

BATTERY USER MANUAL

Rolls

BATTERY ENGINEERING



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



**RENEWABLE
ENERGY**



AGM



GEL



MARINE



MOTIVE POWER



**RAILROAD &
DIESEL STARTER**



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MANUAL

Rolls Battery has been manufacturing deep cycle lead-acid batteries since 1935. Experience gained has helped achieve an unmatched reputation along with specific measures to obtain the maximum performance and life from our product. This manual provides the recommended setup, charging, equalization and preventive maintenance procedures necessary to maximize the life of your Rolls batteries.

EQUIPMENT NEEDED

- Goggles, rubber gloves & rubber boots
- Distilled water
- Baking soda, soda ash
- Voltmeter, ampmeter
- Hydrometer, refractometer
- Battery charger

SAFE HANDLING PROCEDURE

To prevent injury, always wear acid-resistant clothing, PVC gloves, goggles and rubber boots. Flooded batteries must be maintained in an upright position at all times. Always have plenty of water and baking soda on hand in the event of acid spillage during transport.

INSPECTION

When receiving shipment of your batteries, it is important to thoroughly inspect each pallet, battery and packaging. Before signing acceptance of the shipment, remove the shrink-wrap from the pallet and inspect each battery for damage (i.e. cracks, dents, punctures, deformations, acid leaks or other visible abnormalities).

Do not accept shipment if the batteries appear to have been damaged in anyway.

Confirm that connection terminals are secure and clean. If the battery is dirty, or if any minor amount of acid has spilled onto the case due to loose bayonets, refer to the cleaning instructions in this manual to properly neutralize and clean as necessary. Wet pallets or signs of acid leak on or around the batteries could indicate shipping damage or improperly sealed battery casing. Perform a voltage check to confirm the battery polarity and marking of the terminals are accurate.

In the event of a suspected leak or damage, do not accept the shipment.

Contact your battery retailer or Rolls Battery to determine whether the batter(ies) require replacement.

Battery shipments which are known to be damaged, but accepted, will not be replaced under the terms of Rolls Battery manufacturer warranty.

QUICK CHECK LIST

SHIPPING/RECEIVING (MUST INSPECT PRIOR TO DRIVER RELEASE!)

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

INSTALLATION

- Protective equipment should be worn
- All electrical components should be turned off
- Acid spill cleanup material should be readily available

INITIAL CHARGE

- Verify electrolyte levels (add distilled water as necessary)
- Measure specific gravity
- Set up battery charge voltage/current limits

GENERAL

- Safety first!

INSTALLATION

Rolls deep cycle batteries are manufactured for use in a wide variety of applications. No matter the use, it is important that the battery is installed securely, free of contaminants and that all connections are in good contact with the terminals. Excessive heat or cold temperatures will result in the reduction of the overall life of your batteries.

Flooded batteries should be installed in a temperature-controlled room or in an enclosure that insulates the batteries from freezing or overheating. Batteries should never be installed in a completely sealed cabinet. Valve regulated battery enclosures should at minimum be passively ventilated, while enclosures for flooded models should be actively ventilated with both positive and negative flow installed to remove and replace hydrogen gas generated during charging (as cell voltage reaches 2.25 VPC or above). Hydrogen concentration in excess of 2-4% is explosive. Every effort should be made to avoid hydrogen accumulation. For all Rolls battery models it is recommended that batteries are separated 2.5cm-7.5cm (1"-3") inches apart to allow for ease of maintenance and proper airflow and cooling.

BATTERY ORIENTATION

Flooded lead acid batteries must be kept in an upright position at all times. Electrolyte in the battery may spill if tilted more than 20 degrees.

AGM & GEL batteries may be mounted upright or horizontally on the side (longest) of the battery case. Use caution not to cover valves located on the top of the batteries when using strapping to secure as damage may occur. AGM & GEL batteries may not be mounted upside down or horizontally on the end (shortest side) of the case.

CABLE SIZING

Cabling should be proportionate to the amperage of your system. The table below notes the maximum current carrying capacity based on cable gauge. Battery cabling should be selected allowing a maximum voltage drop of 2% or less across the entire length of the cable. Interconnection cables (battery to battery) should also be sized at the same gauge and of equal length between connections.

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
“Free Air” Ratings

WARNING

Loose or over-tightened connections may cause high resistance. The result is an unwanted voltage drop as well as excessive terminal heating, causing the terminal to melt or even catch fire. To limit the possibility of damage or fire, use a torque wrench to properly adjust terminal connections during your regular maintenance schedule.

Using an Infrared (IR) temperature sensor may assist in identifying poor connections when testing under load or during charge.

Connections that have overheated and/or developed problems will often be welded to the terminal. Visual inspections may not always detect poor connections. It is recommended that terminal connections are disconnected, cleaned and re-torqued periodically as part of the regular maintenance routine.

FLOODED LEAD ACID TERMINALS

Terminal connections should be tightened to 25 ft/lbs or 33 N.m for all flooded FS, 4000, 4500 & 5000 Series models.

AGM & GEL TERMINALS

Torque settings vary by terminal type, please refer to the chart below and/or provided specifications:

AGM Terminals	Torque N.m
Button Terminal (M8)	9.6-10.7
Button Terminal (M10)	12.2-14
AP	5.6-7.9
LT	9.6-10.7
DT (AP and stud terminal)	5.6-7.9
M6 (TP08)	3.9-5.4
M8 (TP08)	9.6-10.7

PARALLEL/SERIES CONNECTIONS

Applications often demand more voltage or more ampere capacity than the capacity of one battery. By connecting multiple batteries in series, parallel or series parallel configurations, you are able to increase the output voltage or battery bank amperage as needed.

To increase voltage, batteries are connected in series. Capacity of the battery bank remains the same as voltage increases. To increase the available amount of current and capacity, batteries are connected in parallel. In this situation it is best to use lower voltage, higher capacity cells to minimize the amount of parallel strings.

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

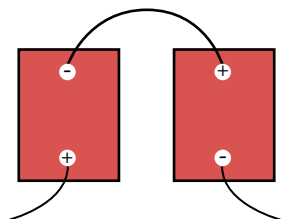


FIGURE 1:
Voltage Increase

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

EXAMPLE:

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

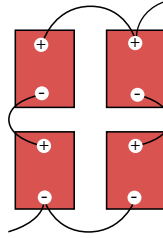


FIGURE 2:
Voltage/Capacity
Increase

EXAMPLE:

Twenty-four (24) 2 Volt models at 2430 AH each = 2430 AH at 48 Volts

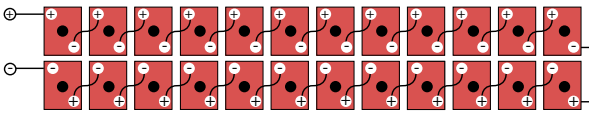


FIGURE 3:
Single Series String
+ “Best Option”

EXAMPLE:

Two (2) strings of eight (8) 6 Volt 428 AH each = 2 x 428 AH at 48 Volts = 856 AH at 48 Volts

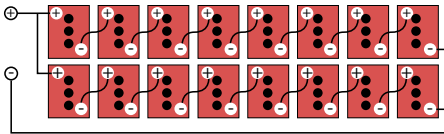


FIGURE 4:
Two Parallel Strings.
Series/Parallel

EXAMPLE:

Three (3) strings of four (4) Batteries at 357 AH each = 3 x 357 AH at 48 Volts = 1071 AH at 48 Volts

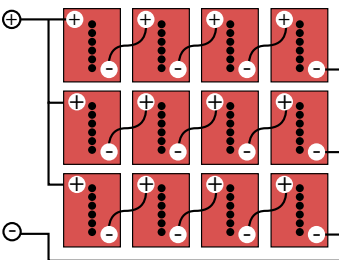


FIGURE 5:
Three Parallel Strings.
Series/Parallel

NOTE: We do not recommend more than three (3) series strings. Multiple parallel connections will often create uneven resistance between strings, causing an imbalance of charging and discharge currents, resulting in possible cell damage or premature failure.



**FLOODED
LEAD ACID
BATTERIES**

Rolls

INSPECTION & INITIAL CHARGE OF FLOODED LEAD ACID BATTERIES

WARNING

- ALWAYS WEAR THE PROPER PERSONAL PROTECTIVE EQUIPMENT (GOGGLES, GLOVES, CLOTHING) WHEN HANDLING FLOODED BATTERIES AND ELECTROLYTE.
- WET BATTERIES MUST BE FULLY CHARGED BEFORE BEING DELIVERED TO THE END USER.
- UNLESS INSTRUCTED BY ROLLS TECHNICAL SUPPORT, NEVER ADD ACID TO THE BATTERIES AT ANY TIME. USE DISTILLED WATER ONLY.
- **FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN MALFUNCTION AND WILL VOID WARRANTY.**

A battery may not be fully charged when received. An initial charge brings the battery to an operational state. Before charging, inspect for physical damage, check polarity and electrolyte levels in each cell. Ensure the electrolyte (liquid) covers the plates completely. It is normal for electrolyte levels to lower as the battery case will relax (bulge) slightly after filling. If the plates are exposed, add distilled water until all are just submerged. It is important not to overfill each cell as the electrolyte level will rise during the charging process. Charge voltages are indicated in **Table 2 (a) & 2 (b) Flooded Charging Parameters**.

INITIAL INSPECTION & CHARGING

1. Inspect batteries for damage. Important: read all warning labels on batteries before proceeding.
2. Wet batteries are fully charged and tested before shipping, however batteries will self-discharge when not in use during transportation and storage. The first charge brings the battery to an operational state. Before this charging process, electrolyte levels should be checked, making sure the plates are covered in each cell. If required, add distilled water until all the plates are submerged. It is important not to over fill because the level will rise during the charge process.
3. Check for correct polarity. Attaching the positive and negative voltmeter lead to the positive and negative battery terminal should give a positive voltage reading. If it is negative, a reverse polarity condition exists and you should contact your dealer or Rolls Battery Technical Support.
4. Place batteries on charge. Please see **Table 2 (a) & 2 (b) Flooded Charging Parameters** for required charging settings. Do not let the cell temperature exceed 52°C (125°F). If the temperature becomes excessive or the cells begin to gas vigorously, reduce the rate of charge. Continue charging until all cells reach the specific gravity of the filling acid. All cell specific gravities should be even (1.260-1.280).

FLOODED LEAD ACID BATTERY CHARGING

MULTI-PHASE CHARGING

The most common type of charge method at present is a three phase charge plus periodic equalizations. Check with your charger manufacturer for specific programming instructions.

BULK CHARGE

The first phase 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 charge current is 10%-20% of the AH capacity of the battery bank, based on the 20 Hr AH rate (C20). Higher current levels may cause the battery bank to overheat. A lower current may be used; however, this will prolong charge time and increase the potential for sulfation build-up.

Bulk charge voltage set points are outlined in **Table 2 (a) & 2 (b) Flooded Charging Parameters**.

ABSORPTION CHARGE

The most important part of the charge cycle is the Absorption charge. The Bulk charge typically recharges the battery bank to approximately 80% state of charge, the Absorption charge then completes the charging cycle. Most three phase chargers include an Absorption time setting which allows the user to program the duration of time needed to reach a full state of charge. To set the Absorption time, a simple calculation is required. Using the 20 Hr AH rating of the battery bank (C20) and the charger output, it is possible to determine the time needed to fully charge the battery bank.

As stated previously, the Bulk charge phase brings the bank to approximately 80% state of charge. The remaining 20% charge is a function of time and current. The charger will maintain current level until the Bulk set point has been reached. The charger will then switch to the programmed Absorption voltage and timer. As the battery charge nears completion, the internal resistance in the battery increases and charge current begins to decrease. It is assumed that over the time of the Absorption charge that 50% of your maximum charge current will be available (this is factored into the equation). $0.42 = (20\%/50\%) + 5\%$. 5% is added due to losses.

ABSORPTION CHARGE TIME

Where : $T = 0.42 \times C / I$

T = ABSORPTION CHARGE TIME

C = 20 hr RATED CAPACITY (total battery bank)

I = Charging Current (Amps) (recommended 10% to 20% of C20 discharge rate)

$0.42 = (20\%/50\%) + 5\%$ (5% is added due to losses)

EXAMPLE:

2 strings of 6 Volt 6 CS 25P models

20 hr AH rate = 820 AH x (2 strings) = 1640 AH

I = 10% of 1640 AH = 164 Amps. If charger output is 120 Amps max, 120 is used

T = 0.42 x 1640/164 = 4.2 hrs OR T = 0.42 x 1640/120 = 5.75 hrs

FLOAT CHARGE

When the Absorption charge is completed, the batteries require a certain amount of voltage to maintain a full charge when no load is applied. This Float voltage maintains the battery bank at a constant full state of charge. To prolong battery life, the Float settings on the power supply should be adjusted to the voltage indicated in **Table 2 (a) & 2 (b) Flooded Charging Parameters**. Higher or lower voltage settings may result in unnecessary overcharge or sulfation.

END AMPS OR RETURN AMPS

As batteries near full capacity the charge current drops. End Amps or Return Amps generally refers to the lowest amount of current (Amps) running from the charger when the batteries have reached full capacity and are no longer accepting a charge. Some chargers will measure the actual current output. If the charge current drops to the End Amps or Return Amps set point, this will trigger the charger to shut off. This setting is typically 2%-3% of the 20 Hr AH rating (C20) of the battery bank. Rolls recommends setting this at 2% for new installations.

WARNING: This setting combined with a sulfated battery can confuse the charger and cause a state of charge reset prior to actually hitting 100% (SOC) state of charge.

LOW VOLTAGE DISCONNECT (LVD OR LVCO)

Many charging systems offer the ability to program a Low Voltage Disconnect (LVD) or Low Voltage Cut Off (LVCO), which triggers an alternate power source (often a generator) to turn on and begin charging the battery bank. When the programmed low voltage setting is reached, the system initiates the charge source which then safeguards from overdischarging the battery bank. By default, this may be set by the charger manufacturer at 1.75 volts per cell (VPC). Always verify the default settings and adjust as required.

Low Voltage Disconnect setting is a personal preference. Deep cycle batteries are intended to be discharged no more than 50%. Allowing the battery bank to discharge to a lower voltage will reduce over all cycle life. Alternatively, a higher set point may result in more frequent use of the charging source (ex: generator) when discharge reaches the low voltage cut-off.

To prolong battery cycle life, Rolls recommends setting the Low Voltage Disconnect (LVD) between 1.85 volts per cell (VPC) to 1.95 volts per cell (VPC). This may be adjusted up or down, depending how often you wish to run the charging source (generator or alternative power) when the voltage of the battery bank reaches the programmed set point.

WARNING: Low Voltage Disconnect only cuts off the draw from the inverter/charger. It does not disconnect all loads from the battery bank. A prolonged connection will eventually lead to over-discharge and battery collapse.

OTHER CHARGER MODES

Many Inverter and Charge Controller manufacturers design and include other operational modes to enhance their products. It is recommended that you contact the manufacturer to better understand how these operate and properly program the Rolls recommended charging parameters. **See Table 2 (a) & 2 (b) Flooded Charging Parameters.**

FLOODED BATTERY CHARGING PARAMETERS

Regular Cycling / PSOC Recovery		0°C (32°F)	10°C (50°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	40°C (104°F)
2V	BULK & ABSORPTION CHARGE VOLTAGE	2.63 V	2.55 V	2.53 V	2.50 V	2.48 V	2.41 V
	FLOAT VOLTAGE	2.38 V	2.30 V	2.28 V	2.25 V	2.23 V	2.16 V
	EQUALIZATION VOLTAGE				2.60 - 2.65 V		
12V	BULK & ABSORPTION CHARGE VOLTAGE	15.75 V	15.30 V	15.15 V	15.00 V	14.85 V	14.45 V
	FLOAT VOLTAGE	14.25 V	13.80 V	13.65 V	13.50 V	13.35 V	12.95 V
	EQUALIZATION VOLTAGE				15.6 - 15.9 V		
24V	BULK & ABSORPTION CHARGE VOLTAGE	31.50 V	30.60 V	30.30 V	30.00 V	29.70 V	28.90 V
	FLOAT VOLTAGE	28.50 V	27.60 V	27.30 V	27.00 V	26.70 V	27.50 V
	EQUALIZATION VOLTAGE				31.2 - 31.8 V		
48V	BULK & ABSORPTION CHARGE VOLTAGE	63.00 V	61.20 V	60.60 V	60.00 V	59.40 V	57.80 V
	FLOAT VOLTAGE	57.00 V	55.50 V	54.60 V	54.00 V	53.40 V	55.00 V
	EQUALIZATION VOLTAGE				62.4 - 63.6 V		

TABLE 2 (a): Flooded Charging Parameters - Regular Cycling/PSOC Recovery

Infrequent Cycling / Backup System		0°C (32°F)	10°C (50°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	40°C (104°F)
2V	BULK & ABSORPTION CHARGE VOLTAGE	2.58 V	2.50 V	2.48 V	2.45 V	2.43 V	2.40 V
	FLOAT VOLTAGE	2.38 V	2.30 V	2.28 V	2.25 V	2.23 V	2.20 V
	EQUALIZATION VOLTAGE				2.60 - 2.65 V		
12V	BULK & ABSORPTION CHARGE VOLTAGE	15.45 V	15.00 V	14.85 V	14.70 V	14.55 V	14.40 V
	FLOAT VOLTAGE	14.25 V	13.80 V	13.65 V	13.50 V	13.35 V	13.20 V
	EQUALIZATION VOLTAGE				15.6 - 15.9 V		
24V	BULK & ABSORPTION CHARGE VOLTAGE	30.90 V	30.00 V	29.70 V	29.40 V	29.10 V	28.80 V
	FLOAT VOLTAGE	28.50 V	27.60 V	27.30 V	27.00 V	26.70 V	26.40 V
	EQUALIZATION VOLTAGE				31.2 - 31.8 V		
48V	BULK & ABSORPTION CHARGE VOLTAGE	61.80 V	60.00 V	59.40 V	58.80 V	58.20 V	57.60 V
	FLOAT VOLTAGE	57.00 V	55.20 V	54.60 V	54.00 V	53.40 V	52.80 V
	EQUALIZATION VOLTAGE				62.4 - 63.6 V		

TABLE 2 (b): Flooded Charging Parameters - Infrequent Cycling/Backup System

NOTE: Use highlighted values when charge equipment is supplied with temperature compensation at 5mv/°C/Cell.

Temperature sensors should be mounted directly to side of a cell casing below the electrolyte level to determine accurate cell temperature. On dual-container models, remove the cover and mount the sensor directly to cell. See Figure 7. When using chargers that do not feature temperature compensation, voltage settings should be monitored and adjusted based on actual cell temperature.

TEMPERATURE COMPENSATION & SENSOR INSTALLATION

For additional data and safety, many systems use a temperature sensor mounted to the battery to measure cell temperature to adjust charge voltage accordingly. The probe should be installed on the side of one of the batteries or cells located in the center of the bank. If included with charge equipment, a temperature sensor must be properly mounted and connected to ensure the appropriate charge voltage. Failure to use the provided sensor may cause damage due to over/undercharge which is not covered under Rolls Battery manufacturer warranty. As a safety precaution, this sensor may trigger a programmed safety charge cut-off as the battery bank should not exceed an operating temperature of 52°C (125°F).

Temperature sensor should not be mounted to the battery terminals or top of the battery case.

Series 4000, 4500, AGM & GEL models – temperature sensor should be mounted on the side of the battery case in the middle of the bank. To ensure an accurate reading of cell temperature the sensor must be mounted below the liquid level on flooded models. (half way down the side and/or 4-5” from the top of the case is generally sufficient) For AGM & GEL models, the sensor should be mounted half way down the side of the battery case.

Series 5000 – If the battery has a modular, dual-container construction the case cover must be removed to mount the sensor directly to the side of an internal cell. To remove the cover you must first disconnect the terminal connections. Most covers snap-on or may have small plastic pins along the edge which may be easily removed with a screwdriver. Run the connecting cable between the case and cover, being careful not to pinch or damage the wire. You will notice a black silicone has been applied around each terminal. This may be removed and replaced with a standard automotive silicone after reinstalling the cover.

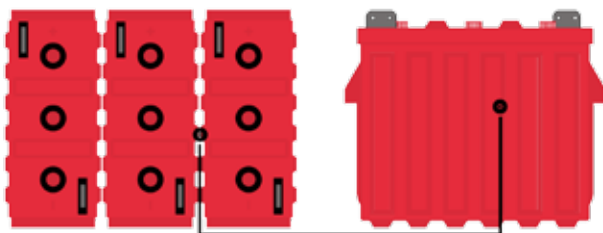


FIGURE 7:
Temperature
Sensor

5000 Series - Remove case cover. Mount sensor to the side of internal cell below liquid level. Replace cover and re-seal around terminals with silicone.

SPECIFIC GRAVITY

The specific gravity of electrolyte in a battery is the most accurate measurement 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" below the vent tube on each cell as shown in Figure 8. Carefully add distilled water to adjust the level as needed.

***Check specific gravity regularly to confirm charging parameters are properly programmed, avoiding possible over/undercharge, resulting in possible cell damage or battery failure.**

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

TABLE 3:
Specific Gravity
vs State of Charge

NOTE: Specific Gravity is dependent on the electrolyte temperature. These values are for a temperature of 25°C (77°F). To adjust, add/subtract 0.003 for every 5°C (10°F) increase/decrease.

ACTIVATION AND INITIAL CHARGE OF DRY-SHIPPED FLOODED LEAD ACID BATTERIES

Special order batteries may be shipped dry (acid shipped separately). To activate these batteries, start by removing the vent caps. Using approved battery grade electrolyte (1.265), slowly fill each cell until the liquid level reached halfway between the plates and the bottom of the vent well tube. (See Figure 8.) 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 overflow and require cleanup. 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%-10% of the 20 hour rate). The rate may be increased if the battery does not begin to bubble and gas. Do not let the cell temperature exceed 52°C (125°F). 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 25°C (77°F). We recommend allowing the charge to continue for an additional 60 minutes to insure no further rise in specific gravity. A longer lower charge rate is better than a higher heavier charge.

Following activation, top up cells with distilled water only as necessary. Replace vent caps and remove any spillage. If necessary, clean up spills as outlined below. Do not add additional electrolyte after activation.

***Do not place on charge until electrolyte temperature is below 35°C (95°F).**

BATTERY MAINTENANCE & STORAGE

Batteries should be kept clean at all times. If installed or stored in a dirty location, 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 litre), gently wipe the battery and terminals with a damp sponge, then rinse with water.

A common cause of failure with flooded battery banks is poor maintenance. Systems are often installed and then left to owners who are unaware of these requirements or simply choose not to follow proper maintenance procedures. To maintain cycle life and protect your investment, specific gravity of flooded batteries should be checked regularly and cells topped up with distilled water as needed. Often customers will neglect this for long periods of time and, when doing so, over-water the cells resulting in loss of electrolyte, overflow during charging and/or corrosion issues. Failing to top up cells may result in plate exposure, overheating, and possible explosion.

ELECTROLYTE - ADDING DISTILLED WATER

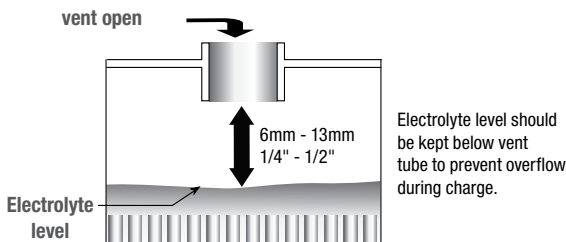


FIGURE 8:
Electrolyte level



CAUTION: Do not add water or electrolyte to cells before initial charging unless plates are exposed. If so, add distilled water until plates are submerged. Please contact Rolls Technical Support if you have any questions or concerns.

NOTE: If the battery cells require watering more than once every two (2) months the programmed charging voltages may be too high. Adjust and monitor accordingly. If a particular cell requires significantly more water than others this may be a sign of charge imbalance in the battery bank caused by resistance and/or cell failure.

TERMINALS

Inspection of battery terminal connections is also important. Loose connections may result in ignition of hydrogen gases or cause a short, melting the terminals. It is important to inspect, disconnect, clean and properly torque these connections on a regular basis.

MAINTENANCE SCHEDULE

For the first 6-12 months of a systems life you should check the following things:

MONTHLY

- Measure and record resting/loaded voltage.
- Check and record electrolyte levels.
- Test and record specific gravity measurements.
- Record ambient temperature where the batteries are installed.
- Inspect cell integrity for corrosion at terminal, connection, racks or cabinets.
- Check battery monitoring equipment to verify operation.
- Add distilled water as necessary.

QUARTERLY

- Test Ventilation.
- Check for high resistive connections.
- Check cabling for broken or frayed cables.
- Verify Charge Output, Bulk/Absorption voltage of Inverter/Charge Controller.
- Check cells for cracks or indication of a possible leak.
- Check Ground connections.

Deep cycle batteries will increase in capacity during the initial break-in period of 60-90 cycles. Adjustments to charging parameters may be necessary during this time. Battery performance, charging and maintenance requirements will depend on the specific usage. Following these recommendations will ensure the batteries reach their rated capacity and keep them in good working order. Following the break-in period a regular maintenance routine will be established after 9-12 months of service.

Typically, 4000 & 4500 Series models will require maintenance every 30-60 days. Series 5000 batteries generally require maintenance every 60-90 days as these models are designed with a higher electrolyte reserve allowing longer periods between watering.

STORAGE

NOTE: It is normal to expect 1% self discharge per day when not in use, under normal temperature conditions. Stored batteries should be recharged every 3 months until battery is put in service to avoid sulfation and possible freezing in cold temperatures.

WINTER STORAGE

Prior to placing batteries into winter storage make certain the electrolyte level is approximately 13 mm (1/2") above the top of the separators. The electrolyte level in a very cold battery will be lower than normal, so let batteries warm to a normal ambient temperature before judging electrolyte levels. If the batteries become discharged, the electrolyte may freeze when stored below -7°C (20°F).

Specific Gravity	Freezing Temperature
1.280	-69°C (-92°F)
1.265	-57.4°C (-72.3°F)
1.250	-52.2°C (-62°F)
1.200	-26.7°C (-16°F)
1.150	-15°C (5°F)
1.100	-7°C (19°F)

EQUALIZATION

Individual cell readings 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 build-up of sulfation on the plates; two circumstances that shorten battery life. Corrective equalization of the battery bank is recommended every 60 to 180 days, depending on the usage of the individual system. To equalize the battery bank, charge the batteries until the voltage elevates to the "Equalization" voltage as shown in **Table 2 (a) & 2 (b) Flooded Charging Parameters** and maintain for several hours. Equalization time will vary, depending on the level of sulfation and balance of charge. When specific gravity remains constant for 45-60 minutes this generally indicates completion. Monitor electrolyte levels and add distilled water as necessary. If the cells require watering, it is recommended this be done during the equalization process to allow sufficient mixing with the existing electrolyte.

One of the most commonly asked questions is "When is it time to equalize my battery bank?" The answer will depend on several factors, including depth of discharge, cycle frequency, operating temperature, charging voltage and current. Regular monitoring of specific gravity and voltage should indicate when this is necessary. An equalization should be completed when the specific gravity of individual cells within the battery bank are varied by more than .025 -.030 (Ex. 1.265, 1.265, 1.235...). If specific gravity readings are balanced, but consistently lower than recommended, it may be necessary to adjust Bulk/Absorption voltages and/or Absorption time to increase charge time.

FREQUENCY

Most multi-phase charge controllers offer pre-programmed equalization schedules known as preventative equalizations. These are typically set for a shorter 1-2 hour period every 30, 60 or 90 days and are beneficial in balancing and removing small amounts of accumulated sulfation on an ongoing basis. It should be noted that running frequent equalizations on batteries which do not require balancing or de-sulfation will burn and deteriorate the cells prematurely, essentially shortening the life of the battery. For this reason, we recommend monitoring specific gravity and voltage on a regular basis to ensure scheduling equalization times are appropriately set. A corrective equalization may need 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 heavy, accumulated sulfation. 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 will lower capacity gradually, which may take months to reach a point where the drop in capacity is noticeable.

NOTE: Properly charging a battery bank with sufficient voltage and current on each cycle is essential to long cycle life. Periodic equalizations may be required to balance and de-sulfate, but should not be relied on to compensate for insufficient charging sources. Periodic equalizations may not recover a loss of capacity from a build-up of sulfation over time. Repeated equalizations may be required in situations where the battery bank has been consistently undercharged. Recovered capacity, generally partial, may take 1-3 months with battery banks low specific gravity measurements

EQUALIZATION-CORRECTIVE

Equalization time will vary depending on the degree of sulfation and output of the available charging source.

1. Recombination caps (Hydrocaps) should be removed during the equalization process to allow increased hydrogen gas to escape. Flip-top caps (Rolls R-caps) may be left on and open.
2. Equalization voltage should be set to the recommended parameter based on system voltage. **See Table 2 (a) & 2 (b) Flooded Charging Parameters.**
3. Charge at a low DC current (5-10% of C20 battery capacity). If grid power is not available, use solar panels or a DC source with sufficient current when possible. At high voltages, charging with a generator may be difficult and hard on the inverter.

4. Measure and record the specific gravity of each cell in the battery bank and temperature of a test cell. If the temperature rises above 46°C (115°F) and approaches 52°C (125°F), terminate the equalization cycle. You may need to give the batteries a chance to cool off and attempt the cycle again. Check individual cell temperatures using an IR temp sensor to isolate possible damaged cells.
5. If cells are severely sulfated, it may take several 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 (115°F). If the charge controller has been bypassed, it should now be used or put back in line.
7. Continue to measure specific gravity until 1.265 is reached.
8. Charge the battery bank for another 2 to 3 hours, adding distilled water as required to maintain the electrolyte above the plates.
9. Allow bank to cool - 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.

PULSE CHARGING

Pulse charging has shown that the banks do not get as sulfated as one with the traditional 3-Stage charging, but will not eliminate the need for controlled, preventive equalization. The benefit of pulse charging is that the bank will suffer 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.

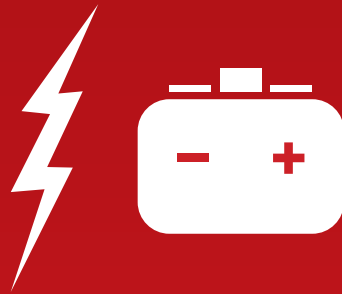
DISPOSAL PROCEDURE

Batteries must NEVER be disposed of 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% recyclable. Rolls Batteries have >66% recycled lead.

SPECIFIC GRAVITY & VOLTAGE READINGS

BATTERY CELL READINGS				DATE:	
CELL #	SPECIFIC	VOLTAGE	CELL #	SPECIFIC	VOLTAGE
1			25		
2			26		
3			27		
4			28		
5			29		
6			30		
7			31		
8			32		
9			33		
10			34		
11			35		
12			36		
13			37		
14			38		
15			39		
16			40		
17			41		
18			42		
19			43		
20			44		
21			45		
22			46		
23			47		
24			48		
INSPECTION					
CHECKLIST	CHECK <input type="checkbox"/>	CHECKLIST: (CONT'D)	CHECK <input type="checkbox"/>		
BATTERIES CLEAN & DRY	<input type="checkbox"/>	TERMINALS CONNECTIONS	<input type="checkbox"/>		
VENT CAPS TIGHT	<input type="checkbox"/>	HYDROCAPS	<input type="checkbox"/>		
ELECTROLYTE LEVELS CHECK & TOP	<input type="checkbox"/>	SPECIFIC GRAVITY	<input type="checkbox"/>		
TERMINALS CLEAN	<input type="checkbox"/>	VOLTAGE	<input type="checkbox"/>		



**AGM & GEL
VRLA
BATTERIES**

Rolls

ROLLS AGM BATTERY CHARGING INSTRUCTIONS

To maximize the life of your Rolls AGM battery, it is important that it is properly charged. Over and under-charging a Rolls AGM battery will result in shortened cycle life. The best protection from improper charging is the use of a quality charger and routinely checking that the charger current and voltage settings are maintained. Please review the following Rolls Battery Charging Instructions.

AGM CHARGER INSPECTION

The charger cabling should be insulated and free of breaks or cuts. The cable connectors should be clean and properly mated with the battery terminals to ensure a snug connection. The charger's AC cord should be free of breaks or cuts and the wall plug should be clean.

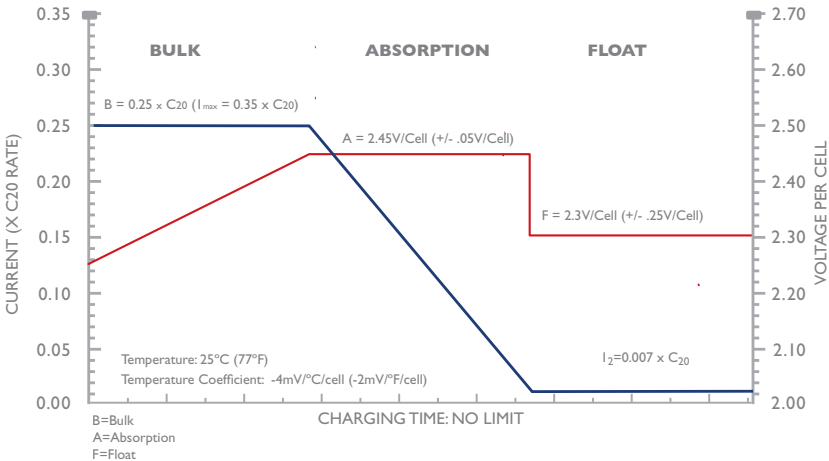
AGM CHARGING GUIDELINES

Fully charge batteries after each use. Charge in a ventilated area as gasses may be released through the pressure relief valve if the batteries are excessively over-charged. Never charge a frozen battery. Ideal charging temperatures: 0°C - 40°C (32°F - 104°F).

AGM CHARGING CHARACTERISTICS

If the charger has a specific setting for AGM type batteries, Rolls recommends using this charge setting. To maximize your battery life, a voltage regulated charger with temperature compensation is strongly recommended. See Figure 1 for the recommended voltage regulated charge profile. If using battery temperature compensation it should be .04mv / Degree C / Cell. Charger voltages should be set to 2.45vpc to allow the proper voltage adjustment by the charger.

VOLTAGE REGULATED CHARGER - UU



AGM BULK STAGE

The charger should deliver the initial current B until the voltage limit A is reached. Absorption Stage - the charger should maintain the voltage A until the current tapers to B. The initial charge current is recommended to be set at $B = 0.25 \times C20$ ($I_{max} = 0.35 \times C20$) in order to fully charge the batteries within a reasonable amount of time. It can be set lower, however; please be aware that charge time will increase so make sure the batteries have enough time to fully charge before being put back into service. Rolls batteries have a low internal resistance allowing them to be charged at a higher current, therefore, faster than conventional flooded/wet batteries.

AGM FLOAT STAGE AND TERMINATION

The charger can maintain the current B indefinitely or until the charger is shut off or unplugged. This stage is ideal to maintain battery state of charge. Make sure the temperature compensation is programmed as specified in Figure 1 ($-4mV/^{\circ}C/cell$ or $-2mV/^{\circ}F/cell$) or manually adjust the voltage setting for temperatures varying from $25^{\circ}C$ ($77^{\circ}F$). As the temperature decreases, the voltage should be increased and as the temperature increases the voltage should be decreased. The profile in Figure 1 can be used with or without the float stage. Without the float stage, recharge can be terminated based on time (this will need to be determined as it will vary with depth of discharge and charge current) or percentage recharge (105%-110%).

AGM CHARGE VOLTAGE QUICK REFERENCE

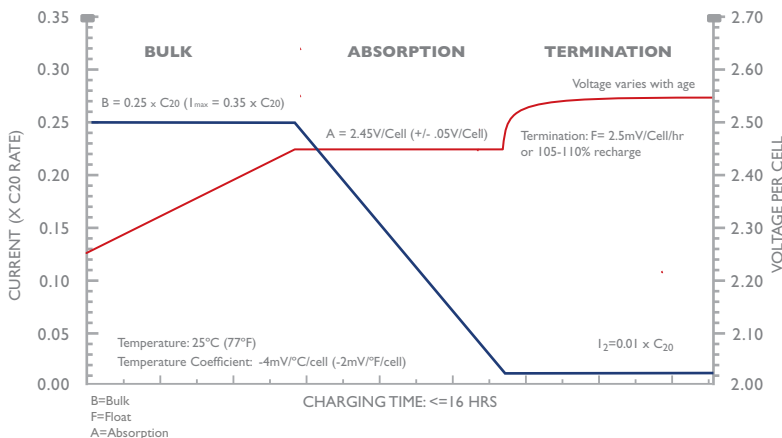
ROLLS BATTERY - AGM		0°C (32°F)	10°C (50°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	40°C (104°F)
2V	CHARGE VOLTAGE	2.55 V	2.51 V	2.48 V	2.45 V	2.42 V	2.39 V
	FLOAT VOLTAGE	2.40 V	2.36 V	2.32 V	2.30 V	2.28 V	2.24 V
12V	CHARGE VOLTAGE	15.30 V	15.06 V	14.84 V	14.70 V	14.55 V	14.34 V
	FLOAT VOLTAGE	14.40 V	14.16 V	13.94 V	13.80 V	13.65 V	13.44 V
24V	CHARGE VOLTAGE	30.60 V	30.12 V	29.69 V	29.40 V	29.11 V	28.68 V
	FLOAT VOLTAGE	28.80 V	28.32 V	27.89 V	27.60 V	27.31 V	26.88 V
48V	CHARGE VOLTAGE	61.20 V	60.24 V	59.38 V	58.80 V	58.22 V	57.36 V
	FLOAT VOLTAGE	57.60 V	56.64 V	55.78 V	55.20 V	54.62 V	53.76 V

NOTE: With the use of temperature compensation, be sure to set the charge voltage at 2.45 volts per cell (VPC). Setting a higher or lower voltage on your charger may cause incorrect adjustments in charge voltage.

If a temperature compensation sensor is not used, then you must manually adjust charging voltages based on the battery temperature when in use, not just ambient temperatures.

AGM CONSTANT CURRENT CHARGER - IUI

A constant current charger may also be used. However, it is important to adhere to the termination criteria mentioned below to minimize the chance of excessive over-charge. See Figure 2 for the recommended constant current charge profile.



AGM BULK STAGE

The charger should deliver the initial current B until the voltage limit A is reached. Absorption Stage - the charger should maintain the voltage A until the current tapers to B.

AGM TERMINATION

If the charger can be programmed, the charge should terminate when the voltage stops increasing over time. This is called a float termination. The charge should terminate when the float is equal to 2.5mV/cell/hour. The charge time in the final phase should not exceed 8 hours and the total charge time should not exceed 20 hours. The percentage recharge should be between 105%-110%.

AGM REFRESH CHARGE

If Rolls AGM batteries are properly charged they should never require an equalizing charge. If they were not properly charged and there is a decrease in capacity, recharge the batteries and make sure they complete the entire charge cycle. If the batteries are stored for extended periods of time, recharge them as follows:

Storage Temperature	Refresh Charge Interval
Below 20°C (68°F)	9 Months
20°C (68°F) - 30°C (86°F)	6 Months
Higher than 30°C (86°F)	3 Months

GEL BATTERY INSTALLATION & CHARGING

Designed and well-suited for regular cycling as well as float and backup applications, Rolls sealed OPzV GEL batteries have a low internal resistance allowing quick recharge and a low self-discharge rate (less than 2% per month). OPzV GEL batteries perform well in high cyclic use even under extreme operating conditions and offer more than 20 year cycle life in float applications at 25°C / 77°F.

INSTALLATION

Rolls GEL batteries may be mounted upright or horizontally on the side (longest) of the battery case. Use caution not to cover valves located on the top of the batteries when using strapping to secure as damage may occur. Rolls GEL batteries may not be mounted upside down or horizontally on the end (shortest side) of the case.

Racking systems are available. Contact your Rolls Battery Distributor or Dealer for options and availability.

GEL BATTERY CHARGING

Rolls GEL sealed VRLA batteries have very similar installation and maintenance requirements as Rolls sealed AGM product lines, with the exception of unique charge and float voltages. Although they are a sealed battery, ventilation is still required to avoid risk of off-gassing and explosion and general battery cleaning and maintenance should be followed.

GEL CHARGE VOLTAGE QUICK REFERENCE

GEL BATTERIES		0°C (32°F)	10°C (50°F)	20°C (68°F)	25°C (77°F)	30°C (86°F)	40°C (104°F)
2V	CHARGE VOLTAGE	2.48 V	2.44 V	2.40 V	2.38 V	2.35 V	2.32 V
	FLOAT VOLTAGE	2.38 V	2.34 V	2.30 V	2.28 V	2.26 V	2.22 V
12V	CHARGE VOLTAGE	14.88 V	14.64 V	14.44 V	14.28 V	14.12 V	13.92 V
	FLOAT VOLTAGE	14.28 V	14.04 V	13.80 V	13.68 V	13.56 V	13.32 V
24V	CHARGE VOLTAGE	29.76 V	29.28 V	28.88 V	28.56 V	28.24 V	27.84 V
	FLOAT VOLTAGE	28.56 V	28.08 V	27.60 V	27.36 V	27.12 V	26.64 V
48V	CHARGE VOLTAGE	59.52 V	58.56 V	57.76 V	57.12 V	56.48 V	55.68 V
	FLOAT VOLTAGE	57.12 V	56.16 V	55.20 V	54.72 V	54.24 V	53.28 V



**RENEWABLE
ENERGY
APPLICATIONS**

Rolls

RENEWABLE ENERGY APPLICATIONS

Most deep cycle batteries used in the Renewable Energy Industry were originally designed and manufactured for use in Industrial applications where consistent charge cycles are carried out from six to twelve hours until the batteries reach a full state of charge. In Renewable Energy (RE) applications, a lengthy charge time is not typical and in most instances a maximum of 4-6 hours of peak charge is achieved each day due to limited daylight and varying weather conditions. To ensure the batteries received sufficient charge, charging systems must be adequately sized or additional charge sources added to prevent deficit charging and premature battery failure.

There are two definitive types of battery-based systems used in Renewable Energy applications; Off-Grid and Grid-Connected. Off-Grid systems are often used where a customer chooses not to connect or there is no available connection to a public utility. This customer may live remotely and have chosen to install a renewable energy system from a single or combination of renewable sources to generate and store adequate power to run all electrical requirements within the home.

With Grid-Connected systems, a customer typically lives in an area where they may experience frequent or extended service interruptions from their public utility. This may be a result of poor weather conditions, an unreliable power grid or natural disasters. The renewable energy system is used as a backup power supply, meant to supplement power during brief outages and/ or to reduce energy costs by selling excess power generated from the system back to the utility.

OFF-GRID SYSTEMS

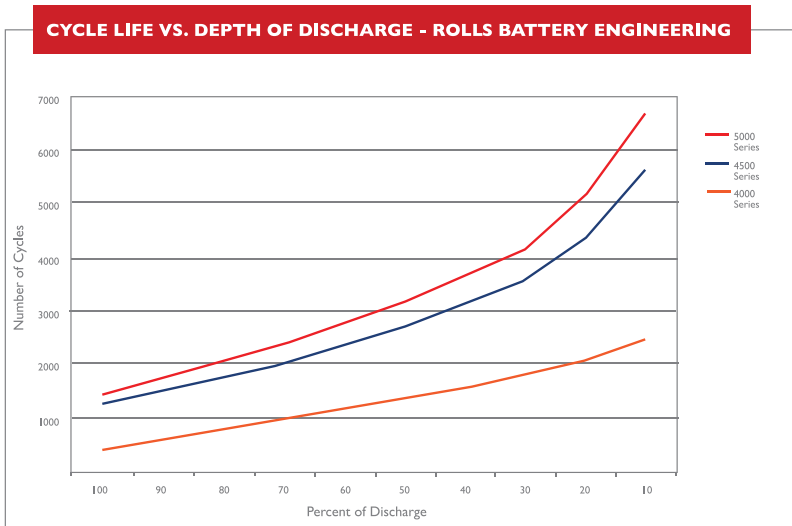
When sizing a battery bank it is important to determine the appropriate capacity requirement to meet the load which will be supported and not oversize for the application. A battery bank which is too large for the charging source often leads to sulfation issues due to lack of proper charging as well as frequent supplemental charging from another source. (ex. generator)

DEPTH OF DISCHARGE

Depth of Discharge (DOD), is used to describe how deeply the battery has been discharged. A battery which is 100% fully charged would have a DOD of 0%. A battery which has been discharged by 20% of its capacity, maintaining 80% of its capacity, would have a DOD of 20%. If a battery has been completely discharged with no remaining capacity, the DOD is 100%.

CYCLE LIFE

Battery manufacturers rate the cycle life of their batteries by comparing the level of discharge on the battery and the frequency of cycling. Higher battery discharge will result in shorter cycle life. In reverse, a smaller discharge percentage will extend the expected cycle life of the battery as the battery will provide more charge/discharges. To provide an example of cycle life, a 48V string of 8 x 6 volt S-550 models in series (428 AH capacity @ C20) which are consistently discharged to 50% state of charge (214 AH of capacity drawn) and consistently recharged to a full state of charge should provide approximately 1280 cycles before end of life.



With traditional off-grid Renewable Energy systems, DOD is set to operate between 20% and 50% to maximize the life of the batteries. Battery-based systems are designed to allow a maximum 50% DOD as this offers a balance between capacity vs. cycle life, also taking into consideration the cost of replacement.

For grid-connected backup systems, Installers will typically design battery banks to operate to a greater DOD percentage to lower initial installation costs. Cycling with grid-connected systems is significantly less frequent than with off-grid, where this may occur daily, a lower DOD is acceptable as long as the customer understands that the overall cycle life is affected when they cycle their battery bank beyond a 50% state of charge.

BATTERY SELECTION

Choosing the appropriate battery for the application is key to long battery life and performance. Once the load is determined a battery bank should be selected to meet the system design. If a battery bank of a specific capacity is needed, it is important to select a battery model which offers sufficient capacity, but also minimizes the number of parallel strings required to accomplish the desired voltage and capacity.

Systems with multiple parallel strings of batteries will often experience an imbalance of charge. These systems will also require additional maintenance as this increases the number of terminal connections requiring cleaning as well as the number of cells to water. When charge imbalance is not addressed through adjustments in charge time and periodic equalizations this will eventually lead to premature failure of the battery bank.

Determining the capacity requirement for off-grid systems is done by completing an audit of energy consumption based on actual load requirements. The load is calculated by the total amount of power necessary to support the load for a 1 day period and then factors in how many days it may be required before recharging. In a typical Renewable Energy system the 20 hr AH rate (C20) is used when sizing systems to cover three days of autonomy or less. The 100 hr AH rate (C100) is used when designing systems to cover more than 3 days of autonomy.

Most systems are designed for a 1-2 day rate, due to the cost of batteries verses the cost of adding a generator and/or additional renewable energy sources. This is also most typical for solar applications as these systems allow the battery bank to be charged each day.

Deep cycle batteries will perform best when they are maintained at a full charge. By holding at a full state of charge this will extend the overall life of the battery bank. For float applications, such as backup systems, it is also important to use the battery bank on occasion as this will prevent stratification and sulfation.

It is important to be aware that as load profiles change this too will affect how quickly battery capacity will be reduced. Often a backup system is sized to meet the load requirement at the time of install, but this demand will increase with every small addition to the load.

DISCHARGE RATES

Discharge and recharge rates should be considered when selecting and sizing a battery bank. Battery manufacturers publish multiple discharge rates for each battery model, which range from 100 hrs to 1 hr. These are often referenced for various type of applications. The most common in Renewable Energy applications is the 20 hr rate as this closely matches a 1 day period. The rating, (ex C20) refers to a controlled load (Amps) which can be placed on the battery for a period of time before the battery voltage reaches 1.75 VPC (volts per cell). A high amp draw may be run for a shorter period of time and vice versa.

As an example, a 400 AH battery can support a controlled 20 Amp draw for 20 hours (C20). Alternatively, the same battery can support a controlled 34 Amp draw over a 10 hour period (C10), meaning it supplies 340 AH capacity for that period of time.

Batteries which are discharged should be recharged as promptly as possible. A Renewable Energy PV system should be designed to provide a charge current that is capable of recharging the batteries quickly, efficiently and within the window of time when the system is generating peak power (peak sun). The charge current should be within 10-20% of the 20 Hr AH rate (C20) rate of the battery bank, or the C4, C5, or C6 rate of the battery. Using the Absorption charge time calculation (charge current of 10% of the C20 rate of the battery bank will take approximately 4.2 hours, plus the untimed bulk phase (usually about 1-2 hours) to bring the bank from 50%-100% state of charge. This is an ideal scenario as a lower charge current will often result in deficit charging as this increases the required Absorption charge time and/or the use of supplemental charging such as a generator. Often customers who need to supplement charge with a generator do not run it long enough to allow the batteries to reach a full state of charge on a regular basis. This often causes sulfation problems and capacity loss which then needs to be addressed through corrective equalizations.

Finally the last issue with some systems, after installing/commissioning end users will inadvertently add more loads after the installation causing problems with how often the battery bank needs to be recharged, thus increasing cycle life usage. This needs to be avoided, and can be by properly educating the customer at the time of sale.

GRID-CONNECTED BACKUP

There are two distinct uses for a grid-connected battery bank. The first, and the most common is a power backup system. The purpose is to provide temporary power in the instance of grid loss. This is similar to a UPS system, but is typically on a much larger scale with higher storage capacity.

The second is a grid-tied system with battery backup. The purpose of this system setup is to generate and sell excess power produced by a renewable source to your utility provider when you are connected to the grid. In the event of a grid failure, the battery bank then provides storage power for the critical loads during the outage. Systems are configured according to how much power is to be sold to the utility vs. how much will be stored. If a higher percentage of the power generated is pushed to the utility, this will decrease the remaining amount available for backup and vice versa. This may be determined by personal preference or may be limited or regulated by the utility.

For grid-tied battery backup systems, the battery bank should only be sized to handle the loads supported for the duration of a temporary outage. These systems are commonly used to run household necessities such as limited lighting, refrigeration, etc. It is important to limit the size of the supported load to essential service only as higher capacity battery banks require more maintenance as well as power usage to hold at full charge, reducing the amount of generated power which can be sold to the utility.

Typically, because outages are infrequent and occur only a few times per year in most regions, these systems are designed for greater depth of discharge than off-grid. In some cases they may be designed to discharge as much as 20% state of charge over a relatively short period of time.

In areas where the grid may not be reliable and extended or intermittent outages occur frequently, it would be necessary to size the battery bank and charging source(s) to support a larger load over a longer period of time. This would prevent the battery bank from over-discharging and/or insufficient charging between cycles.



**WARRANTY
GLOSSARY
& FAQ'S**

Rolls

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. However, should a problem arise, you may be assured that you're covered better than any other battery warranty in the business.

Surette Battery Company warrants that Rolls-branded batteries sold by it are quality tested, 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:

For warranty terms, conditions and model-specific details, please refer to the warranty document found on the website :

www.rollsbattery.com/technical-resources

A copy of the Battery Test Sheet & Warranty Claim Form is also available for download.

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.

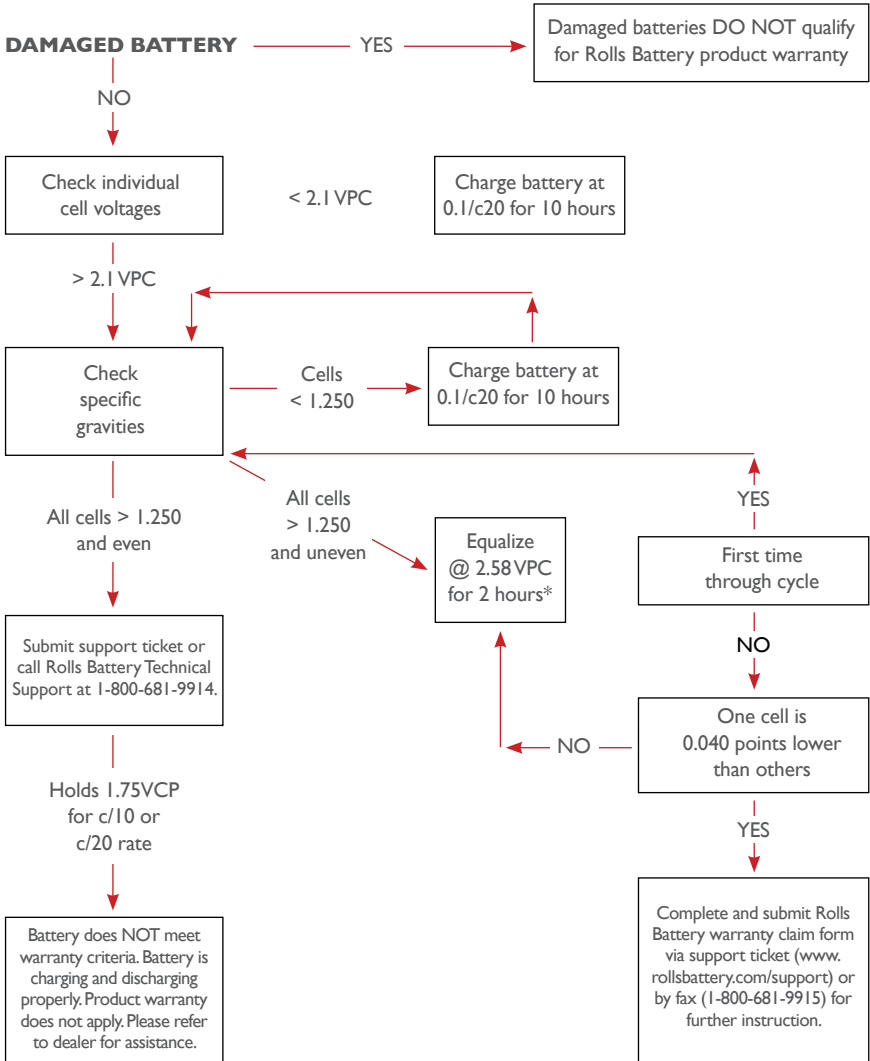
This warranty covers only manufacturing defects.

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 PROCEDURE

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

For warranty requests and inquiries, please submit your request via support ticket (www.rollsbattery.com/support) or by email to support@rollsbattery.com



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. They 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 2, 4, 6, 8 or 12 volt configurations.

TROUBLESHOOTING & FREQUENTLY ASKED QUESTIONS

The following is a list of common scenarios, questions and concerns regarding system setup, battery charging and maintenance procedures. Please refer to these as general guidelines. For further assistance with your specific system setup, please contact your Installer.

NOTE: that specific gravity readings should be taken at full charge, after the batteries have been allowed to cool and are resting in a Float voltage charge for 1-2 hours.

- Specific gravity readings of all cells in the battery bank indicate low state of charge. Readings vary by cell, but not greater than .020 between the cells.
 - Charging voltages may be too low and/or Absorption time may need to be increased. Usage (load) may have increased, resulting in increased depth of discharge (DOD) and sulfation.
 1. Increase Bulk/Absorption/Boost Voltage in .2v to .4v volts increments.
 2. Increase Absorption Time by 15 to 30 minutes increments as necessary.
 3. Decrease DC load usage.

- Specific gravity readings are consistently higher than recommended. (Ex 1.300, 1.300, 1.300...)
 - Charging voltages may be too high and/or Absorption time should be decreased to prevent overcharge. Usage (load) may have decreased, reducing depth of discharge (DOD) and the time required to recharge, causing the batteries to overcharge.
 1. Decrease Bulk/Absorption/Boost Voltage in .2v to .4v volts increments.
 2. Decrease Absorption Time by 15 to 30 minutes increments as necessary.

- Specific gravity readings on individual cell(s) in a battery bank with multiple series strings vary more than .020 (Ex 1.265, (1.265, 1.240, 1.265...))
 - Indicates there may be an imbalance of charge between parallel strings of batteries.
 1. Disconnect parallel strings and charge each string individually to balance charging. For systems with more than two parallel strings of batteries you may find this is necessary 1-2 times a year to maintain balanced charging.
 2. Increase Bulk/Absorption/Boost Voltage by .2v increments.

- Indicates there may be connection issues within each series connection or parallel strings.

1. Clean and inspect all cabling and connections. Physically disconnect cable, inspect for terminal concaving (Over torqued), grease and re-torque connections.

***Specific gravity readings vary more than .030 in multiple strings of batteries indicates an imbalance of charge. If specific gravity readings continue to vary after charging each string individually a corrective equalization charge may be necessary.**

- Capacity of the battery bank has decreased.
 - Capacity loss may be due to sulfation. A balance charge and/or equalization may be necessary.
 - Capacity loss may be due to overheating. Verify that temperature sensors are properly mounted and verify cell temperatures.
 - Capacity loss may be due to over-discharging the battery bank. Capacity of the battery bank may no longer support an increase in load.
- Battery cases are bulging on the sides.
 - If case bulging is a concern upon receipt of new product, please notify your Distributor and/or forward clear photos via a Technical Support Ticket or email to support @rollsbattery.com for review.
 - Due to the weight of electrolyte, some case bulging is normal. New battery cases will “relax” after filling. Verify that electrolyte levels have not dropped below the top of the plates before attempting to charge and top up with distilled water as necessary.
 - In the case of excessive bulging- your batteries may have been exposed to temperatures of over 51°C (125°F). This high temperature has caused the plates/chassis to swell and expand. There is no fix for this and eventually the batteries will fail prematurely.
 - Your batteries may have frozen due to excessive cold temperatures. A fully charged battery (specific gravity of 1.265) may freeze at -70°C (-94°F) or more. A battery that is at 50% state of charge (specific gravity of 1.200) may freeze at -7°C (20°F).

- When a charge is initiated the voltage of the battery bank rises very quickly and the charger goes quickly into the Absorption charge cycle or shuts off charge to the batteries completely.
 1. This is often an indication of sulfated batteries which may be causing a lower than normal impedance in reference to the charger. Capacity of the bank will be reduced and may be confirmed by running a load test.
 2. An increase in Absorption time may be necessary to de-sulfate the battery bank.
 3. If the battery bank is heavily sulfated, a corrective equalization may be necessary. Perform a corrective equalization if specific gravity readings vary by more than .030 between cells.

- Charging current to the battery bank (Amp output) is low.
 - Charging current will decrease as the batteries become fully charged. If charge current is low they may have reached the end of the charge cycle. Verify that the charger is nearing the end of Absorption time or in Float voltage phase. Low current is normal this stage of charging.
 - The battery bank self-regulates charge current. Voltage settings may be forced (too high/low), however amp output to the battery bank cannot be forced and will drop as the batteries reach a full state of charge. When the charge current reaches 2-3% of the capacity of a healthy battery bank the charge is essentially complete. (ex. 500 AH battery bank. Charge current is reduced to 10-15 Amps)

- Check your Specific Gravity
 1. If specific gravity readings are at 1.250 or greater, the batteries are in the Absorption charge phase.
 2. If the specific gravity is lower than 1.250 following a charge, perform a load test to ensure all cells are operating correctly.

- Specific Gravities readings at full charge vary significantly, (greater than .030)
 - This may be caused by multiple parallel strings of batteries in a bank, which often result in charge imbalance. It is not recommended that a system exceed 3 strings of batteries connected in parallel.
 - Charge voltage settings may be too low. Verify they meet Rolls recommended charging parameters for Flooded or AGM models.
 - An increase in Absorption charge time may be necessary. Increase in 15 to 30 minute increments.
 - Indicates there may be failing or dead cell(s) in the battery bank causing a charge imbalance.

- While charging, the battery bank does not reach Bulk voltage setting.
 - If the system is not reaching bulk voltage the charge voltage and/or Amp output to the battery bank may be too low. Verify that these meet Rolls recommended charging parameters for Flooded or AGM models and that charge output (Amps) is sufficient to meet the capacity of the battery bank. To ensure sufficient charge, output should be approximately 10% of the Amp Hour capacity of the battery bank. (Ex1200AH Battery Bank = 120 A charge output)
 - Indicates that DC loads running on the system during the charge cycle may be reducing the charge output to the battery bank, slowing down the charging process.

- When performing a corrective equalization, the battery bank does not reach equalization voltage.
 - Before doing an EQ you should do a full Absorb Charge prior to initiating an EQ charge.
 - Indicates the charge output may be too low. Verify the voltage and charge output meet Rolls recommended charging parameters.
 - Indicates the possibility of a failed or dead cell which may be causing resistance. Verify specific gravity of each cell and voltage reading for each battery in the bank.

- Battery(s) temperatures are very high.
 - If at or near 51°C (125°F) shut off charge and allow batteries to cool.
 - If a single battery or cell in a string is hot, this may indicate a cell failure or short. Verify specific gravity for all cells and take voltage readings from each battery and perform a load test to identify any cell failures and verify proper cell operation.

- Battery Terminal has melted
 - This is most common with loose connections, causing a highly resistant connection. This resistance has caused heat buildup and melted the terminal connection.
 - This can be caused by:
 - Loose connections
 - Over-tightened connections
 - Improper sized cables (too small).
 - Corroded connections
 - Improper use of washers/lock washers.
 - Too many connections on the same terminal

- Battery cover has cracked, shattered and/or dislodged from the case (Not affecting positive and negative terminals or connections)
 - Ignition of hydrogen gas may have caused the battery cover to crack or explode.
 - This sometimes occurs during a charge where a loose connection at the terminal sparked, igniting hydrogen gas from the cell.
 - This may be the result of low electrolyte levels causing high cell temperature and increased hydrogen gas. Check each cell and top up with distilled water as necessary.
 - Battery case has split or cracked originating from the sides.
 - The battery may have frozen in the past, which has weakened the case structure.

- Battery and/or cell(s) do not require watering.
 - The battery may have a cell that has failed and no longer accepts a charge.
 1. Verify specific gravity of all cells and voltage reading of each battery.
 2. Perform a load test to identify any cell failures and verify proper cell operation.

CONTACTS

Surrette Battery Company Ltd.
PO Box 2020, 1 Station Road
Springhill, Nova Scotia, Canada
B0M 1X0

PHONE:

1 902 597 3767 (local)
1 800 681 9914 (toll free)

FAX:

1 902 597 8447 (local)
1 800 681 9915 (toll free)

CUSTOMER SERVICE:

1 902 597 4005
customerservice@rollsbattery.com

SALES:

1 902 597 3767 (local)
1 800 681 9914 (toll free)
sales@rollsbattery.com

TECHNICAL SERVICE

1 902 597 3767 (phone)
1 800 681 9914 (toll free)
support@rollsbattery.com

TECHNICAL SUPPORT TICKET

support.rollsbattery.com