

## USING YOUR E-Z RED HYDROMETER

Voodoo Solar wants you to be satisfied with your system performance in general, and that means understanding and caring for your batteries. A battery hydrometer is an essential tool for accomplishing these goals, but first you have to understand its use. Please be sure to fully read the manual that came with your SolarOne batteries.

### **Overview:**

The E-Z RED battery hydrometer is not a laboratory quality instrument, but it is a highly accurate tool that will serve you well if used correctly and given proper maintenance. A battery hydrometer is the most accurate way to determine the state of charge of a flooded lead-acid battery. Knowing your battery's charge level is essential to proper system calibration and battery care. Periodic battery testing is required to ensure long battery life and to comply with the terms of your SolarOne Warranty. Using the E-Z RED hydrometer is not difficult, but you should read carefully through these instructions to learn the nuances of testing lead-acid batteries. A good understanding of these concepts will save you lots of time and frustration, ultimately making your batteries last longer and saving you money.

### **Precautions:**

Lead-acid batteries contain corrosive electrolyte, which will cause chemical burns of the skin and eyes. Electrolyte will damage clothing and other materials on contact. Battery fumes are explosive, corrosive, and may cause respiratory distress and irritation. Causing a direct short circuit of a battery cell can release tremendous energy and heat, and may cause explosion or fire.

1. Wear protective goggles or face shield.
2. Wear rubber gloves. I suggest keeping a box of disposable nitrile exam gloves near your battery installation so they will always be available for use. Do not reuse.
3. Wear protective clothing, rubber apron, etc, or at least wear some old clothes that are expendable. This includes shoes. Remove and launder clothes immediately after working with batteries, or at the first sign of contamination.
4. Keep metal tools away from battery terminals, or wrap exposed metal thoroughly with insulating tape to prevent short-circuits.
5. Keep a plastic flashlight handy for battery inspection and to see into the cells. Don't use a flashlight with a metal body that might short the battery. Clean the flashlight after each use. A small headlamp is often the best choice for battery maintenance, because both hands remain free throughout the job.
6. Use a small plastic funnel for adding water. It is less messy and less likely to cause splashing.
7. Keep a bottle of sterile eye-wash nearby, available at a pharmacy or industrial first aid supply. If this is not available, keep a clean squeeze-bottle of distilled water ready for immediate use. This would be used for immediate treatment of eye or skin exposure. Flood the area liberally and seek medical care.
8. Keep a bottle of baking soda / water solution ready to neutralize battery electrolyte spills. This should be clearly marked and best kept in a large squeeze bottle. NEVER allow this neutralizing solution to enter into your battery! Do not put it in your eyes.
9. Keep the battery area well ventilated, especially when servicing batteries. Do not stay in the area if fumes are heavy.
10. No smoking, open flames, or sparks of any kind in the battery room.
11. Wash your hands and arms after battery service. Take a thorough shower if you suspect that you

- may have been contaminated with electrolyte.
12. Get medical care if you receive a chemical burn or serious exposure.

### **Battery Electrolyte Level:**

To obtain a reliable reading, you must follow the proper test procedure. Since a hydrometer measures electrolyte density, the battery must have been properly “watered” prior to testing. This means that the proper amount of water has to be present so the electrolyte is at the recommended level. Failure to get this right is the most common cause of false readings. If too much water is added, the electrolyte solution will be weak and the reading will show a false low charge. If there is too little water in the solution, it will be more dense and the reading will be high. **ONLY** use distilled or deionized water to fill your batteries. I recommend keeping several gallons of distilled water on hand at all times. If you suddenly find the electrolyte level to be very low, you'll want to add water right away to cover the plates.

#### Adding water:

1. It is normal for the electrolyte to be a bit low when the battery is partially discharged. The level will rise as the battery is brought to a full charge. **Do not** add water to a partially discharged battery unless the internal plates are nearly exposed.
2. Charge the battery. It is usually considered to be charged when the battery is gassing freely, the battery is at or above the recommended “bulk charge” voltage and charge current is down to 2% -5% of the Amp/hour rating of the battery set.
3. When the battery is fully charged, you can use a small flashlight to get an accurate determination of the electrolyte level. Use a small plastic funnel to add distilled water until the electrolyte reaches the manufacturer's recommended level. For HUP SolarOne batteries, the correct level is **1/4” below** the bottom of the *filler neck throat*. This is the black tube that extends downward into the battery cell. Look carefully with a flashlight to get it right.
4. Add only enough distilled water to reach the recommended level. **Do not overfill**. If you overfill a cell, do not try to remove electrolyte. The level will eventually drop as water is boiled off in later charge cycles. However, there will likely be some spillage from the cell cap during charging, and that spillage should be cleaned and neutralized.
5. When all cells are properly filled, tightly close all cell caps. Clean up any spills with clear water and/or neutralizer as needed. Wipe down the tops of cells and terminals. Dispose of all contaminated items such as gloves and rags. Clean tools and wash hands. Launder clothes. Make a notation on your calendar for the next routine battery maintenance.

### **Using the Hydrometer:**

As previously stated, the most accurate hydrometer readings are obtained when the electrolyte is at the correct level in all cells. The correct electrolyte level can only be known when the batteries are fully charged so, ideally the battery should have been serviced recently and the water replenished as per the previous section.

However, a valid hydrometer reading is impossible directly after watering because the water on the top hasn't “mixed” properly with the existing electrolyte, and so the hydrometer will show a false “low” reading. With this in mind, the “ideal” time to take hydrometer readings is two or three full charge cycles after the battery has been properly watered. A full charge should bring the battery to “gassing” voltage and the bubbling action will mix the electrolyte and water.

Unfortunately, when we need a hydrometer the most is frequently not during the ideal situation just described. But to get useful readings from your hydrometer, you need to understand the concept behind its

use. Simply stated, it measures the density of the electrolyte. If you have over-watered or the electrolyte hasn't had time to mix yet, your hydrometer will show a false LOW reading. If it has been a long time since you have added water and a significant amount has “boiled off”, your hydrometer will show a false HIGH reading. Knowing this can help you to properly interpret the reading under different, less-than-perfect circumstances.

When using your hydrometer to calibrate other equipment such as a charge controller or TriMetric meter, try to do it under the most ideal conditions; about two or three full charge cycles after you have watered the cells to the correct level.

Also keep in mind that electrolyte density changes with temperature. When the **electrolyte temperature** is 77 degrees Fahrenheit, there is no correction needed. At other temperatures, you may need to refer to a chart to correct the hydrometer reading to account for the temperature. Some higher-quality glass hydrometers have a built-in thermometer that measures the fluid temperature, and a tiny chart that shows the correction. The E-Z RED hydrometer is self-correcting with regard to fluid temperature, so the reading can be taken directly without temperature correction. It is also easy to read and maintain, which is why Voodoo Solar has chosen to include one with your SolarOne battery purchase.

Taking a specific gravity reading:

1. First, read and follow the protective precautions mentioned earlier: gloves, eye protection, etc.
2. Carefully open a cell cap, Be careful not to flip it open with too much force, because it might fling a small droplet of electrolyte from the bottom of the cap.
3. Using a clean hydrometer, squeeze the bulb and insert the hydrometer tube into the cell. Releasing the bulb will draw a quantity of electrolyte into the clear chamber of the hydrometer.
4. Note a small horizontal line molded into the plastic of the hydrometer chamber, just below the squeeze bulb. Ideally, you want to fill the chamber very close to that line.
5. There may be small bubbles attached to the plastic float. They will give a false reading. A few gentle sideways taps will usually dislodge the bubbles easily.
6. Note that tilting the hydrometer from left to right slightly, will change the reading. For that reason, it is important to hold the hydrometer vertically. Using the small horizontal line (mentioned above) as an index, tilt the hydrometer slightly until the electrolyte level at the top of the chamber is parallel with the line. This works like a level, to keep the hydrometer vertical.
7. Note the specific gravity reading on the scale. See how squeezing the bulb slightly will affect the pointer. Use a steady hand to get a consistent result. Squeeze the bulb gently to discharge the electrolyte back into the cell. Try taking several readings from the same cell. Practice until your results are consistent. It takes a little bit of skill to use a hydrometer effectively, but it is a skill easily acquired with just a little bit of patience. Be careful and diligent and you will quickly get a feel for it. **1.275 to 1.285** indicates a full charge for SolarOne batteries.
8. Record the specific gravity data for each cell, if that is your goal. Be sure to close all cell caps and clean up any electrolyte you may have spilled.
9. Immerse the hydrometer tube in the top of a full gallon bottle of distilled water. Draw up a full measure of water, then squirt it back into the bottle. Repeat this 6-10 times to clean out your hydrometer. Any small amount of acid will go into the water, and eventually back into your batteries during your next watering cycle. If you sucked any electrolyte into the black bulb, make sure that it gets well rinsed also. Shake out any residual water in a safe place, such as a sink or outside. Return your hydrometer to the protective pouch, and clean up tools.
10. The RED scale on your E-Z-RED indicates a fully discharged battery, not just “LOW”!