



Testing and Evaluation of Energy Storage Devices

DOE Energy Storage Systems Research Program Annual Peer Review

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Presented by:

Tom Hund,
and Wes Baca

Sandia National Laboratories
Albuquerque, NM
(505) 844-8627
tdhund@sandia.gov

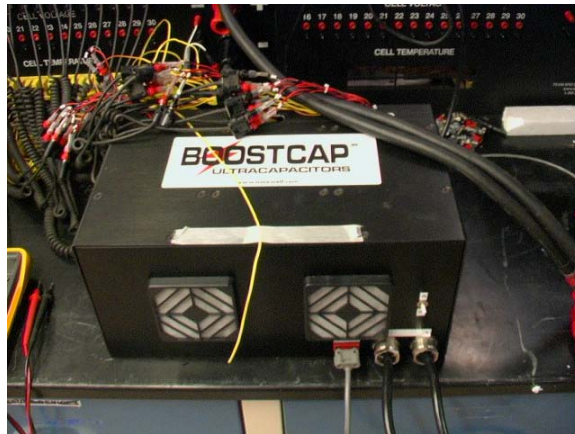
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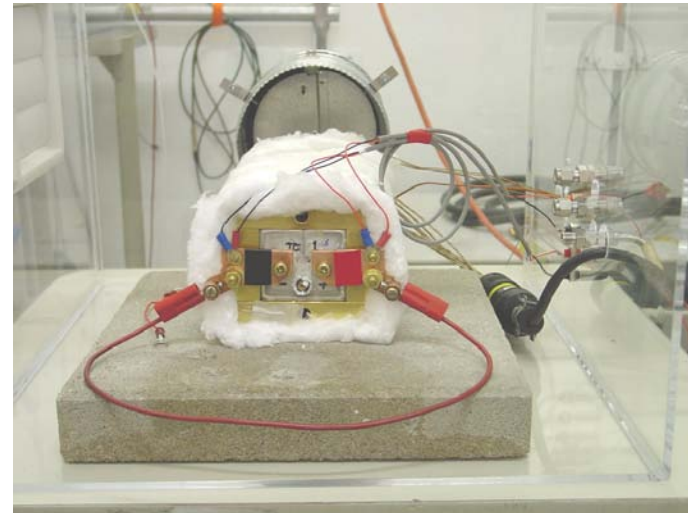
Historical Sandia Battery Testing Introduction (2002 – 2010)



ESMA
Supercapacitors



Maxwell Supercaps



NessCap Supercaps



East Penn
lead-acid/carbon
(ALABC)



Sandia Battery Testing Introduction FY-10

Unbiased testing is needed to establish performance improvements.

Testing:

- The large format (1,000 Ah) Furukawa and East Penn Ultrabattery
 - VRLA + Supercap incorporating an electrochemical supercapacitor in parallel with the negative electrode.
- International battery Li-ion FePO₄ prismatic cell
 - large format prismatic cell
- Hoppecke OPzS and OPzV cells
 - vented and valve regulated tubular cells
- GS Yuasa
 - granular silica tubular gel
- New test equipment installed 2010
 - Arbin SCTS 200 amp, 60V
 - Bitrode 1,000 amp, 72 volt tester 2 circuits

Sandia Battery Testing Introduction FY-10



East Penn
UltraBattery®
Lead-Acid/Supercap



Furukawa UltraBattery®
Lead-Acid/Supercap



International Battery
Li-FePO₄

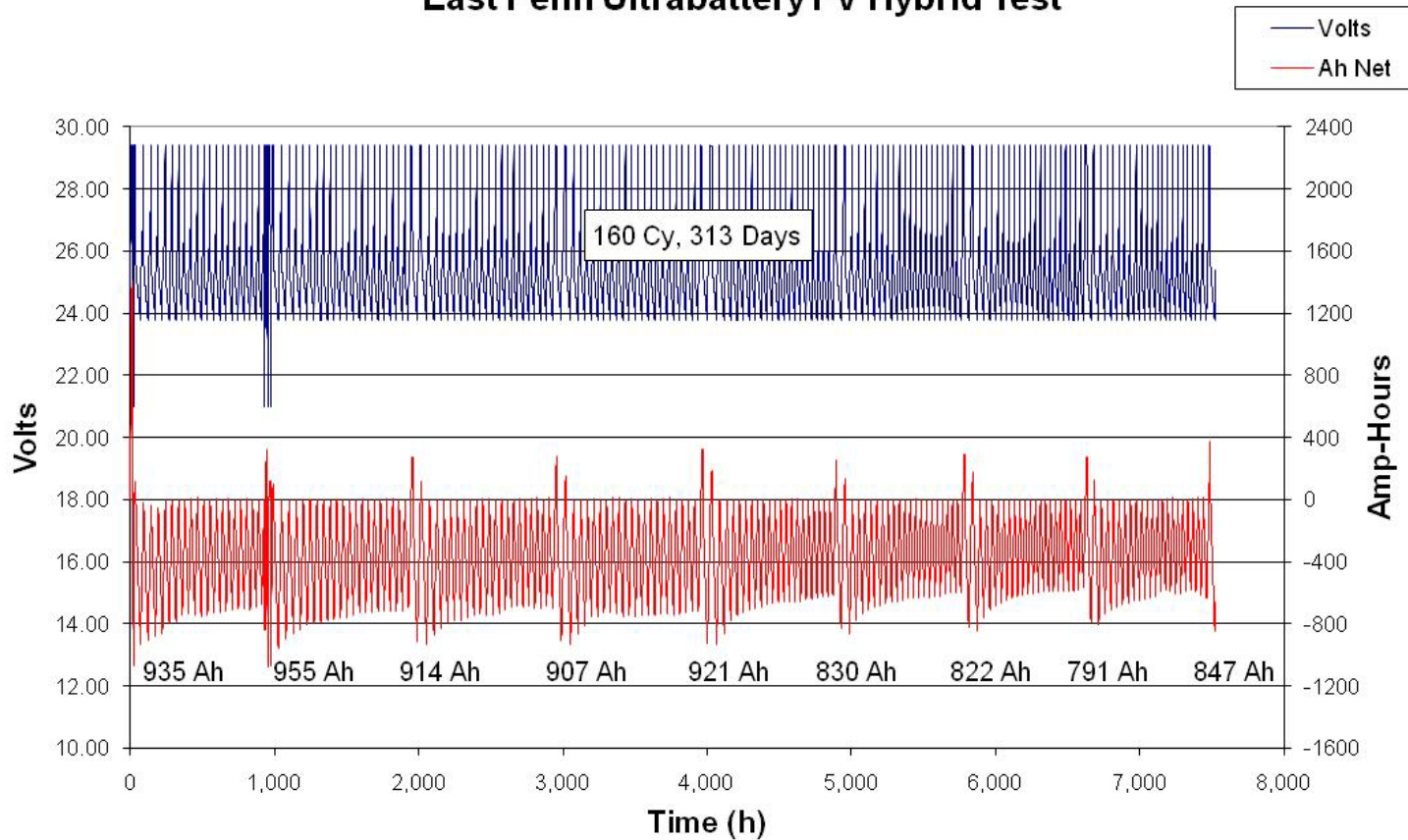


GS Yuasa
granular silica
tubular gel

Results – PV-Hybrid Cycle Test

UltraBattery®/Lead-Acid Carbon Supercap

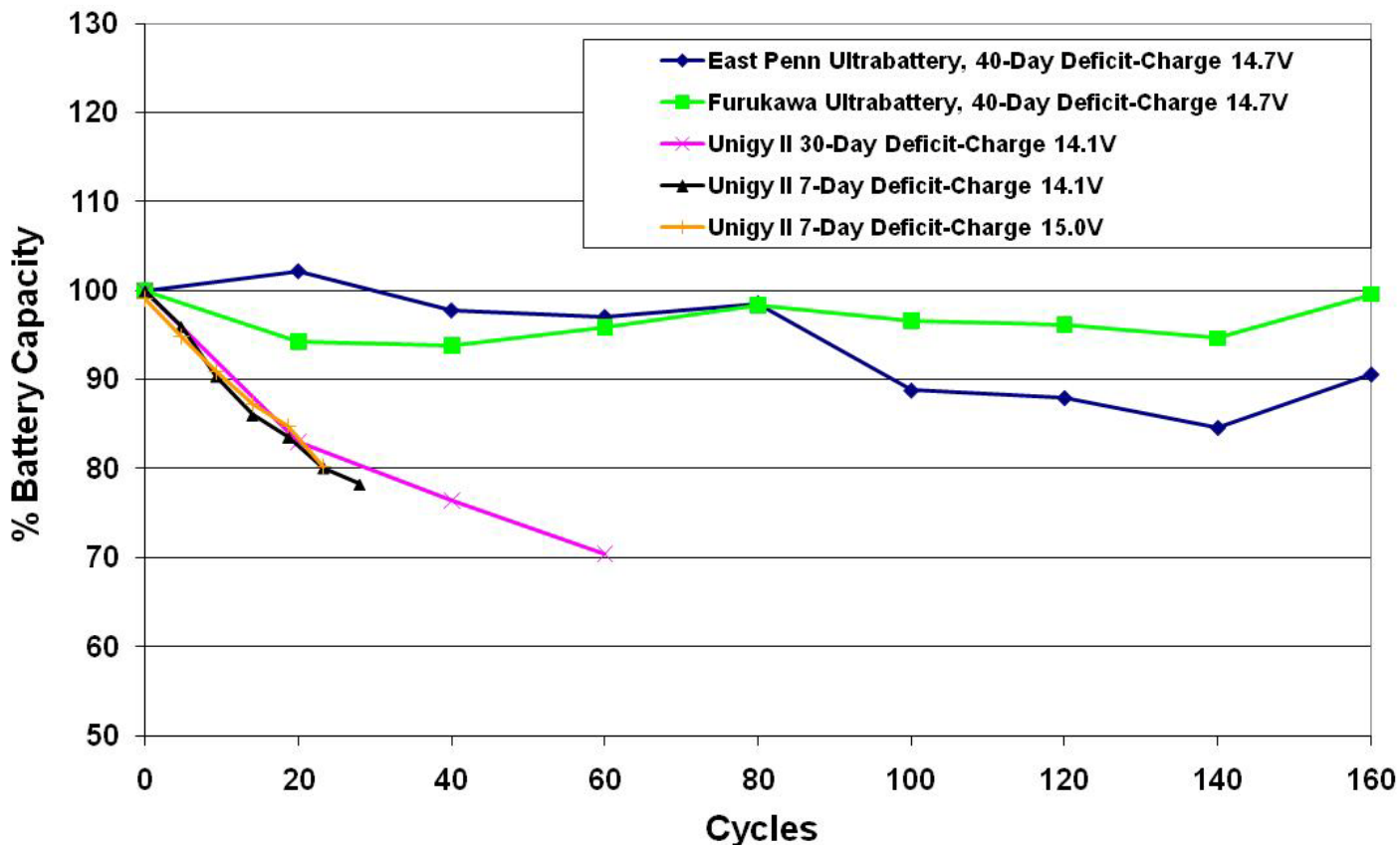
East Penn Ultrabattery PV Hybrid Test



Results – PV-Hybrid Cycle Test

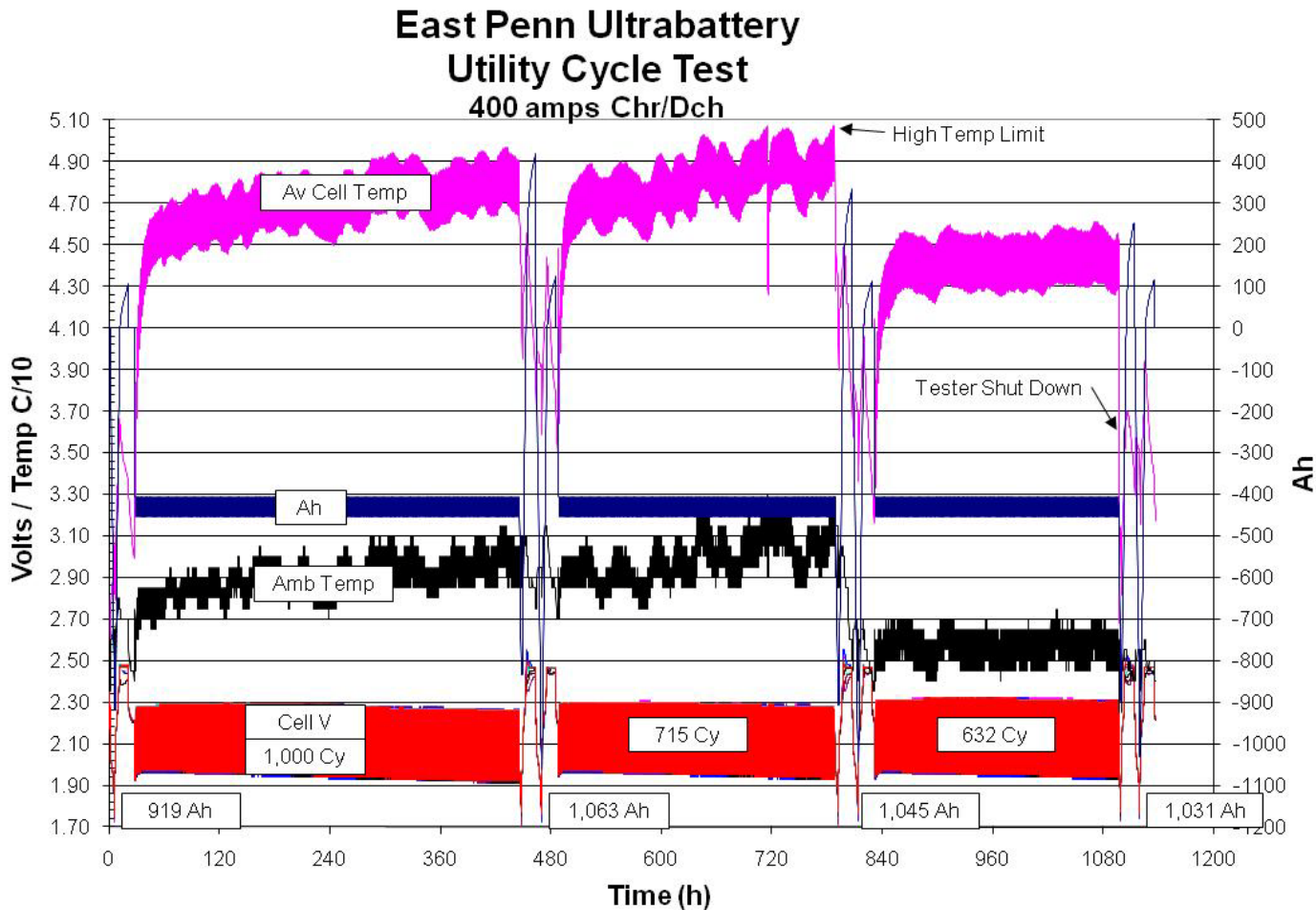
UltraBattery®/Lead-Acid Carbon Supercap

East Penn and Furukawa 1,000 Ah Ultrabattery
PV Hybrid Cycle-Life Tes



Results – Utility Cycle Test

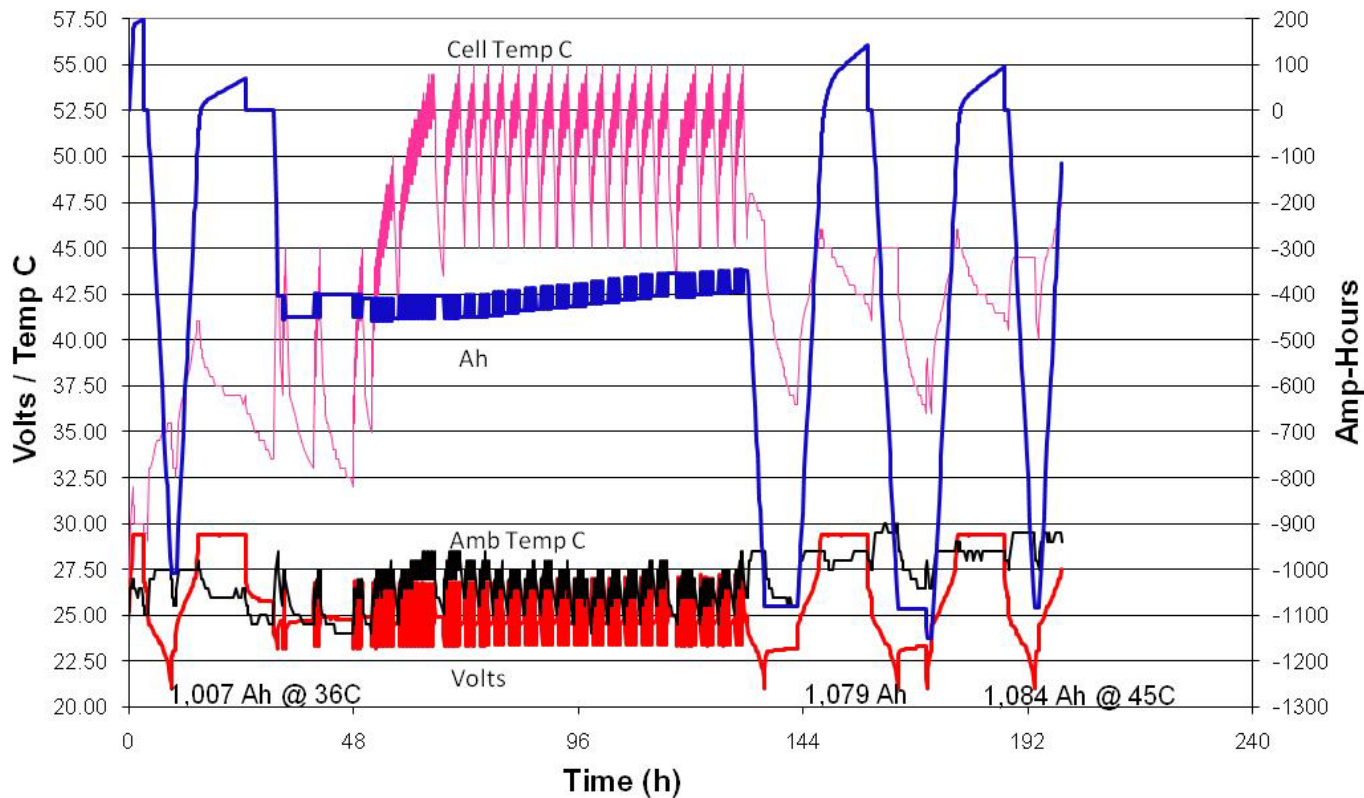
UltraBattery®/Lead-Acid Carbon Supercap



Results – Utility Cycle Test

UltraBattery®/Lead-Acid Carbon Supercap

Furukawa Ultrabattery Utility Cycle
400A Chr/Dch





FY-10 Conclusions

Summary

- UltraBattery® cycle performance has proven to be significantly better than conventional VRLA batteries.
 - PV-Hybrid Cycle Test - 1 to 9% capacity loss in 1 yr vs. ~20% in 1 month (>10X cycling performance)
 - Utility Cycle Test – capacity increased after 1,000 cycles
 - Utility Cycle Test – cell voltage is stable over the 1,000 cycles
- UltraBattery® does cycle at higher than expected temperatures at 400 amps
 - Utility Cycle Test – East Penn ~45C
 - Utility Cycle Test – Furukawa >55C



FY-11 Work

- **Cycle UltraBattery®**
 - Continue PV-Hybrid Cycle Test - >20% capacity loss or 2 yr are complete
 - Continue Utility Cycle Test – >20% capacity loss or 1 yr is complete
- **Utility Cycle International Li-FePO₄ Cell**
 - Utility Cycle Test – >20% capacity loss or 1 yr is complete
- **Utility Cycle Altairnano Li-titanate oxide Cell**
 - Utility Cycle Cest – >20% capacity loss or 1 yr is complete
- **Flow battery testing (UTRC & Red Flow)**
 - **Environmental testing, efficiency, reliability**