Question: How are Batteries rated for capacity?

Answer:

The most common battery rating is the AMP-HOUR RATING. This is a unit of measurement for battery capacity, obtained by multiplying a current flow in amperes by the time in hours of discharge until a specific end of discharge voltage is reached. (Example: A battery which delivers 5 amperes for 20 hours to a final voltage of 1.75 volts per cell delivers 5 amperes times 20 hours, or 100 ampere-hours.)

The amp-hour rating varies with the discharge period and final voltage. The longer the discharge period, the higher the rating. Batteries used for telecommunications are generally rated over an 8-hour period, those used for solar electric systems are rated over 100 hours. For this reason Amp-Hour Ratings and discharge period are both considered when evaluating a battery's capacity for selection purposes.

The amp-hour rating also varies with temperature, most ratings are at 25°C/78°F. Lower temperatures decrease the rating while higher temperatures increase the ratings.

Some batteries are rated on a constant power basis rather than amp-hour basis because the application is with electronic equipment that draws a constant power even as the voltage decreases during discharge (current increases during discharge to keep the power level constant). These batteries are rated in watt-hours, again to a specific end of discharge voltage.

Detailed battery technical data is available at:
http://www.azsolarcenter.com/technology/technical/batteries.html

Specific Gravity = Cell Open Circuit Voltage - 0.845

Question: What Safety Precautions apply to installing batteries?

Answer:

- Keep a copy of the applicable battery manual and layout drawings (if any) near the battery installation at all times.
- Only allow properly trained personnel to perform battery installations and servicing.
- Batteries contain sulfuric acid which is harmful to skin and eyes. In the event of contact, flush immediately with water and obtain medical attention.
- Batteries contain lead and lead compounds which are toxic materials, wash thoroughly after handling.
- Use protective equipment, such as acid resistant rubber gloves, protective aprons, safety shoes, safety glasses and insulating tools when working with or around battery systems.
- Batteries are capable of high voltage and current which can cause injury to personnel. Do not lay any metallic objects on the battery as it may cause a short circuit. Do not wear metallic objects, such as jewelry, when working around batteries.
- Neutralize static buildup just before working on battery by contacting the nearest effectively grounded surface.
- Use caution when lifting batteries. Use proper lifting devices. DO NOT lift cells by the terminal posts.
- DO NOT smoke, use an open flame or create a spark in the vicinity of the battery.
- DO NOT install cells in sealed (airtight) enclosures. Each cell is fitted with a vent through which hydrogen gas may escape under all operating conditions. Provide adequate ventilation in accordance with local, state or federal building and fire codes.

Precautions must be routinely practiced to prevent explosions from ignition of the flammable gas mixture of hydrogen and oxygen formed during overcharge of lead-acid cells. The maximum rate of formation is 0.418 liters of hydrogen and 0.209 liters of oxygen per Ah overcharge at standard temperature and pressure (per battery cell). Sealed lead-acid batteries form hydrogen and oxygen within the cells the same as flooded (vented) batteries, however under normal operation the hydrogen and oxygen recombine inside the cell to return the water to the electrolyte. In the event of extreme overcharging, sealed lead-acid batteries are designed to vent the excess pressure at a safe pressure, releasing the hydrogen and oxygen to the room.

The gas mixture is explosive when hydrogen in air exceeds 4 percent by volume. Standard practice is to set warning devices to alarm at 20-25 percent of this lower explosive limit (LEL). Low cost hydrogen detectors are available commercially for this purpose.

With good air circulation around the battery, hydrogen accumulation is normally not a problem; however, if relatively large batteries are confined in small rooms, exhaust fans should be installed to vent the room constantly or be turned on automatically when hydrogen accumulation exceeds 20 percent LEL. Battery boxes should also be vented to the atmosphere. Sparks or flame can ignite these hydrogen atmospheres above the LEL. To prevent ignition, electrical sources of arcs, sparks, or flame must be mounted in explosion-proof metal boxes. Battery cells similarly can be equipped with flame

arrestors in the vents to prevent outside sparks from igniting explosive gases inside the cell cases. It is good practice to refrain from smoking, using open flames, or creating sparks in the vicinity of a battery.

Some building codes require ventilation of battery rooms even if sealed batteries are used. Consult with the local building inspector.

Question: What if I have to store my battery for a while?

Answer:

Batteries should be placed into service as soon possible after receipt. If the battery cannot be installed immediately upon receipt, it should be stored indoors in a cool clean and dry location.

Batteries will self discharge during storage and must not be allowed to discharge too far or permanent capacity loss may occur. The following table lists the maximum storage interval before a freshening charge must be applied. Consult the battery manufacturer's literature for the recommended method of applying a Freshening Charge. Record and keep dates and charging conditions each time a freshening charge is applied, to validate warranty. Batteries are better stored disconnected and given freshening charges as required rather than maintaining a float voltage.

Average Temperature Maximum	**Storage Time**
32 - 50ºF (0 - 10ºC)	9 Months
51 – 77ºF (11 – 25ºC)	6 Months
78 –95ºF (26 – 35ºC)	3 Months
96 – 104ºF (36 – 40ºC)	2 Months

Question: What should be considered when Connecting Batteries in Parallel?

Answer:

The capacity of a battery installation can be increased through parallel connection. In theory, an unlimited number of strings may be connected in parallel, however, a maximum of 4 strings in parallel is recommended.

NOTE: Contact the Battery manufacturer for specific recommendations if more than 4 strings must be connected in parallel.

The following should be considered when sizing a battery system with multiple parallel strings:

- Batteries must be of equal age, voltage, and capacity.
- Parallel cables must have equal resistance (usually the same length with looping to accommodate the extra lengths for some strings) and should be sized to maintain a safe temperature increase in case one or more strings fail causing the remaining strings to support a higher load than normal.
- During discharge, a weak battery string may cause the other strings to support more of the load resulting in reduced back-up time. In addition, the weak string may discharge below the specified end-voltage (over-discharged).
- When connected in parallel, the current from a charger will tend to divide almost equally between batteries in good condition. However, during charge, a weak battery string may draw most of the charge current and prevent other strings from being fully charged.
- Check that the system power plant (rectifier) will be capable of maintaining the load and recharging the batteries at the same time without overloading.

Question: What if I need less than the full battery voltage for an additional load (tapping the battery)?

Answer:

This is called 'Voltage Tapping'. Tapping into a battery string to provide a voltage other than the total battery voltage is not recommended. Tapping results in an imbalance of the cells during charging and discharging, and can greatly reduce the service life of the battery.

Consider using a DC/DC converter to supply the secondary voltage.

Question: What is the recommended Installation Inspection?

Answer:

Only after the installation inspection is completed may the battery be connected to the charger or equipment. Prior to this connection be sure to:

- Check the polarity of the batteries (each and every cell).
- Check the torque of every terminal connection against the values listed in the Torque Table.

Bolt Size	Tightening Torque Value
1/4-20 Hex Bolt	85 in/lbs (7.1 ft/lbs)
5/15-18 Hex Bolt	216 in/lbs (18 ft/lbs)
3/8-16 Hex Bolt (Grade 8)	420 in/lbs (35 ft/lbs)

- Make a photocopy of the manufacturer's recommended Installation Report and save the original for subsequent use.
- Record the date of installation, order #, battery type, number of strings, and number of cells per string.
- Measure and record the ambient temperature and open-circuit voltage for each battery/cell.

NOTE: Installation records are required for any future warranty claim.

Question: What are the recommended Inspections and Record Keeping for my battery system?

Answer:

To prevent premature battery failure, the following inspection and maintenance schedule based on IEEE Std 1188 is recommended.

NOTE: Maintenance records will be required for warranty claims. Some maintenance procedures may require special tools or skills. Voltage readings may require special probes or techniques, consult the battery manufacturer's literature for guidance.

Initial Inspection

After the battery has been on float for one week, measure the following data and record on the installation report:

- Ambient temperature in the battery room or area should be measured. If the temperature is not 77°F (25ºC) or less, environmental controls should be used to control the temperature. If temperature controls are impractical, the float voltage must be compensated for temperature (Refer to manufacturer's requirements).
- Charger output current.
- Charger output voltage.
- Overall float voltage measured at battery terminals.
- Charger imposed AC ripple current and or voltage.
- Condition of ventilation and monitoring equipment.
- Condition of battery (Appearance, Cleanliness, Accessibility).
- Cell number.
- Float voltage.
- Internal Ohmic Value.
- Negative terminal temperature.
- Intercell Connector Resistance.
- Visually inspect each battery for signs of wear to the case, cover and terminals, electrolyte leakage, and corrosion at the terminals, connections or racks.

Monthly Inspection

The following should be checked and recorded at monthly intervals:

- Ambient temperature in the battery room or area should be measured at the same point(s) every month. If the temperature is not 77°F (25ºC) or less, environmental controls should be used to control the temperature. If temperature controls are impractical, the float voltage must be compensated for temperature (Refer to manufacturer's requirements).
- Charger output current.
- Charger output voltage.
- Overall float voltage of each battery string should be measured at the battery terminals.

- Condition of ventilation and monitoring equipment.
- Condition of battery (Appearance, Cleanliness, Accessibility).
- Cell number.
- Visually inspect each battery for signs of wear to the case, cover and terminals, electrolyte leakage, and corrosion at the terminals, connections or racks.

Quarterly Inspection

The quarterly inspection should include the items in 8.2 and the following:

1. Float voltage.
2. Internal ohmic value.
3. Negative terminal temperature.
4. Intercell connector resistance.

Annual Inspection

The annual battery inspection should include the items in the Monthly and Quarterly inspections and the following:

- Cell-to-cell and terminal connection detail resistance of entire battery.
- AC ripple current and/or voltage imposed on the battery.