored to assure the batteries are being properly charged. Measure and record the specific gravity of the pilot cell when the battery is thought to be fully charged (after the bulk charge) for comparison with subsequent readings. See page 7 for more about checking specific gravity. See back cover for a record keeping chart.

### Battery Use Quick List

- Inspect the battery
- Check initial acid levels
- Check battery voltage
- Charge the battery
- Check and record specific gravity levels

## Preventative Maintenance

Preventive maintenance involves, *at a minimum*, checking the cell electrolyte level for correct acid volume once a month and equalizing once every six months. The more often you record data on your batteries, the easier it will be for you to detect any problems with your system. The minimum recommended preventative maintenance program is summarized as follows:

### Every month or as required:

**Add distilled water to each cell to return the acid level to original level.**

The cells should be watered back to the original acid level which is 1/4" below the bottom of the vent well (tube inside the battery cell with slots on each side). Distilled water should be used. Use of non-distilled water can cause mineral build-up in the battery cell. Only add water as it is consumed.

### Every three months:

**Record the specific gravity readings of each cell.**

The electrolyte's specific gravity is the most accurate measurement to determine if the cells are fully charged. The specific gravity should be constant for 3 hours for an accurate full charge reading. See page 7 for more about checking specific gravity.

### Every six months or as required:

**Equalize the batteries.**

To avoid battery sulfation, a lead acid battery must be equalized or given a controlled overcharge on a regular preventive basis. Equalization is very important and must be performed correctly but only as required.

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 reduces stratification and sulfating, two conditions that shorten battery life. Equalization of the battery bank is recommended every 60 to 180 days, depending on usage of the individual system.

To equalize the cells, charge the batteries until the voltage elevates to the equalization voltage shown in Table 1 on opposite page, and maintain for 2 to 3 hours per bank. A constant specific gravity for 30 minutes is a good indication of cell equalization. It is recommended to water the battery cells halfway through the equalization. This will assure the water is mixed with the electrolyte. See page 9 for more about equalization.

### As needed:

**Clean the battery terminals and case / cover.** A weak solution of household baking soda and water can be used to neutralize any spilled acid (100 g per liter or 4 oz per pint). Make sure the vent caps are securely tightened and NO soda solution gets into the battery cells.

### Minimum Maintenance Quick List

#### Monthly

Check acid levels.

#### Every 3 months

Check specific gravity.

#### Every 6 months

Equalize batteries.

## Charging

The most common method of charging has three stages: the *bulk* and *absorption* charge stages bring the batteries to full charge, and the *float* charge maintains the batteries at that level.

When charging, do not let the cell temperature exceed 125°F (51.8°C). If the temperature becomes excessive or the cells begin to gas vigorously, reduce the rate of charge. Continue charging until all cells reach a specific gravity of 1.25-1.275. The specific gravity should be constant for 3 hours for an accurate full charge reading. All cell voltages should be even. Once the battery is fully charged, verify the electrolyte level in the cell once more. The fluid should be 1/4" below the vent tube in each cell as shown on page 3. Carefully add distilled water to adjust the level if needed.

### Charge Voltage Settings

The following voltage settings are recommended:

Table 1

Charge Stage	Volts per Cell			12V			24V			48V		
	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Bulk/Absorption	2.40	2.45	2.50	14.4	14.7	15.0	28.8	29.4	30.0	57.6	58.8	60.0
Equalization	2.58	2.63	2.67	15.0	15.8	16.0	30.8	31.6	32.0	61.6	63.2	64.0
Float	2.20	2.22	2.23	13.2	13.3	13.4	26.4	26.6	26.8	52.8	53.2	53.5

To calculate the correct settings for another battery bank voltage, divide the total nominal voltage by two and use this number as a multiplier. For example an 18V system,  $18/2 = 9$ , equalization preferred =  $9 \times 2.58 = 23.2V$

### Bulk Charge

In this first part of the charging process, the maximum amount of current flows into the battery bank until a desired voltage is reached. Bulk charge voltage set points are outlined here:

Table 2

Specific Gravity	1.110-1.130	1.155-1.165	1.180-1.200	1.215-1.235	1.255-1.275
State of Charge	0%	25%	50%	75%	100%

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

### Absorption Charge

The second part of the charge cycle is the absorption charge. The bulk charge recharges the battery bank to an 80% 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 switch to absorption time. Current levels will decrease as internal resistance in the battery increases.

Table 3

Capacity (AH)	200	400	600	800	1000	1200	1400	1600
Absorption Time (minutes)	60	90	120	150	180	210	240	270

### Float Charge

Batteries require a certain amount of voltage to maintain full charge when no load is applied. The power supply keeps the batteries at a constant full state of charge. To prolong battery life, the float settings on the power supply should be adjusted to the charge voltage settings in Table 1.

**Caution:** The ideal float voltage is the lowest voltage setting that will maintain the battery at full charge. The higher the voltage, the more water the cell will consume. If 'topping up' with water is required more than once

every two months, the voltage settings are too high on your system. The minimum equalization voltage is highly recommended unless it is suspected a sulfation problem exists and corrective equalization is required.

## Equalization

To avoid battery sulfation, a lead acid battery must be equalized or given a 'controlled overcharge' on a regular preventive basis. Equalization is very important and must be performed correctly but only as required.

Individual cells will vary slightly in specific gravity after a charging cycle. Equalization brings each battery plate to a fully charged condition. This reduces stratification and sulfating, two conditions 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 1 on page 5, and maintain for 2 to 3 hours per bank. A constant specific gravity for 30 minutes is a good indication of cell equalization. It is recommended to water the battery cells halfway through the equalization. This will ensure the water is mixed with the electrolyte.

### Frequency

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, sulfation will occur from 'deficit' cycling. This undercharge condition can take months before it becomes a major and noticeable problem.

As the bank is deficit cycled and eventually starts to sulfate, the sulfate will cause a resistance to charge and a 'false high voltage' reading will occur. The 'false high voltage' is measured by the charge controller, which lowers the charging current to maintain the voltage set point, further increasing the undercharge condition. Taking specific gravity measurements rather than relying on voltage to measure state of charge will reduce 'false high voltage' readings.

Amperage-hour meters can compound the problem and make it appear that enough energy is being returned to the batteries to maintain a good state of charge. Because fundamental calculation errors can be introduced by the equations used by amp-hour meters, they should be considered only a rough measure of the state of charge. You should always confirm (at least initially) state of charge by taking a specific gravity measurement of one cell when it is thought the bank is fully charged.

### Method

Corrective equalization can take a very long time depending on the degree of sulfation.

1. If you have hydrocaps, remove during equalization.
2. Set the charging controls to the highest voltage allowable by the charge controller (inverter). Temperature should be monitored very, very closely and kept below 125°F (51.8°C).
3. Once every hour, measure and record the specific gravity and temperature of a test cell. If the temperature exceeds 115°F (46°C) and approaches 125°F (52°C), remove the battery from charge.
4. If the battery is severely sulfated, it may take many hours for the specific gravity to rise.
5. 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 125°F (46°C). If the charge controller was bypassed, it should now be used or put back in line.

6. Continue measuring the specific gravity until 1.265 is reached.
7. Charge the batteries for 2 to 3 hours more. Add water to maintain the electrolyte above the plates.
8. Allow bank to cool and check and record the specific gravity of each cell. The gravities should be  $1.265 \pm 0.005$  or lower. Check the cell electrolyte levels and add water if necessary.

*It is recommended that a specific gravity reading of one pilot cell be measured and recorded on a regular basis when it is thought that the bank is fully charged. If the measurement is lower than previous readings, 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 very small adjustments as necessary.*

**Caution:** If you have hydrocaps, remove during equalization.

## Tools for Measuring Specific Gravity and Determining State of Charge

The best way to truly monitor your system over its lifetime is to regularly take and record specific gravity readings with a hydrometer or refractometer.

### Using a Refractometer

The most accurate and convenient way to measure specific gravity is with a refractometer. A refractometer is a precision optical instrument that indicates concentration by measuring how light bends as it passes through a solution. To use:

1. Lift the clear sample window cover and place a drop of battery acid from one cell on the sample window. Close the sample window cover.
2. Look through the eyepiece as you would look through a telescope.
3. The point at which the light and dark areas of the measurement screen intersect the scale indicates the specific gravity of the sample.
4. Record the reading and wipe the sample window clean before testing the next cell. Repeat for each of the remaining cells. Compare readings to Table 2 on page 5 to determine state of charge.



### Using a Hydrometer

If you use a hydrometer to measure specific gravity, the recommended type has a float contained within a glass tube with a rubber bulb to draw an acid sample, and gives a direct numeric reading. Avoid those with floating colored balls as they give very subjective and inaccurate results. A good hydrometer is accurate to +/- 0.005 points so 1.265 could read from 1.260-1.270. Procedures for use are instrument dependent; this method is given as a general procedure and assumes a hydrometer with glass float and body:

1. Disconnect the battery and let it sit for 30 minutes. If the electrolyte is hot, allow it cool to room temperature.
2. Put on eye protection and rubber gloves.
3. Remove the vent cap. Insert the hydrometer into cell, not pushing down on the top of the plates, and draw electrolyte into the glass cylinder with the squeeze bulb. Draw just enough acid into the cylinder to make the float rise. Hold the hydrometer vertical as the sample is drawn.
5. Note the exact point at which the fluid level intersects the scale on the float and record it.



- Repeat the test for each of the remaining cells. Record the reading for each cell. Compare readings to Table 2 on page 5 to determine state of charge.
- If it is very warm or very cold, correct the specific gravity for temperature. If the ambient temperature is fairly consistent and original gravities were taken when the batteries were put into service, temperature correction is not as critical and only necessary if problems arise.

### Using a Voltmeter

A voltmeter can also be used in determining the state of charge of your batteries. To use:

- Turn on the voltmeter and set to DC voltages.
- Touch the voltmeter's red lead to the positive battery terminal, and the black lead to the negative terminal.
- Read and record the voltage. Compare reading to Table 6 on page 10.



### Correcting Readings for Temperature

Most chargers have a battery temperature sensor which configures the charging voltage based on the battery's external temperature. If this configuration is not available, use the following information.

#### Correcting Specific Gravity Readings for Temperature

If the temperature of the electrolyte is below 80°F, subtract .003 from the actual reading for each 10 degree change. Add .003 points for each 10 degree change above 80°F.

For example, if the actual specific gravity reading is 1.265, but the electrolyte temperature is only 30°F, then the true, corrected specific gravity is 1.250 (1.265-.015 = 1.250).

Why? Because the higher 1.265 specific gravity reading at 30°F is the result of the increased density of colder electrolyte, not because the sample contains a higher concentration of acid.

See Table 5 on opposite page for specific gravities corrected for various temperatures.

#### Voltage Settings Corrected for Temperature

The following voltage settings are recommended:

Table 4

	Temperature/Volts per cell	Example: 12V (6 cells)
Bulk/Absorption	32°F (0°C) to 62°F (16°C)	2.5 Volts
	63°F (17°C) to 81°F (27°C)	2.4 Volts
	82°F (28°C) to 104°F (40°C)	2.36 Volts
Float	2.19 Volts	13.14 Volts
Equalization	2.58 – 2.67 Volts	15.48 – 16.02 Volts

## Determining State of Charge

A battery's level of charge can be determined in two ways: by measuring the specific gravity of the electrolyte in each of its cells with a refractometer or hydrometer, or by reading voltage.

### Measuring State of Charge using Specific Gravity

The most accurate and direct way to test the state of charge of a battery cell is to determine the specific gravity of the battery electrolyte.

As a battery is charged, water is electrolyzed into hydrogen and oxygen gas, and the acid content of the electrolyte increases. As a battery discharges, the electrolyte contains more and more water and less acid. Since water is lighter than acid, the weight of electrolyte decreases as the battery discharges. Electrolyte in a charged battery weighs more by volume than electrolyte in a discharged battery, so higher specific gravity of the electrolyte indicates a higher state of charge.

Unlike voltage readings, specific gravity readings are valid whether the battery is on charge, being discharged, or being stored. This table shows the approximate state of charge indicated by specific gravity readings at various temperatures:

Table 5

State of Charge	-20°F	0°F	20°F	40°F	80°F
0%	1.080-1.100	1.086-1.106	1.092-1.112	1.098-1.118	1.110-1.130
25%	1.125-1.135	1.131-1.141	1.137-1.147	1.143-1.153	1.155-1.165
50%	1.150-1.170	1.156-1.176	1.162-1.182	1.168-1.188	1.180-1.200
75%	1.185-1.205	1.191-1.211	1.197-1.217	1.203-1.223	1.215-1.235
100%	1.225-1.245	1.231-1.251	1.237-1.257	1.243-1.263	1.255-1.275

### Measuring State of Charge using Voltage Readings

Voltage can also be used to estimate state of charge but caution must be used when interpreting voltage readings. Voltage readings will vary and are greatly affected and dependent on whether the battery is being charged (load voltage), discharged, or in storage (open cell voltage).

**Load Voltage** When a battery is charged the plates polarize and develop a resistance to the charge (surface charge). This resistance adds to the battery voltage, so voltage readings will not reflect the true state of charge. The surface charge is removed when the battery is being discharged. In general, battery voltage will recover or increase when the load is removed, especially if the load is very high.

**Open Cell Voltage** is determined by taking all the loads off of the battery, but the battery must stand for at least four hours before taking a reading to allow the surface charge to dissipate. To get around this problem, determine the 50% state of charge.

#### Determining the 50% State of Charge Voltage Reading

Most three-step chargers or inverters monitor voltage and have an adjustable set point that determines when the batteries are low (50% discharged) and should be charged. When this set point is reached the inverter will sound an alarm, start a generator, or tie the battery bank back into the grid power. Since the voltage will change when the bank is on load, the set point can be determined by a specific gravity reading. A reading of 1.200 means the battery is 50% discharged.

Battery cable lengths, system set-up, and other variables can affect the voltage readings as well. Below is a procedure to verify the 50% mark and the following table gives approximate cut-off

voltages at various state of charge. Notice 100% is given as an open cell voltage and all other percentages as under load.

When using a generator with a low voltage cut-off, set the generator to start at the 50% mark given in Table 6 below, and put the bank into service (11.58V for a 12V system). When the generator starts up, measure the specific gravity of one cell in the bank. Compare this reading to Table 2 on page 5. If the measured specific gravity indicates the state of charge is more than 50%, decrease the low voltage cut-off setting. If the indicated state of charge is lower than 50%, increase the low voltage cut-off setting. Note: 50% is the desired depth of discharge, but a range of 45-55% is acceptable. The actual battery voltage corresponding to 50% will change with a change in load. In general, the higher the discharge amperage, the lower the corresponding voltage. To summarize:

1. Put all or as many loads as possible on the battery. Disconnect any incoming current, such as that from solar panels, turbines, or grid power.
2. Take the specific gravity of one cell.
3. Take readings 15 minutes and 30 minutes later. This should give an indication of how fast the batteries are dropping.
4. Continue to take readings until they indicate that a 50-55% state of charge has been reached.
5. Take and record voltage readings (when on load) of any meters to be used for monitoring the state of charge and take a voltage reading across the terminals of one battery.
6. Compare readings to these figures:

Table 6

% Charged	Single Cell	12V	24V	32V	48V	
100%	2.10	12.60	25.20	33.60	50.40	OPEN CELL
75%	2.01	12.06	24.12	32.16	48.24	UNDER LOAD
50%	1.93	11.58	23.16	30.88	46.32	UNDER LOAD
25%	1.84	11.04	22.08	29.44	44.16	UNDER LOAD
0%	1.75	10.50	21.00	28.00	42.00	UNDER LOAD

7. These readings will give you a very accurate voltage reading which can be used in the future either as a set point for the inverter or as a day-to-day monitoring parameter.

*Note: This will give you a very good idea on how your battery bank will behave and how long it will last with no power inputs. New batteries will give about 75% of the specified capacity until the battery has been cycled 40-60 times (1-3 months of service).*

## Storage

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.

### Preparing Batteries for Winter Storage

Prior to placing batteries into winter storage make certain the electrolyte level is approximately 1/2" (13mm) above the top of the separators. The electrolyte level in very cold batteries will be lower than normal, so let batteries warm to a normal temperature before judging electrolyte levels.

Once the electrolyte level is correct, ensure that the batteries are fully charged. Check that the battery tops are clean and dry.

In marine applications, you may choose to leave the batteries aboard your boat or remove and store in a cool dry area. If the batteries are stored aboard the boat, disconnect the terminal cables. This will prevent premature discharge of the batteries due to a ground in the electrical circuits or failure to turn a piece of electrical equipment off.

If the batteries become discharged, the electrolyte can freeze when stored below +20° F (70° C). The following table shows temperatures at which electrolyte, in various states of charge, starts to freeze.

Table 7

Specific Gravity (cor. to 80° F/26.7° C)	Freezing Temperature
1.280	-92° F (-69° C)
1.265	-72.3° F (-57.4° C)
1.250	-62° F (-52.2° C)
1.200	-16° F (-26.7° C)
1.150	+5° F (-15° C)
1.100	+19° F (-7.2° C)

A 3/4 charged battery is in no danger of freezing. Therefore, batteries should be kept at least 3/4 charged, especially during winter weather. The frequency of checking batteries depends greatly on temperature. The effect of temperature on self discharge for the average fully charged, new, conventional battery in good condition is approximately as follows:

1. At 100° F (37.8°C) .0025 specific gravity per day
2. At 80° F (26.7°C) .001 specific gravity per day
3. At 50° F (10°C) .0003 specific gravity per day

A fully charged battery stored at 80° F (26.7°C) will take 30 days before it self discharges 25 percent. At 50°F (10°C) the time period increases to 100 days. This will give an idea of how often a battery should be checked.

Some makes of batteries will have a higher and some a lower rate of self discharge. This depends on the method of manufacture and purity of materials used.

## Cleaning and Disposal

### Cleaning Batteries

Batteries should be kept clean at all times. If stored in a dirty area, regular cleaning should be performed. Before cleaning, ensure that all the vent caps are tightly fastened. Using a solution of water and baking soda (100 g per liter or 4 oz per pint), gently wipe the battery and terminals with a damp sponge, then rinse with water.

### Battery Disposal

Batteries must NEVER be discarded in household waste. Lead acid batteries are 97-98% recyclable. To reduce environmental impacts, bring your battery to a certified recycling center at the end of its life. Call Renewable Energy Systems for help with recycling.

Rolls Batteries have >66% recycled lead.

## 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.

## Rolls Battery Warranty Claim

To receive a returned goods authorization for a Rolls battery that has failed, we require an analysis of the battery in question. To do so, please fill out the form below and fax it back to our technical support department (1-800-861-9915).

FROM POSTO NEG END OF STRING			
BAT	VOLTAGE	CELL	SG
1		1	
		2	
		3	
2		4	
		5	
		6	
3		7	
		8	
		9	
4		10	
		11	
		12	
5		13	
		14	
		15	
6		16	
		17	
		18	
7		19	
		20	
		21	
8		22	
		23	
		24	

BATTERY MODEL:				
DATE PURCHASED:				
CUSTOMER/DEALER:				
<b>SYSTEM INFORMATION</b>				
Stand alone	<input type="checkbox"/>			
Grid-Tie	<input type="checkbox"/>			
Back-up	<input type="checkbox"/>			
<b>INVERTER</b>				
Make & Model				
Charger Output				
Absorption Voltage & Time				
<b>CHARGING SOURCE</b>	<b>TYPE</b>	<b>QTY</b>	<b>OUTPUT</b>	
Panels				
Wind				
Generator				
Other				
Average daily consumption: KWH/AC or AH/DC				
Duty cycle:				
Any irregular occurrences? (Lighting, component/controller failure)				

\*\*Open cell voltage should be taken after 2 hours rest with negative connection removed\*\*

Date code is the four digit number located on the edge of the cover.

1st digit = day of week (3 = Wednesday)

2nd and 3rd digits = week of year

4th digit = year (2 = 2001)

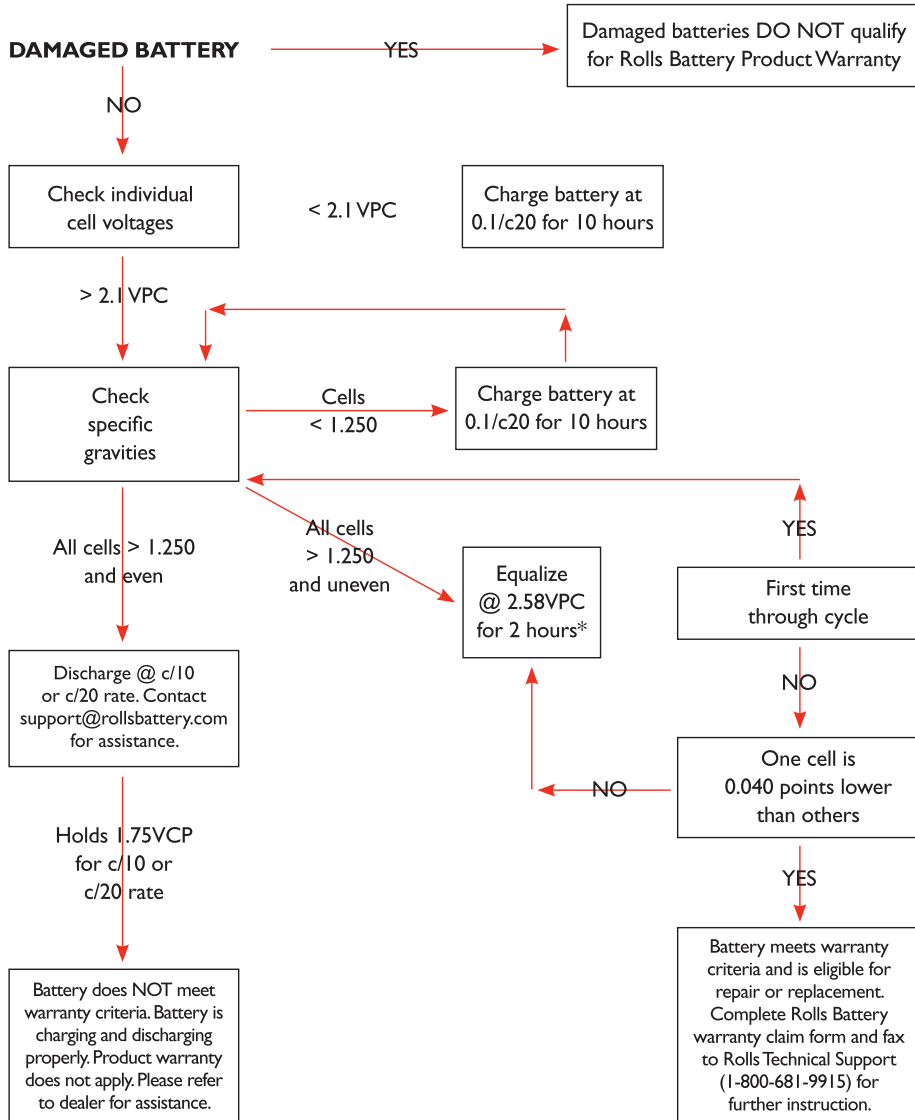
If low SG (Specific Gravity)

Equalize at 2.58 VPC (Voltage Per Cell). Monitor Centre Cell <sup>TM</sup>.

## Rolls Battery Warranty Procedure

Please refer to product warranty for the specific model as terms and conditions may vary.

For warranty requests and inquiries, please consult your Rolls Battery Distributor or Dealer (point of purchase.)



## Lead Acid Battery Glossary

**Absorbed (or Absorptive) Glass Mat** A type of sealed lead-acid battery. 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 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.

**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 specific gravity of a fluid, such as the electrolyte in a flooded battery. Typically, a sample of fluid is drawn with a squeeze bulb, and a float indicates the specific gravity.

**Refractometer** An optical device used to test the specific gravity of battery acid to find the battery's state of charge. When a liquid is placed on the prism, the light passing through it is bent. The more concentrated the liquid, the more the light will bend. The refractometer contains a reticle, or scale, that is enlarged through the eyepiece to measure this bent light.

**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 fluid with a specific gravity greater than 1 is heavier than water; less than 1 is 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 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 volts. A single cell is 2 volts.

**Water** Batteries need water to replenish the constant loss during each charging cycle as hydrogen gas is released, and only distilled water should be used. Do not use tap water, "hard" water, or water having dissolved solids which can increase sulfate problems and cause mineral build-up in the battery cell. NEVER fill batteries with seawater, as deadly chlorine gas will be liberated.



