BATTERY INFORMATION

Typical 12-volt lead-acid batteries have a voltage of about 14 volts when fully charged and 11 volts fully discharged. Most amateur radio equipment does not operate properly below 11.5 volts. You cannot practically exceed the depth of discharge at which battery voltage under load drops to below that figure. Oversized loads or excessive duty cycle causes rapid depletion of battery capacity, so battery systems must be sized for the expected load.

Cranking amps tell nothing about how long a starting battery can run your transmitter. **Cold Cranking Amps (CCA) represent the current a ">starting" battery provides continuously for 30 seconds at zero degrees. F before voltage is drops to 1.7 volts per cell** at which point it is fully discharged. MCA or Marine Cranking Amps are measured at 32 degrees. F. Reserve capacity is the time a starting battery can sustain a 25-amp load before cell voltage drops to 1.7vpc. A 12-volt battery has six cells, so at 1.7 vpc, a discharged battery has only 10.2 volts. Most 12-volt radio equipment fails to function properly before a lead-acid battery is fully discharged. Discard any 12-volt battery with open-circuit voltage below 10.2 volts, it probably has a bad cell and probably will not accept a full recharge.

Performance measurements for "deep cycle" batteries are amp-hour capacity at a specified depth of discharge (DoD). Amp-hour capacity is current available over time, measured at 80 degrees. F. DoD is percentage of capacity available during a charge-discharge cycle. Amp-hour ratings of deep cycle batteries are based upon a discharge rate at 1/20 capacity, expressed as C over 20". A marine battery rated 200ah at C20, when discharged continuously at 10 amps, at 80^{o} F., sustains the load for 20 hrs. Starting batteries are designed for 20% DoD, gel cells 25%, "deep cycle" batteries from 50% to 80%.

Engine starting batteries perform poorly for communications because they are designed for short periods of high load. Deep cycle batteries are better for communications because they withstand long periods of slow discharge.

For a typical 25% transmit duty cycle, a 100w HF rig on SSB, requires 20 amps on transmit, provided by a minimum BCI Group 27 Marine deep cycle battery (65 pounds!) to stay within a C20 discharge rate, at 80^{o}F. A smaller group U1, 33ah gel cell (25 lbs.) will power the same HF rig at reduced power, such as 25w, with a loss of about an S-unit in signal strength. At lower temperatures, available capacity is reduced. Lead-acids lose 50% of their capacity at 32^{o}F!

More rapid rates of discharge (such as using a marginally sized battery for the load) reduce capacity and the number of charge-discharge cycles the battery will provide. A BCI Group U1 (25 lb., 31ah) gel cell, often recommended for portable communications, is well balanced to power a 2-meter mobile at 20-25% duty cycle, on medium power (10-25w) transmit, requiring about 6A, approximating the C20 discharge rate. Increasing transmitter output to 50w increases the current load to 10 amps, approximating C/10 at the same duty cycle. The battery will tolerate intermittent full power 50w transmit, but routine use of an undersized battery for such duty severely shortens its useful life.

A common rule for sizing communications battery systems for a C/20 discharge rate is one amp-hour per watt of transmitter output. Estimate the amp-hour capacity required for 24 hours by summing all loads: transmit current times total operating time times duty cycle, plus receive current with squelch open times standby time and repeat for each piece of equipment. Multiply total loads by 150% safety factor and assume the result as a minimum for 24 hours of SSB or 12 hours of FM or digital operations. ***For greater confidence of adequate capacity in critical systems, use a factor of 200%.***

Measuring SG of a wet, lead-acid battery during discharge is a good indicator of the state of charge. A fully charged battery has a SG of 1.265 grams per cc, at 75% charge 1.225, 50% charge 1.19, fully discharged 1.120.

Because of uncertainty of mixing, SG is not an absolute measure of capacity, but should always be considered in combination with load testing and open circuit voltage. This is because during charging of a flooded battery SG lags charge state because complete mixing of the electrolyte does not occur until gassing commences at the end of the charge cycle.

Lead-acids at normal ambient temperature should be recharged with current of 1/10 to 1/20 of capacity. They will accept only about 1/10 of the charging current at 30 degrees F which they will at 80 degrees. F.

When not in service all lead-acid batteries self-discharge at rate of about 5% per month. The rate of self-discharge increases as the temperature increases. If left in a deeply discharged condition for a long time lead-acid batteries “sulfate" as sulfur in the acid combines with lead in the plates to form lead sulfate.

Auxiliary batteries should be connected to a charge controller to provide a regulated, low-level current of 1 to 1.5% of C to compensate for self-discharge and protect against sulfating.

A fully-automatic, low amperage charger such as the Schumacher Model SE-1-12S, available from Sears or Wal-Mart for around $25, recharges small SLA batteries and will maintain vehicle starting or deep cycle batteries up to BSI Group 30 (105ah).

Flooded lead-acid batteries require regular testing, inspection and replacement of lost electrolyte. If water is lost during charging and not replaced, the process of sulfating is accelerated in plates, which are partially exposed, to air. "Treeing" is a short circuit occurring between positive and negative plates. This may be caused by manufacturing defects or rough handling, which results in misalignment of the plates and separators. "Mossing" caused by circulating electrolyte bringing particulate matter to the tops of the plates can also cause a short.

Sealed, flooded (wet) lead-acid batteries also called "maintenance free" and experience less self-discharge. They contain lead-calcium or lead-strontium plates to reduce water loss and usually have catalytic recombiners to reduce water loss and sealed, valve regulated vents. Sealed-flooded lead-acids tolerate the same temperatures as unsealed batteries, but because SG is not readily measured, some sealed-wet batteries are provided with a captive float hydrometer in the electrolyte.

Sealed-wet batteries are common for engine starting, but should not be discharged below 25%, or their life is dramatically shortened.

Sealed lead-acid (SLA) batteries include gel cells and absorbed glass mat (AGM) types. Sometimes called "starved" electrolyte or valve regulated, these units are completely sealed. Because there is no free liquid electrolyte to spill, the battery can be used safely in any position. SLAs are safer than flooded types for indoor use and in sensitive equipment such as computer backup power supplies, which would be damaged by exposure to acid fumes.

Any sealed battery will vent if overcharged to the point of excessive gassing, because the valves are designed to purge excessive pressure building up inside the battery case. Therefore, battery chargers designed for flooded cells must not be used to charge gel cells unless they have voltage limiting circuitry to prevent exceeding 14V during charging.

Self-discharge of gel cells is minimized by storing them in moderately cool areas of 5 to 15 degrees. C. A suitable charger for larger gel cell batteries is the Schumacher SE-600A especially for 12-volt gel cell batteries, see http://www.batterychargers.com

Auxiliary batteries in your ham shack may also be floated in parallel across a regulated 13.8V DC power supply. Shotky diodes should be placed in line to prevent back-feed into the power supply if the AC mains fail and the system "fails to battery."

Most gel cells are NOT deep cycle. Depth of discharge greater than 25% significantly reduces their life. Gel cells must not be used below -20 degrees; in vehicle engine compartments or in uses subjecting them to temperatures above 50 degrees. C.

Absorbed glass mat (AGM) batteries are deep cycle can be quickly recharged with no current limit and provides a broad operating temperature range. Their depth of discharge approaches wet NiCds, with reduced maintenance and lower life cycle cost. New aviation AGMs are more expensive than flooded deep cycle batteries of equal capacity, but much less expensive than flooded NiCds.

Marine or emergency vehicle AGMs such as Lifeline or Optima are not prohibitively expensive, have aviation type cell construction and are very well suited as auxiliary power sources for emergency communications.