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Charging Service

To maximize performance and life, batteries should be recharged fully after each discharge period; fully charged is 2.12 volts per cell (VPC) AND specific gravity (SG) readings of at least 1.270 when measured with hydrometer. If BOTH of these readings are not achieved, the battery requires more charging.

Refer to the following chart for **initial** charge control settings:

	System Voltage				
Voltage Setting	**6V**	**12V**	**24V**	**36V**	**48V**
Absorption/Bulk	7.3	14.5	29.0	43.6	58.1
Equalize	7.7	15.5	31.0	46.4	61.9
Float	6.8	13.5	27.0	40.5	54.0

The suggested settings above assume two things:

- A depth of discharge (DOD) / low voltage disconnect (LVD) setting of no more than 50% of battery bank capacity (although lighter depths of discharge settings will enhance battery bank performance and longevity)
    - 1.96 volts per cell; this accounts for electrical load
    - 1.200 specific gravity
- The total input amperage from the charging source is at least 10 amps per 100 Ah (c/20) of battery bank

Suggested starting or initial timer setting for the absorption phase is 2 hours per parallel string. Suggest no more than 2 parallel strings within the battery bank

DOD / LVD settings beyond 50% and / or charge input amperage of less than 10% of overall battery bank capacity, may / will result in necessary changes to the above stated absorption phase settings

These are suggested settings and are not “set in stone”; the off grid world is nebulous and ever changing. Regular monitoring of the batteries (especially specific gravity; via a hydrometer) is necessary during the first 2 -4 weeks after installation, to ensure system is calibrated to properly charge the battery bank.

In the first 2-4 weeks after installation, spot check specific gravity readings every few days after system has gone to “float”.

Specific gravity readings that fail to attain at least 1.270 at “float”, may / will result in modification of charge control settings

Also repeat this process, after a change in seasons (spring / summer / fall / winter).

Suggest equalization charge of battery bank every 30 days, for batteries that are subjected to DOD of 50% or less.

The suggested equalization charge is 3 hours and should be done using a generator. Confirm successful equalization charge with use of hydrometer, after equalization charge terminates. Specific gravity readings of at least 1.270 or higher are required for a successful equalization phase.

Note: For a proper equalization 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 1.270)

Watering Service

The need / frequency to water the battery bank will vary due to several factors:

- DOD beyond 50% will require more frequent watering
- Warmer climates will require more frequent watering
- Older / aged battery banks will require more frequent watering

Initially, inspect fluid levels in cells after 2 weeks of service. If change in fluid level is minimal or unchanged, extend inspection to a monthly cycle. Proper fluid is ¼" below vent well, which drops down into cell from the underside of the cover.

Inspect electrolyte levels (and add distilled water only, as necessary) after battery bank is fully charged; confirm with hydrometer (reading of at least 1.270) before inspection or adding

Preventative Maintenance

Keep terminals and battery covers clean of corrosion

Make sure cable connections are tight and free of corrosion

Miscellaneous

"End Amps Setting" (if required) = 2%-3% of battery bank's c/20 capacity

Temperature Compensation: 3mV per 1 C

Battery State of Charge
(Open Circuit Voltage / OCV = NO Surface Voltage / NO "Load")

Percent Charge	Specific Gravity	12 Volt	24 Volt	48 Volt	Freeze Temp ° F
100%	1.275	12.7	25.4	50.9	-90
90%	1.255	12.6	25.2	50.4	-68
80%	1.235	12.5	25.0	49.9	-45
70%	1.225	12.4	24.7	49.4	-32
60%	1.210	12.2	24.5	49.0	-18
50%	1.190	12.1	24.2	48.5	-7
40%	1.170	11.9	23.9	47.8	1
30%	1.150	11.8	23.6	47.3	6
20%	1.130	11.7	23.4	46.8	13
10%	1.105	11.6	23.2	46.3	17
0%	1.100	< 11.5	< 23.0	< 46.1	20

Understanding & Using A Battery Hydrometer

A battery hydrometer is used to test and determine the state of charge of a battery cell

The hydrometer does this by measuring the density or specific gravity of the electrolyte. 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

The specific gravity readings of the electrolyte solution in the cells will go up and down – as the battery state of charge goes up and down

"Factory" battery electrolyte is a mixture of sulfuric acid and water; blended to a concentration that measures 1.270 specific gravity when measured with a hydrometer

As a battery is discharged; a corresponding amount of just sulfuric acid enters and bonds with the material on the positive plates within the battery – leaving behind a lighter and lighter concentration of sulfuric acid in the electrolyte, the further the battery is discharged

A fully discharged (100% depth of discharge / DoD) battery's specific gravity will measure 1.125 (or less) with a hydrometer

Conversely; as a battery is being recharged, 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

A battery thus then is fully (re) charged when all of the sulfuric acid that bonded with the plate material during the discharge cycle - is "purged" from the plates and re-blended with the electrolyte solution; which can be verified with a 1.270 specific gravity reading by the hydrometer (electrolyte solution is back to original "factory" concentration)

The specific gravity reading is the best / most accurate way to determine battery state of charge; even more so than a voltage based state of charge meter (offgrid charge control meter, grid tied battery charger, etc) – which can be "tricked" in any number of ways and which then leads to an imbalance between what the state of charge meter is exhibiting and what the actual specific gravity readings of the cells are showing

Troubleshooting w/ Battery Hydrometer

Because the specific gravity reading is the best / most accurate way to determine battery state of charge:

The first step in troubleshooting battery bank issues is to run a complete charge cycle on the battery bank; which will provide an "electrical baseline" of the battery bank (ie; theoretically; the battery bank is fully charged – as the charge cycle has been completed)

Then; to ensure the "electrical baseline" is "in balance" with the "chemical baseline" (or "out of balance"; as the case may be); inspect and measure specific gravity readings of each cell with hydrometer

After charge is complete, battery cells SHOULD measure 1.270 – if they do not; more charging is required until 1.270 is attained

If after repeated charging; specific gravity readings do not attain 1.270 – or – "plateau" prior to achieving 1.270; "damage" has occurred to some extent within the battery

Check with your servicing dealer or distributor for additional in-depth detail and / or analysis in regards to battery "damage"