—Technical Tips for NiCd/NiMH Pack Users—

NiCd discharging and the "memory effect"
Briefly, the "memory effect" doesn't exist.
At least, not as a true memory of how the pack was previously used. The apparent loss of capacity (often attributed to "memory") is really just a reduced cell voltage typically caused by overcharging. The full capacity of the pack is still available, just at a lower voltage.

Overcharging causes the formation of a different cadmium compound that has a lower voltage level and higher internal resistance. This results in a lower pack voltage and the appearance of reduced capacity as the pack will appear "empty" sooner.

When the pack is only partially discharged, only a part of the lower-voltage cadmium compound is converted back to the higher-voltage, "normal" compound. After charging the pack and using it again, the pack will begin to discharge this higher-voltage compound first and everything will appear normal. But, as soon as the higher-voltage part of the cell is discharged, the cell's voltage will rapidly drop to the lower-voltage compound's level. This lower voltage makes the cell appear to be discharged, especially if a low-voltage cutoff circuit exists in whatever device the pack is being used in. This cutoff might shut off current from the pack thinking that it is discharged.

Since the switch over to the lower-voltage compound occurs at the same place as the previous use of the battery pack, it appears to have a memory of that previous use.

Continuing to charge the pack and then using it only down to where the switchover to the lower-voltage compound occurs will only reinforce this switchover by encouraging the growth of ever larger (higher resistance) crystals of the lower-voltage compound.

This happens most often with NiCd cells, but it can occur with NiMH cells too (via a different electro-chemical process).

Regular discharging of your packs down to approximately 0.9V/cell helps to break up this lower-voltage compound, converting it back to the normal cadmium compound when charged, and increases the pack's voltage level and useful capacity.

NiCd/NiMH cell life
Eventually, no matter how carefully you charge, discharge and store your packs, the cells will eventually die. There are two main reasons for this (other than abuse):
1. Failure of the separator
2. Failure of the plate material

Failure of either of these can be held off as long as possible by:
- Avoiding overcharging.
- Avoiding needless cycling of your packs.
- Not overheating your cells during charging or discharging.
- Properly discharging your packs to 0.8V/cell-1.1V/cell.
- Properly storing them when not being used, avoiding high temperatures.

If you treat your cells well, you can get up to 1,000 charge/discharge cycles from high quality NiCd and NiMH cells, but the life expectancy of many NiMH cells can be significantly shorter. Check the data sheets of your cell's manufacturer to be sure.

CamLight Systems • New York City, USA • tel: 00-1-212-579-1901 • URL: http://www.camlight.com/battery • e-mail: info@camlight.com

Cell zapping – worth it?
In our opinion, for reviving a "dead" or "tired" cell, no.
For achieving a very small increase in the cell's voltage under load, yes. But, only you can determine whether the possible damage to the cell caused by zapping it is worth the small performance gain.

When a cell's crystals have grown large enough (or have formed dendrites long enough) to poke through the separator and short out the cell (increasing the cell's self-discharge rate), "zapping" can provide a temporary fix. The high-current pulse vaporizes the part of the crystal that's shorting out the cell and the cell appears to be "revived". The problem is that the vaporized crystal material has now contaminated the separator, leading to a higher than normal self-discharge rate, and additional crystal or dendrite growth will soon follow the material just blown out.

If your cells are only reaching about 80% of their rated capacity at a 1C discharge rate (e.g., a 3A discharge for a 3000mAH capacity cell), then it's time to start considering the replacement of that pack. Proper charging, discharging, and storage will make sure your packs last as long as possible.

Storing your cells
NiCd and NiMH cells can be safely stored for very long periods of time if you follow these procedures:

- Discharge each NiCd cell individually down to 0 volts. If that is not practical, discharge the pack down to 0.9V/cell. A charged NiCd pack that is allowed to self-discharge is subject to large cadmium crystal growth and voltage depression when used again.
- You'll often see advice to store NiMH cells partially charged. But, we've been storing all of our NiMH packs discharged to 0.9V/cell between uses and have noticed no loss in capacity or voltage under load beyond what would be seen due to normal use over the years. Due to the conflicting advice that's available (and lack of manufacturer guidance), we are unable to advise you on which is better.
- Do not exceed 85ºF. during storage. Keeping the temperature a lot lower is preferable, but do not go below 32ºF. Store the cells in an air-tight container or other packaging to prevent condensation if the cells need to come up to room temperature after storage (and before using them).
- To use the cells after they've been stored, perform a slow 0.1C-rate charge and 1C-rate discharge before charging again normally and using them. If the cells have not been conditioned every 3-4 weeks during storage, you may need to cycle them this way up to 3-5 times before the cells regain their rated capacity.

Conditioning new cells and packs
Most cells, particularly NiMH cells, will perform best if they are conditioned properly before using them for the first time, especially in high discharge-current situations.

Cycle the pack at least 3 times, charging at a 0.1C rate (or less) and then discharging at a 1C rate. If the capacity of the cells (measured using a watt-hour meter or other method) keeps increasing for every cycle, keep cycling the pack until the capacity starts to level out. You can now use the pack in your application.

Be sure to read our **CamLight Systems Why Discharge?** document to learn why you should be using a discharger to help get the most out of your packs and extend their life as much as possible.

CamLight Systems • New York City, USA • tel: 00-1-212-579-1901 • URL: http://www.camlight.com/battery • e-mail: info@camlight.com