How to Wreck your Battery.

These are notes from a presentation by a sales person for PowerSonic. My recollection and notes may be in error; any errors are my fault.

Dry cells

Batteries are split between dry cell and wet cell. The old original dry cells were the kind with a carbon rod down the middle, and they had little power and shelf life. Current non-rechargeable dry cells have an excellent shelf life and generally provide 1.5VDC. Rechargeable dry cells have a shelf life of less than a year before needing to be charged again.

NiCads have given rise to the idea of batteries having a memory. Failing to fully discharge a NiCad before recharging it eventually led to a loss of battery life. Companies started selling chargers that "conditioned" NiCads by setting up a discharge cycle before charging them.

None of that applies to other batteries, such as NiMH and lithium batteries. There is no need to "condition" these batteries, and it is better to keep them on a float charge and fully charged than it is to cycle them by discharge then recharge. Cycling a battery makes it wear out faster.

Wet cells

Wet cells are the batteries we have in our cars - an acid and lead plates that generate electricity. Most car batteries are not sealed. They will spill or leak acid if not kept upright. Sealed lead-acid batteries will not leak, although they may discharge gasses if not charged properly. Sealed lead-acid batteries come in two forms: Gel cells and AGM (absorbed glass mat).

Gel cells are somewhat more difficult to manufacture (getting the gel just right is the problem); instead of liquid acid, the acid is in a gel form which remains between the lead plates. Gel cells are said to work better than AGM batteries in conditions where they have long use and frequent cycling. Golf carts and wheelchairs are uses where gel cells work better than AGMs. The batteries are more deeply discharged and are used frequently, then recharged.

AGMs seem more efficient at uses where they are deeply discharged but only infrequently, being kept on a floating charge. Uninterruptible power supplies is one such use. The battery in a UPS is kept fully charged while the power is on, but when the power goes off, the computers, monitors, printers, and such pull a lot of current from the battery until they can be shut down properly.

The differences between gel cells and AGMs may make no difference to non-critical users who need a big capacity, portable battery for occasional use. This may include ham radio operators who need a big battery for a day or two in the field for an event or for campers who want a battery on camping trips to run lights or to recharge AAs.

Discharge

Using a charged battery discharges it. Wet cells and dry cells "self discharge" over time. Wet cells can

maintain a workable charge for about a year after the last full charge. When cold, wet cells lose power and cannot deliver their rated charge. Instead of waiting a year for the battery to run down, either recharge your wet cell every six months or keep it fully charged all the time by putting a floating charge on it.

When the manufacturer gives a rated capacity, it is based on a draw of 1/20 of the rated capacity. This is sometimes expressed by the formula 1/20 x C, where C is the rated capacity. If the battery has a manual, it may have a chart showing different capacities based on different draws. If the discharge rate is greater than 1/20 x C, the battery will not last for its rated capacity. For example, a 10 amp-hour battery discharged at 1/4 x C will not last for the expected time.

"Full" discharge for a 12V lead-acid battery is 10V. When fully charged, a 12V battery will measure over 13.2V at the terminal. When the battery shows 10V at the terminal with no load, the manufacturer deems the battery fully discharged. Frequent full discharges damage the battery, causing the lead plates to sulfate. If you have a 7 amp-hour battery and drain it at the recommended 1/20 x C until the battery is at or less than 10V, you will damage the battery, and it will no longer charge and deliver its rated capacity.

Going back to the electric cart, if you go out for a weekend of shopping and dining and use the cart for a couple of days without recharging, even if you drain the preferred 1/20 x C from a 7 amp-hour battery for 24 hours (12 hours at the mall both days), you have drained (.35 amps X 24 hours =) 8.4 amps from the battery - it will be dead before you finish your second day, and the battery will be over discharged. On the other hand, if you have a UPS and the power fails, you have a job to finish, so you run the computer, monitor, and printer for 30 minutes to print, save, and shut down, but your gear draws 7 amps, you have drawn only (7 amps X .5 hour =) 3.5 amps from a 7 amp-hour battery. It will recover.

Charging

The rule of thumb is to divide the capacity by 10 (C/10) to recharge a battery. With the 7 amp-hour battery, we want about 700 milliamps to recharge it. A hundred or so milliamps either way will do no damage. Smaller amperages will take longer to charge and may not ever fully charge a big enough battery. Larger amperages, though, may damage the battery. The higher current will heat the solution (liquid or gel), causing it to give off gasses. Sealed batteries have one-way valves to vent the gas, but remember the gas is hydrogen, which is flammable. Do not charge batteries in an enclosed box. With non-sealed lead-acid batteries, the liquid will evaporate when overheated, exposing the lead plates and allowing them to sulfate.

This rule of thumb means that it can take over half a day to fully charge a battery; 15 hours is not uncommon.

If your recharger is too big for the battery (providing, for example, 2 amps for a 7 amp-hour battery) and the charger provides a switch from charge to maintaining a float charge, the battery may never provide enough resistance to the charger for it to sense that the battery is fully charged and to switch from charge to float. This means you will still be charging the battery as long as the charger is connected, and you will overcharge the battery.

Battery life

Battery life depends on many factors, and I'll cover only cycles. Discharging a battery, then recharging it is a cycle. A sealed lead-acid battery which is fully discharged (as defined above) has a life of about 200 cycles. If a battery is subject to "shallow" discharges (30% or 40% down from the voltage read when fully charged), then the life may be 800 or more cycles. It is better to keep a sealed lead-acid battery on a floating charge than to allow it to fully discharge by sitting a year between uses. The next best option is to fully recharge the battery monthly.

People who use their batteries infrequently and then use them to full discharge (and beyond) will damage their batteries and shorten the battery's life substantially from any advertised life. I have in mind people who go camping once a year for a week. They don't recharge their batteries until a day or two before they leave, drain the batteries dead during the week, then bring the batteries home and put them away discharged until next year. If the batteries are not critical to safety or health, this is not a problem when they fail early and often.

You can estimate your battery's current condition by fully charging it, measuring the voltage (it should be over 13.2V), and putting a known draw on the battery while keeping the volt meter connected. Let's say that you have an automobile headlamp that you know draws 4 amps. If you have a 12 amp-hour battery and fully charge it, connect the lamp and volt meter to the battery, turn the lamp on, and note the time. When you notice the light fading, start watching the meter and note the time the voltmeter reads 10.5V. Let's say it took 2 hours. For 12 amp-hour battery, the battery's rated capacity at a draw of four amps is 3 hours, so your battery's capacity is now 2/3 its rated capacity. Its capacity will continue to degrade until you find the battery useless and recycle it.

(Many thanks to Jerry Haag for his suggestions and comments.)