The Power Behind Performance

CROWN® BATTERY SINCE 1926

# Safety.First.

## Battery Handling, Maintenance & Test Procedures

## Safety is Your Responsibility

Crown Flooded Lead Acid (FLA) Deep Cycle batteries are low-maintenance, safe, and high-performance energy storage products. The chemistry and plate design of Crown Deep Cycle batteries are totally different than that of automotive starter batteries. Rugged, SolidCast™ deep cycle plates are specifically designed to increase the adhesion of high-density C-Force™ active mass to provide the best available running performance, charge acceptance, and usable life.

Crown Deep Cycle batteries do require periodic maintenance and effective charging service to ensure dependable service life. Be sure to follow these safety precautions when working with batteries:

- Wear appropriate protective gear including safety glasses, protective footwear and gloves to prevent electrical shocks and ensure fall protection. Battery electrolyte can cause blindness or severe burns. If exposed to electrolyte, immediately flush affected area with water and seek medical attention.
- Remove watches and jewelry and avoid causing sparks with tools. When possible, use tools with insulated or non-conductive handles when securing batteries or cabling in the application.
- All lead acid batteries generate highly flammable hydrogen gas. Keep sparks, flames, and cigarettes away from batteries at all times.
- Maintain good ventilation when working on or charging batteries.
- After cell inspections and watering service, always verify that vent caps are secured tightly to batteries.

Crown Deep Cycle batteries feature advanced engineering, intelligent, robust construction and industry-first innovations that combine to accept charge more effectively, maintain it longer and deliver on-demand power for a variety of commercial, industrial and leisure applications. And precision-automated assembly processes consistently ensure best-in-class performance, reliability and return on investment.


In addition to power and performance, proprietary components are built into each Crown Deep Cycle battery, making maintenance predictable and efficient regardless of the model selected.

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# INSPECTION & HANDLING

1. Upon receipt of your batteries or new equipment fitted with batteries, examine the batteries for signs of impact or damage in shipment.
2. If there is evidence of damage – notify the supplier for the batteries, or the equipment supplier, to make a damage report.
3. Charge the batteries before deploying the products to service. Charge the batteries in a well-ventilated area using a battery charger that is matched to the application. Verify that the charger is programmed with an approved charging algorithm or profile.
4. FLA Deep Cycle batteries can be safely stored and maintained in your inventory. Store batteries in a cool and dry location that protects batteries from the elements. The chemistry of deep cycle batteries allows gradual self-discharge when resting off charge, so batteries in storage should be charged when their state of charge (SOC) declines to 65 to 70% SOC. Take care to protect battery inventory from impact and to keep batteries free of any connections that may cause parasitic loads.
5. Storage in hot environments (ambient temperatures greater than 30°C / 86°F) can affect battery life. Battery owners should anticipate accelerated self-discharge at higher temperatures and should take precautions to avoid exposing batteries to heat sources. Hot temperature storage conditions will require more frequent maintenance charging and watering service.
6. Crown FLA Deep Cycle batteries are regulated by the U.S. Department of Transportation, IATA, ICAO, and IMDG as UN2794 / Class 8 Corrosive Hazardous Materials. These batteries are restricted to surface and water transportation modes and are prohibited for transportation by air.
7. FLA Deep Cycle batteries, and all lead batteries, can be recycled and should be returned to an authorized battery disposal agent for recycling. Refer to **www.batterycouncil.org** for more information about battery recycling.

## MAXIMIZING YOUR INVESTMENT

Deep Cycle batteries deliver all the power required by EV, motive power or renewable energy systems. One full cycle represents a full battery recharge followed by a complete battery discharge.

Battery life is usually measured in cycles or in terms of ampere-hour throughput delivered to the application – but in practical terms, your batteries will deliver reliable performance and a strong ROI when maintained with effective charging service and attention to the best practices identified in this document.

## GENERAL DEEP CYCLE BATTERY CARE & PREVENTATIVE MAINTENANCE

Batteries must always be stored or installed upright. Keep batteries and terminal connections clean, dry and free of corrosion or dirt. Check battery connections and cables. Re-torque connections and replace any torn or damaged cabling or connectors. Charge batteries after the completion of work (or "the duty cycle") – never leaving batteries in a discharged state. Users or equipment owners should periodically verify the state of charge for batteries after completion of charging service. Doing this will help to identify or avoid problems that can affect application performance and battery life.

Because Crown Battery is continually improving its products, specifications are subject to change without notice. The most current specifications are listed at **www.crownbattery.com**.

The information included on the website may amend and supersede the information in this pamphlet. Purchasers are encouraged to visit the website to view the most current specifications.


## OTHER FACTORS THAT AFFECT BATTERY LIFE & PERFORMANCE:

When deployed in EV, motive power, or renewable energy applications, the expected characteristics for Crown FLA Deep Cycle batteries include "deep" discharge cycling (potentially greater than 50% of usable capacity) and recovery without loss of capacity, fast recharge capability, and uncomplicated service requirements. Under normal operating conditions, the expected life for these products is primarily affected by the typical depths of discharge and the operating temperatures that they are subjected to. Certain application or use factors can significantly impact battery life and performance. They are:

- Batteries are rated in ampere-hours (Ah) and kilowatt-hours (kWh) and are designed to perform a specific workload within an established period. Increasing the rate of discharge or the battery's depth of discharge has a direct effect on the duty cycle and life performance – with frequent deep discharge resulting in shortened battery life.
- Optimize battery life by limiting duty cycle depth of discharge to 80% or less of available discharge. Depth of discharge is typically indicated by open-circuit voltage conditions during the duty cycle. However, during the duty cycle, the depth of discharge voltage points will be significantly affected by the specific discharge rate or load applied to the battery. For example, a battery discharged at a rate of 50 Amps will achieve an 80% depth of discharge at a voltage of 2.00 volts per cell; discharging at a rate lower than 40 Amps will see the battery arrive at an 80% depth of discharge at a rate of 1.93 volts.
- Battery life can be protected by including a Low Voltage Disconnect (LVD) apparatus or inverter setting when the predetermined or optimal end-point voltage is achieved.
- Batteries should always be recharged immediately following the completion of a duty cycle discharge. Never allow batteries to remain in a fully discharged condition, otherwise, permanent damage will result.
- After charging service is completed, batteries should be allowed to cool down for 6 to 8 hours before starting the next duty cycle. If a battery is hot to the touch, allow it to cool to ambient temperature before discharge or charging service.

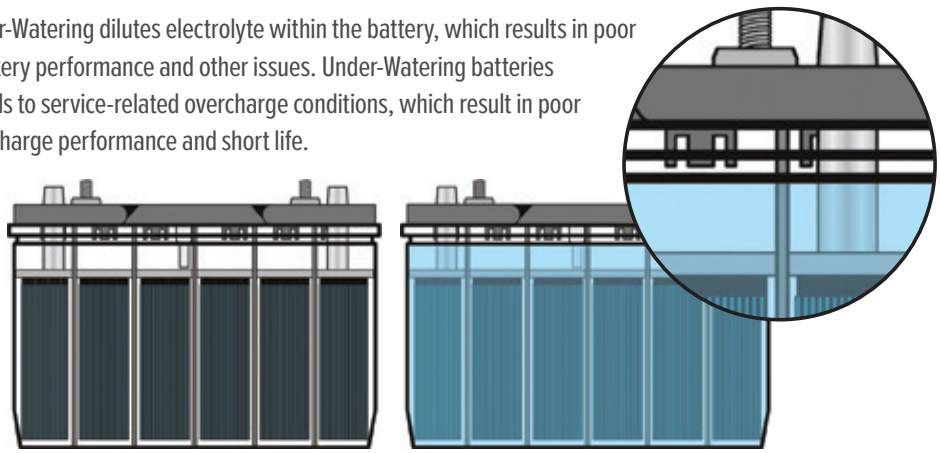
# WATERING SERVICE GUIDELINES

FLA Deep Cycle batteries begin service consuming low amounts of water. Deep Cycle battery applications vary, so watering service frequency will vary according to battery use frequency, charging service, the operating environment temperature, and battery age. New batteries should be inspected at a two-week interval to establish a baseline for watering frequency. As your batteries age, or if their use frequency changes, batteries should be inspected weekly as they will need more frequent watering service.

## THERE ARE THREE SCENARIOS WHEN WATERING SERVICE CAN BE HARMFUL TO YOUR BATTERIES:

**Over-Watering** **Under-Watering** **Use of Non-Distilled Water**

Over-Watering dilutes electrolyte within the battery, which results in poor battery performance and other issues. Under-Watering batteries leads to service-related overcharge conditions, which result in poor discharge performance and short life.



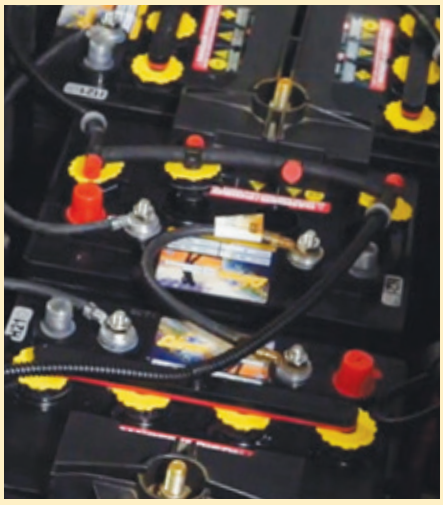
As demonstrated in the above image, maintain battery electrolyte levels above the top of the battery plates – but no higher than battery cover vent well. Never fill batteries to the brim of the cell or to a point where fluid overflows out of the cell.

## WATERING CRITICAL REQUIREMENTS

- Always wear safety glasses, gloves, and other protective gear when servicing batteries
- **USE ONLY DISTILLED OR DE-MINERALIZED WATER**
- Never add battery acid or other foreign materials to battery electrolyte
- Watering service should occur only after charging service is completed
- Never charge batteries if their plates are exposed or not submerged in electrolyte. When this condition is detected, fill the battery only until the tops of plates are covered with fluid
- After service is completed – always check that vent caps are tightly secured onto batteries

# WATERING BEST PRACTICE RECOMMENDATION

A Single-Point Battery Watering Systems (SPW) is the safest, easiest, and most cost-effective solution for optimizing battery performance and overall life. Crown Battery's FLA Deep Cycle battery array is engineered to integrate with Flow-Rite Controls' Pro-Fill and Qwik-Fill systems as well as other SPW products available from battery maintenance suppliers.



And thanks to proprietary innovations, Crown Deep Cycle batteries can accommodate SWP injectors manufactured by other battery companies which until this point were only compatible for use with their products.

Our preferred Flow-Rite Pro-Fill system also integrates with additional bolt-on solutions that help equipment owners take control of battery management:

- Advanced Battery Steward allows users to track information from their battery set wirelessly to let you know exactly when your battery requires service – along with battery condition.

- The Eagle Eye Electrolyte Fluid Level Indicator monitors and displays the status of cell electrolyte levels via highly visible LED signal lighting.

**Contact Crown Battery for more information regarding Single-Point Watering maintenance accessories at commercial@crownbattery.com.**

# INSTALLATION BEST PRACTICES

## ORIENTATION & INSTALLATION IN THE APPLICATION

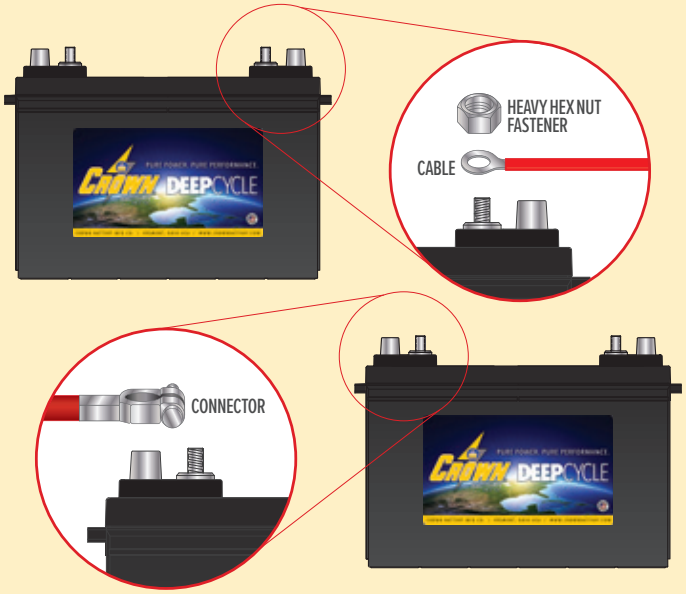
- For all applications, follow the machine manufacturer or system designer recommendations for installation of batteries.
- FLA batteries must be always installed upright.
- Never install batteries on their sides or at an angle.
- Always provide adequate ventilation to allow battery gassing during charging or the duty cycle.
- Never install lead batteries in a sealed battery box or compartment.

## TERMINAL CONNECTIONS

Battery terminal connections should be secured and tight at all times. Replace torn or damaged cabling or connectors upon discovery of damage. Terminal connections must be tightened using the specified torque values below:

| TERMINAL TYPE | In-lbs | Nm |
|---|---|---|
| SAE / Top Terminal Style | 50 – 70 | 6 – 8 |
| Stainless Threaded Terminal | 100 – 120 | 11 – 14 |

### Cables should be secured to battery terminals following the installation diagram shown below:




The battery terminal surface should be clean and dry prior to installation and torquing of the connectors to the terminals. Never place a washer or terminal treatment material between the battery terminal surface and the connector surface as this will increase electrical resistance – which affects battery and charger performance and can create potential safety hazards.

## CONNECTING MULTIPLE BATTERIES

Crown deep cycle batteries are available in various BCI group sizes, voltages and electrical capacities. Certain systems require the installation and connection of multiple batteries to accommodate minimum voltage or capacity specifications to ensure expected performance.

Users and technicians should always confirm that batteries are oriented in proper position according to battery terminal polarity – as indicated by the raised polarity mark on the battery cover.

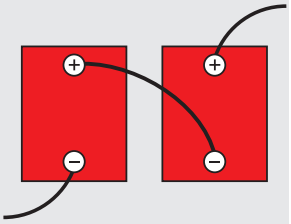
Cables and connectors should be secured with the appropriate terminal hardware and tightened to the torque values specified by Crown Battery.

### SERIES CONNECTION:

To increase voltage, connect batteries in "series" as shown:

**EXAMPLE:**

Individual Battery Voltage = 6 Volts
Individual Battery Capacity = 250 Ah
Series Connection Voltage = 12 Volts
Series Connection Capacity = 250 Ah

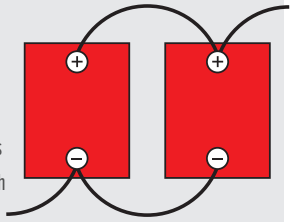


### PARALLEL CONNECTION:

To increase electrical capacity, connect the batteries in "parallel" as shown below:

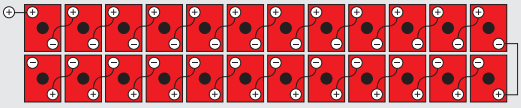
**EXAMPLE:**

Individual Battery Voltage = 12 Volts
Individual Battery Capacity = 150 Ah
Parallel Connection Voltage = 12 Volts
Parallel Connection Capacity = 300 Ah



### SERIES CONNECTION:

Single String Series Connection of twenty-four 2 Volt batteries.



**EXAMPLE:**

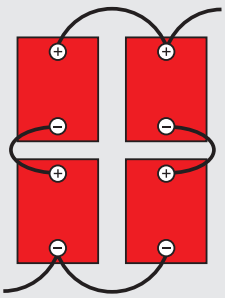
Individual Battery Voltage = 2 Volts
Individual Battery Capacity = 2500 Ah
Series Connection Voltage = 48 Volts
Series Connection Capacity = 2500 Ah

### SERIES-PARALLEL CONNECTION:

To increase both voltage and electrical capacity, connect the batteries in a "series-parallel connection" as shown below:

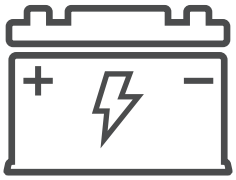
**EXAMPLE:**

Individual Battery Voltage = 6 Volts
Individual Battery Capacity = 250 Ah
Series-Parallel Connection Voltage = 12 Volts
Series-Parallel Connection Capacity = 500 Ah



# CHARGING, MAINTENANCE & OPERATION BEST PRACTICES

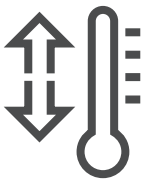
## GENERAL USE BEST PRACTICES:



### CHARGING SERVICE AT RECEIPT OF INVENTORY

Ambient temperatures above 80°F / 27°C during shipment will affect the state of charge (SOC) of FLA Deep Cycle batteries. Customers who are in hot weather regions should verify battery voltage at the time of shipment receipts to determine if inventory requires charging before storage.

After installation (but before first use), connect batteries to the charger supplied with the application to ensure batteries are in full charge conditions.



### EFFECT OF AMBIENT TEMPERATURE ON BATTERY PERFORMANCE & LIFE

Battery capacities and projected life are based upon operating temperatures of 80°F / 27°C. The recommended operating temperature range for FLA Deep Cycle batteries should not exceed -40°F to 120°F (-40°C to 49°C) and appropriate temperature compensation controls must be included on the charger. Battery users and owners should consider that battery life is reduced as operating temperature increases.

**APPLICATION NOTE:** Maintain a state of charge greater than 60% when operating batteries at temperatures below 32°F (0°C).

### DUTY CYCLE CHARGING SERVICE

Effective charging service delivers optimal life and a strong return on investment for FLA Deep Cycle battery users. Use charging equipment that has been configured or is programmable for application with your Crown Deep Cycle batteries; do not use chargers that are not configurable to support the minimum charge requirements for Crown Battery's FLA Deep Cycle batteries, or chargers that are designed for AGM or GEL battery service.

Contact Crown Battery via email at **commercial@crownbattery.com** if you require support with verifying your charging system's capabilities

## WHEN TO CHARGE?

Batteries should be fully recharged after each discharge event. To optimize battery life, charge batteries after the completion of each daily duty cycle event. When charging batteries, connect the charger (if necessary) to the battery pack and allow the equipment to operate until charging is terminated and the charger automatically powers off.

"Opportunity Charging" is a concept that recharges batteries at every opportune time possible (operator breaks, scheduled machine downtime, etc.)

Opportunity charging service should only be performed with equipment that is designed specifically for this service mode, as standard duty battery chargers cannot effectively perform Opportunity Charge service. Opportunity Charging service must be limited to when batteries are no more than 50% discharged, and batteries must be fully recharged after the completion of work or duty cycle.

## CHARGING INSTRUCTIONS

**Electric Vehicle (EV) & Motive Power Application: Normal Charger Settings at 80°F / 27°C**

| Maximum Charge Current* (% of C/20) | Absorption Voltage† (V/Cell) | Maximum Absorption Phase Time (Hours) | Finish Current (% of C/20) | Equalization Voltage (V/Cell) | Float Voltage (V/Cell) | Temperature Compensation (V/Cell) | |
|---|---|---|---|---|---|---|---|
| | | | | | | °F | °C |
| 20% | 2.42 | 4 | 3 – 5% | 2.70 | 2.25 | 1.6 mV | 3.0 mV |

*If charging time is limited, contact Crown Battery for assistance

†If charger has a bulk voltage parameter instead of a current parameter, refer to the absorption voltage per-cell above

# RENEWABLE ENERGY BATTERY CHARGING

To ensure reliable RE system and battery bank performance, it's important to take a few simple steps during installation of the battery bank to set up the system's charge controller voltage and timer settings for optimal performance. To maximize performance and life, batteries should be fully charged after each discharge period.

**NOTE:** Fully charged State of Charge is achieved when **BOTH** the "float" voltage on the charge control meter **AND** specific gravity readings (via hydrometer) indicate full float charge conditions:

**2.25 Volts per Cell, and specific gravity density of at least 1.265**

Refer to the following suggested Renewable Energy charge control settings and information to achieve the best performance and ROI from Crown Battery's FLA Monobloc products in your application:

## CHARGE CONTROL VOLTAGE SET POINTS

| | SYSTEM VOLTAGE | | | |
|---|---|---|---|---|
| | VPC | 12 Volts | 24 Volts | 48 Volts |
| Bulk | 2.44 | 14.52 | 29.05 | 58.15 |
| Absorption | 2.42 | 14.50 | 29.00 | 58.10 |
| Float | 2.25 | 13.50 | 27.00 | 54.00 |
| Equalization* | 2.59 | 15.50 | 31.00 | 62.00 |

## TIMER SET POINTS

| | |
|---|---|
| Bulk | N/A |
| Absorption | 2 hours per parallel "string" in the battery bank<br>Suggest no more than 2 parallel strings within the battery bank |
| Float | N/A |
| Equalization* | 2-3 hours maximum |

*Refer to equalization charge service instructions below.

## EQUALIZATION CHARGE SERVICE

Equalization (Eq) charging service is a regularly scheduled charge cycle. Eq Charge frequency is primarily dependent on daily DOD:

| | |
|---|---|
| **Below 50% DOD:** | Biweekly schedule |
| **50% and above DOD:** | Monthly schedule |

The suggested Eq charge is 2-3 hours and should be done using a generator. Confirm Eq charge effectiveness with the use of a hydrometer after termination of charge. Specific gravity readings of at least 1.265 or higher are required for a successful equalization phase.

**NOTE:** For a proper Eq charge to occur, the battery bank must have successfully completed the absorption phase of charging and be at true "float" voltage (confirmed with hydrometer readings of at least 1.265).

## THE SUGGESTED CHARGE SETTINGS ARE BASED ON SEVERAL TECHNICAL ASSUMPTIONS:

1. A depth of discharge (DoD)/low-voltage disconnect (LVD) setting of no more than 50% of C/20 battery bank overall Ah capacity:
   a. 1.96 volts per cell (open circuit voltage) is 50% DoD.
   b. System owners should note that lighter DoD settings **WILL** extend battery bank longevity
2. The total input amperage from the charging source is at least 10 amps per 100 Ah (C/20) of battery bank capacity.
3. DoD LVD settings beyond 50% and/or charge input of less than 10% overall battery bank capacity (C/20) will likely result in additional changes to the stated voltage / timer set points here.

The constantly changing dynamics of off-grid renewable power energy storage require a strong system owner commitment to regular monitoring of batteries' SOC to verify charge control voltage meter readings. Regular verification will ensure that your system is calibrated to properly charge the battery bank.

## BEST PRACTICE ALERT:

### VALIDATING SOC AT END OF CHARGE

**Do NOT assume the battery bank is at full state of charge (SOC) when the charge control meter indicates battery bank is at "float" voltage.**

True 100% SOC should be confirmed on a regularly scheduled basis (at least monthly) with the use of a battery hydrometer to measure specific gravity readings after the system charge control meter shows batteries at "float voltage."

**IMPORTANT:** WHEN CHARGE CONTROL METER IS SHOWING BATTERY BANK IS AT "FLOAT" VOLTAGE – THE SPECIFIC GRAVITY READINGS **MUST** BE AT A DENSITY OF LEAST 1.265 FOR THE BATTERY BANK TO BE VALIDATED AT FLOAT VOLTAGE AND FULLY CHARGED.

## MISCELLANEOUS RE BATTERY TIPS

**"End Amps Setting"** (if required): 2%-3% of battery bank's C/20 overall Ah capacity

**Temperature Compensation:** 3mV per 1°C

# RENEWABLE ENERGY BATTERY CHARGING
CONTINUED

## IMPORTANT BEST PRACTICE:

## UNDERSTANDING & USING A BATTERY HYDROMETER

A battery hydrometer is used to test and determine the state of charge of a battery cell by measuring the density of sulfuric acid that is present in the electrolyte after charging service.

The greater the concentration of sulfuric acid within the electrolyte solution, the denser the electrolyte becomes (and thus the higher the measurement of the specific gravity) - which equates to a higher battery state of charge (Full Charge = 1.265 Specific Gravity).

The specific gravity readings of the electrolyte solution in the cells will increase and decrease as the battery state of charge goes up and down.

As batteries discharge; sulfuric acid is absorbed by the active mass on the positive plates within the battery – reducing the concentration of sulfuric acid in the electrolyte.

A fully discharged (100% depth of discharge) battery's specific gravity will measure 1.040 to 1.145 with a hydrometer, depending upon the discharge rate.

During recharge service, the electrical current entering the battery "breaks the bonds" between the sulfuric acid and the battery plate material, allowing the sulfuric acid to re-blend with the electrolyte solution. Batteries are fully recharged when all of the sulfuric acid is transferred from the plates to the electrolyte fluid. This can be verified via the use of a hydrometer.

The specific gravity reading is the best / most accurate way to determine battery state of charge as it allows system owners to verify the voltage-based state of charge meter reading.


### For a part-time or seasonal residence with an off-grid system:

Consider two options to address the battery bank when residence is un-inhabited for no longer than 3-4 months.


### IF NO POWER REQUIRED WHEN RESIDENCE IS UNINHABITED:

- Perform an equalization charge on day of departure (after normal daily charge is complete)
- Confirm full charge with hydrometer specific gravity readings of at least 1.265 (100% SOC)
- If the battery bank is at 100% SOC, shut the system down and eliminate possibility for parasitic draws from the battery bank (disconnect inverter charge controller leads from battery bank)
- Upon return; perform complete normal/daily recharge as well as an Eq charge – confirming specific gravity readings of at least 1.265 after completion of equalization

### IF POWER IS REQUIRED WHEN RESIDENCE IS UNINHABITED:

- Determine the energy budget required from the system when the residence is uninhabited (assuming reduced loads)
- Perform an Eq charge on the day of departure (after normal daily charge is complete)
- Confirm full charge with hydrometer specific gravity readings of at least 1.265 (100% SOC)
- If battery bank is 100% SOC, adjust absorption timer setting accordingly to account for revised energy budget (with reduced loads; absorption timer setting should be reduced)
- Upon return; perform complete normal/daily recharge as well as an Eq charge – confirming specific gravity readings of at least 1.265 after completion of equalization

# BATTERY ANALYSIS

Battery testing is most effective as a diagnostic resource when employed at scheduled intervals. An effective testing program can also identify conditions that affect battery performance in normal as well as abusive conditions – including situations that may result in premature failure. Crown Battery utilizes several FLA battery test procedures that can be performed to verify battery serviceability. These tests do not determine the battery's actual capacity – but can indicate a need for replacement or a more complete assessment of battery integrity.

**Safety.First.**
**BATTERY INSPECTION PROCESS**

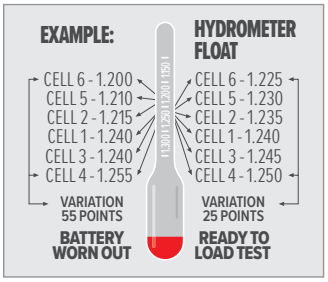
1. **VISUAL INSPECTION**
2. **FULLY CHARGE BATTERIES –** Followed by an 8-Hour Rest Period
3. **OPEN CIRCUIT VOLTAGE TEST**
4. **BATTERY DISCHARGE TEST**

1. **VISUAL INSPECTION:** Check battery age or length of service if available. Inspect battery for damage – when physical damage to the battery container or terminals is present, replace the battery. If none, check the battery's cell electrolyte levels. Fluid levels should be above the top of plates in all cells, and no higher than 1/4" (6 mm) below the cell opening's vent well:

   If the battery is sufficiently filled with electrolyte – proceed to step 2. If the top of the battery's plates are not covered with liquid, add water, replace vent caps and place the battery on charge. Be sure no open flame or spark is near while the battery's vent caps are removed from the battery.

2. **SPECIFIC GRAVITY INSPECTION:** Using a reliable Hydrometer, all cells should be at least 1.225 and show less than 50 points difference between high and low.
   - More than 50 points difference: replace the battery
   - Less than 50 points difference, but some cells read less than 1.225: recharge the battery

   Secure the vent caps during recharge. Charge the battery using a properly matched charger until all cells measure a specific gravity of 1.265.
   If charging will not restore specific gravity levels, replace the battery.




| STATE OF CHARGE LEVEL | SPECIFIC GRAVITY |
|---|---|
| 100% | 1.265 or Greater |
| 75% | 1.225 – 1.230 |
| 50% | 1.190 – 1.205 |
| 25% | 1.150 – 1.175 |
| Discharged | 1.125 or Less |

| STATE OF CHARGE LEVEL | 12 VOLT BATTERY OPEN CIRCUIT VOLTAGE | 8 VOLT BATTERY OPEN CIRCUIT VOLTAGE | 6 VOLT BATTERY OPEN CIRCUIT VOLTAGE |
|---|---|---|---|
| 100% | 12.60 or Greater | 8.40 or Greater | 6.30 or Greater |
| >75% | 12.30 | 8.20 | 6.15 |
| >50% | 12.00 | 8.00 | 6.00 |
| >25% | 11.64 | 7.76 | 5.82 |
| 0 – 10% | 11.46 – 11.52 | 7.64 – 7.68 | 5.73 – 5.76 |
| Specifications require a fully charged specific gravity of 1.265 | | | |

| STATE OF CHARGE | BATTERY VOLTAGE UNDER 15 SECOND LOAD | | |
|---|---|---|---|
| | 12 VOLT BATTERY | 8 VOLT BATTERY | 6 VOLT BATTERY |
| 100% | 12.60 or Greater | 8.40 or Greater | 6.30 or Greater |
| 75% | 12.00 – 12.30 | 7.87 – 8.20 | 5.90 – 6.15 |

3. **OPEN CIRCUIT VOLTAGE (OCV) TEST:** Batteries with less than 75% state of charge should be charged and rested for at least 8 hours before recording OCV conditions for the battery or batteries in the set. If the voltage readings differ by more than 0.3 volts from full-charge OCV or from other batteries in the set, conduct an equalization charge and re-test batteries. Recorded voltages showing differences greater than 0.3 volts from full charge or from other batteries in the set usually indicate a damaged or failed battery.

4. **ELECTRICAL LOAD TEST:** Electrical load testing is an effective troubleshooting technique for identifying batteries with internal defects – but is not an approved method for determining deep cycle battery capacity.

   Batteries with less than 75% state of charge should be charged and rested for at least 8 hours before an electrical load test is applied to the battery. When load testing batteries, remove all battery cables, disconnecting the negative cables first. Make sure the battery terminals are clean and free of corrosion. Always connect the load tester to a lead terminal, or lead charging post for batteries with stainless steel terminals. Using a carbon pile load tester, apply a 50 to 75 ampere load for 15 seconds; remove the load. Refer to the chart above to determine the minimum passing voltage.

## PREVENTATIVE MAINTENANCE TIP:

If electrolyte is spilled onto batteries or the battery compartment, neutralize it with a solution of baking soda and water mixed in the proportion of one cup of baking soda to one gallon of water (60 ml of baking soda to one liter of water).

Use a cloth or disposable towel to clean the area. Do not allow the solution to contaminate the battery electrolyte.

# LIMITED WARRANTY

1. **SCOPE OF LIMITED WARRANTY:** Free Replacement Period: All Crown batteries are warranted to be free from defects in material and workmanship. Any battery which demonstrates a defect in material and workmanship (discharged or sulfated batteries do not apply) within a Free Replacement Period specified by Crown Battery Manufacturing Company will be replaced or repaired at the option of Crown Battery, free of charge, except for the cost of transportation of the battery. Please reference your current Crown Battery Price Schedule to determine the Free Replacement Period available for Crown Battery's lineup of SLI battery products.
2. **LIMITATIONS:** In all sales other than direct retail sales by the seller of batteries considered to be consumer products to individual consumers, the foregoing warranty is in lieu of all other warranties not expressly set forth herein, whether express, implied or statutory, including those of merchantability or fitness for a particular purpose. The seller's liability for breach of this warranty or for any other purpose is limited, at seller's option, to the replacement of the battery or a refund of the purchase price of the battery.

   In any event, the seller's maximum liability shall be limited to the refund of the price paid for the battery. THE SELLER IS NOT RESPONSIBLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL OR CONSEQUENTIAL COSTS, INCLUDING ANY EXPENSES FOR INSTALLATION, TOWING, ELECTRICAL SYSTEMS TESTS, CHARGING A BATTERY OR LOSS OF TIME. PLEASE NOTE: SOME STATES DO NOT ALLOW LIMITATION ON HOW LONG AN IMPLIED WARRANTY LASTS, OR EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATIONS MAY NOT APPLY TO YOU. THIS LIMITED WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY HAVE OTHER RIGHTS THAT VARY FROM STATE TO STATE.
3. **EXCLUSIONS:** The limited warranty does not apply to batteries that are only discharged, have broken containers, covers or damaged terminals, have been frozen, overcharged, sulfated, have foreign material or additive put in the electrolyte, or when evidence of neglect or abuse is present. The warranty does not apply if Crown Battery's proprietary manufacturing code markings have been tampered with or destroyed, if the battery is used in applications for which it is not designed, or if it was installed incorrectly or charged in reverse. Batteries installed in electric vehicle applications must not be used to run auxiliary loads that are unaccounted for by the battery charging system, and such use will void the warranty.
4. **WARRANTY SERVICE:** Return the suspect battery to any factory service center or factory authorized specialist or merchant. If an authorized representative cannot be located, contact Crown Battery's Customer Service Department via phone (**+1.419.334.7181**) or email (**commercial@crownbattery.com**). An authorized factory representative will be appointed to perform warranty service.

# TROUBLESHOOTING

When properly maintained and charged, Crown Deep Cycle batteries will provide many years of trouble-free service. However, failure to follow the operating and maintenance guidelines covered in this document may result in poor performance or premature failure.

The following chart addresses typical errors in operation or maintenance that could affect performance:

| CONDITION | CHECK FOR |
|---|---|
| POOR BATTERY PERFORMANCE | Undercharged Battery |
| | Sulfated Battery |
| | Cold Operating Environment (Less than 32°F / 0°C temperature reduces usable battery capacity) |
| | Defective Connectors or Cables |
| | Low Electrolyte |
| | Old Batteries |
| | Defective Charge-Level Gauge |
| UNEQUAL/LOW SPECIFIC GRAVITIES | Over-filling |
| | Undercharging |
| EXCESSIVE WATER SERVICE | Overcharging |
| | Container Leak |
| | Old Batteries |
| ODOR DURING CHARGING | Low Electrolyte |
| | Overcharging |
| HIGH TEMPERATURE | Overcharging |
| | Battery Overworked |
| | Opportunity Charging |

*The Power Behind Performance*

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