Deterioration of 12V Lead-Acid Batteries

- Lead-acid batteries deteriorate in capacity and efficiency with both time and use. The batteries in our uninterruptable power supplies (UPS) were suspected to be old/overused. I charged and discharged them along with two new batteries of the same design to see how they performed.
- I measured the charge of the batteries by taking the open-circuit voltage (OCV). After charging or discharging, I waited at least 4 hours to make this measurement to let the battery stabilize and give accurate data.

Charging

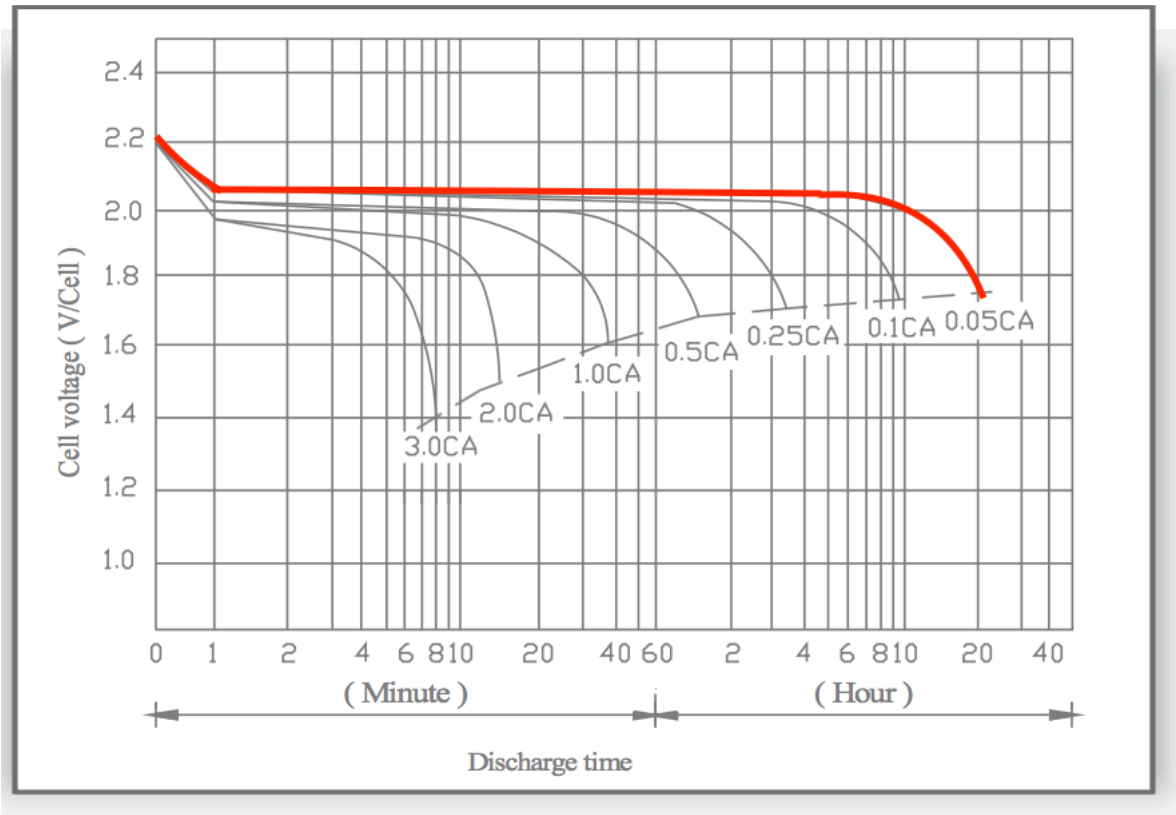
Batteries 1-6 are old. Batteries 7 and 8 are new.

Battery #	Initial OCV (V)	Charging Procedure	Final OCV (V)	OCV After 3 Days Standing (V)
1	13.2	None	13.2	13.2
2	13.2	None	13.1	13.1
3	9.0	14.4V for 5 hours, then 13.8V for 24 hours	11.9	11.9
4	12.0	14.4V for 3 hours, then 13.8V for 16 hours	13.0	13.0
5	7.3	14.4V for 5 hours, then 13.8V for 24 hours	10.2	8.1
6	13.0	None	13.0	10.9
7 (new)	12.5	14.4V for 3 hours	12.9	12.9
8 (new)	12.5	14.4V for 3 hours	12.9	12.9

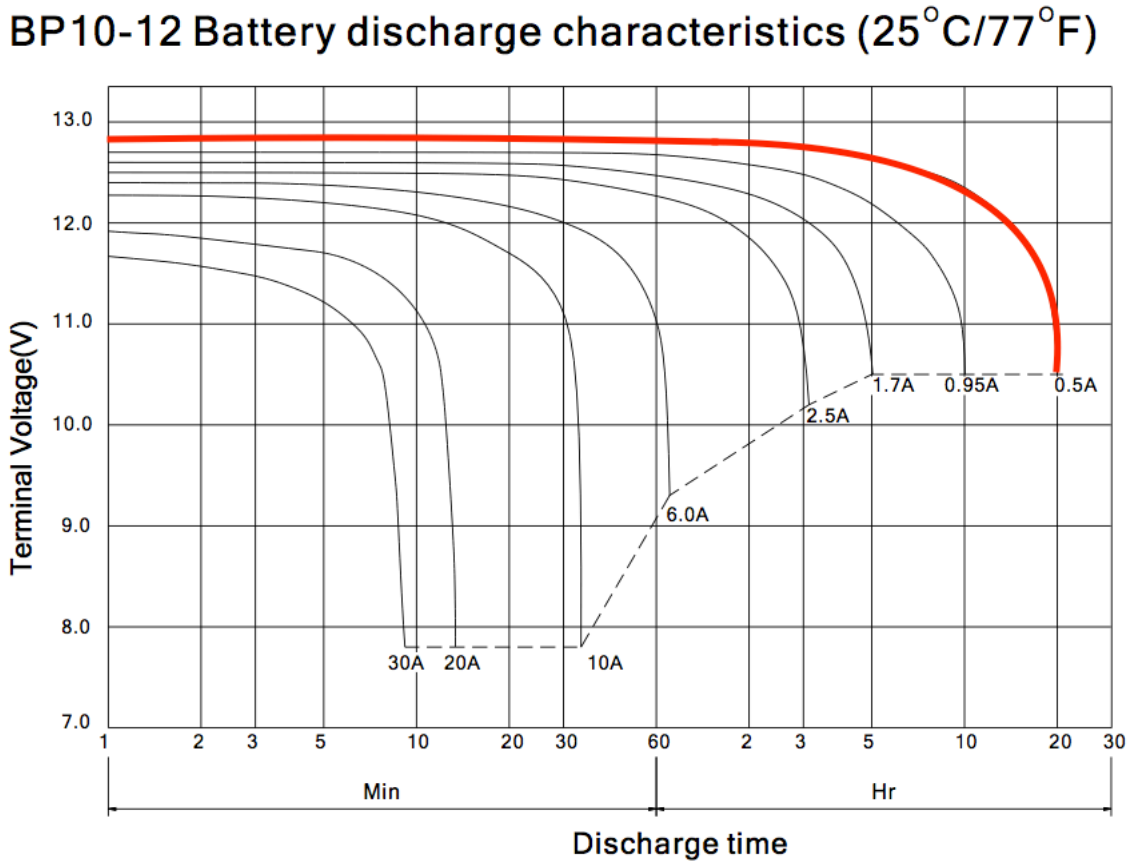
- A fully discharged lead acid battery has an OCV of around 11.5V, not 0V. A measurement below 10.5V suggests a potentially damaged battery. Highlighted cells indicate batteries with OCVs below 10.5V.

Discharge Curves

New Battery



Old Battery



- Each battery was discharged through a 30R power resistor for 19 hours. For a 12V battery, this is roughly 0.4A current or .04CA for a 10Ah battery.

Discharging

Battery #	OCV Before Discharge (V)	OCV After Discharge (V)	Power Resistor Heat At End Of Discharge	Expected Voltage Based On Discharge Curves (V)
1	13.2	11.7	Warm	11.5
2	13.1	11.1	Cold	11.5
3	11.9	8.9	Cold	Fully discharged (<10.5V)
4	13.0	11.5	Cold	11.5
7 (new)	12.9	11.6	Hot	11.4
8 (new)	12.9	11.6	Hot	11.4

- I did not discharge batteries 5 and 6 as they had demonstrated signs of damage while charging.
- Batteries 1, 2, and 4 are working as expected. Batteries 3, 5, and 6 are not.