Large Format Carbon Enhanced VRLA Battery Test Results

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Objective

- **Test Advanced Lead-Acid Battery Consortium (ALABC) technology for utility partial state of charge (PSOC) cycling applications. Utility applications may include:**
  - **Wind farm energy smoothing**
  - **Photovoltaic energy smoothing**
  - **Utility ancillary services**

Energy Storage System

- **East Penn Manufacturing**
  - **Large format ALABC carbon enhanced absorbed glass mat (AGM) valve regulated lead-acid (VRLA) for utility PSOC cycling applications**

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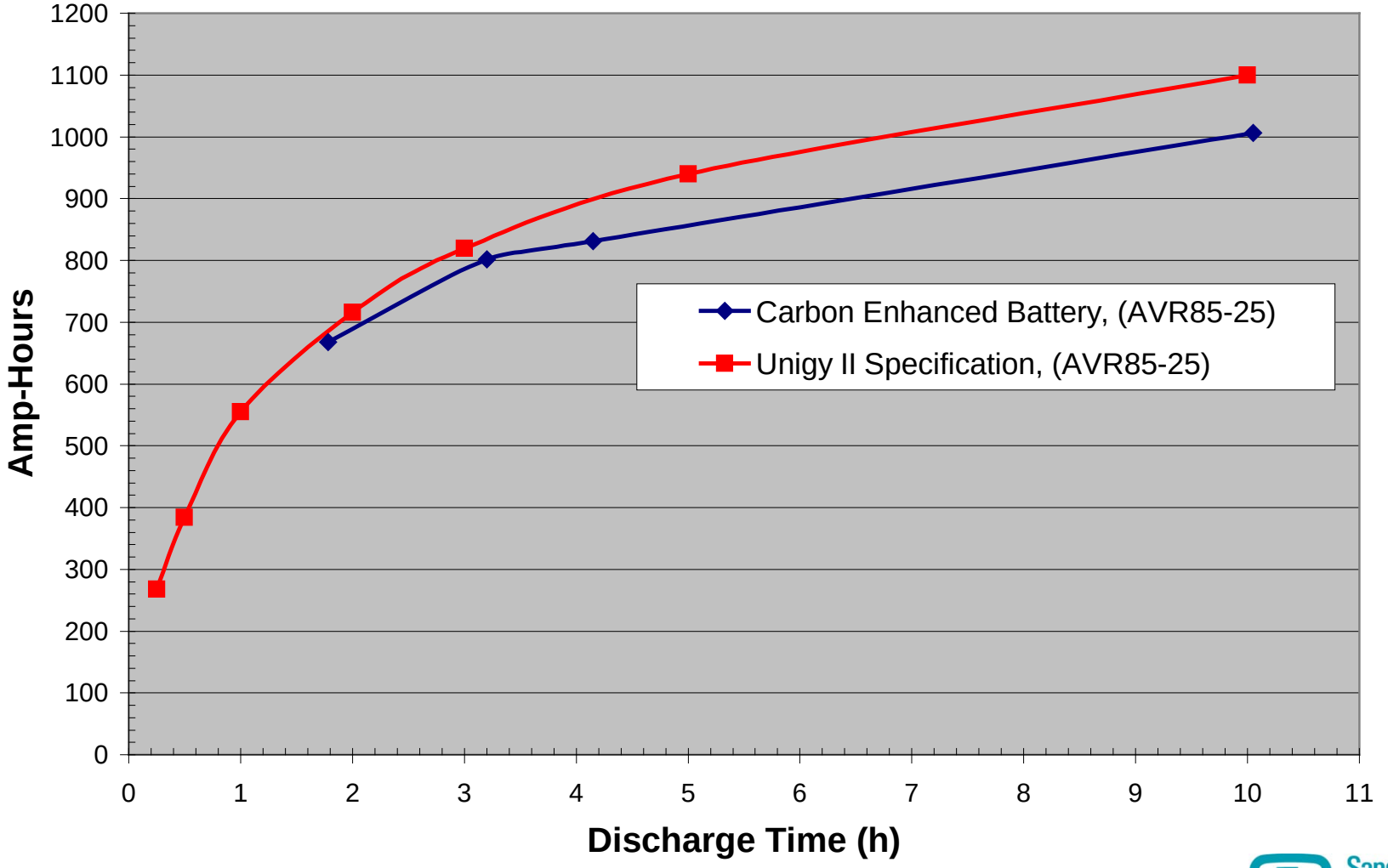
Test Plan For Battery

- Capacity.
- DC Ohmic resistance
- Float current
- Utility PSOC cycle test (10% DOD @ 50% SOC)
- Final DC Ohmic resistance
- Final capacity

Capacity Curve For Unigy II and Carbon Enhanced Battery



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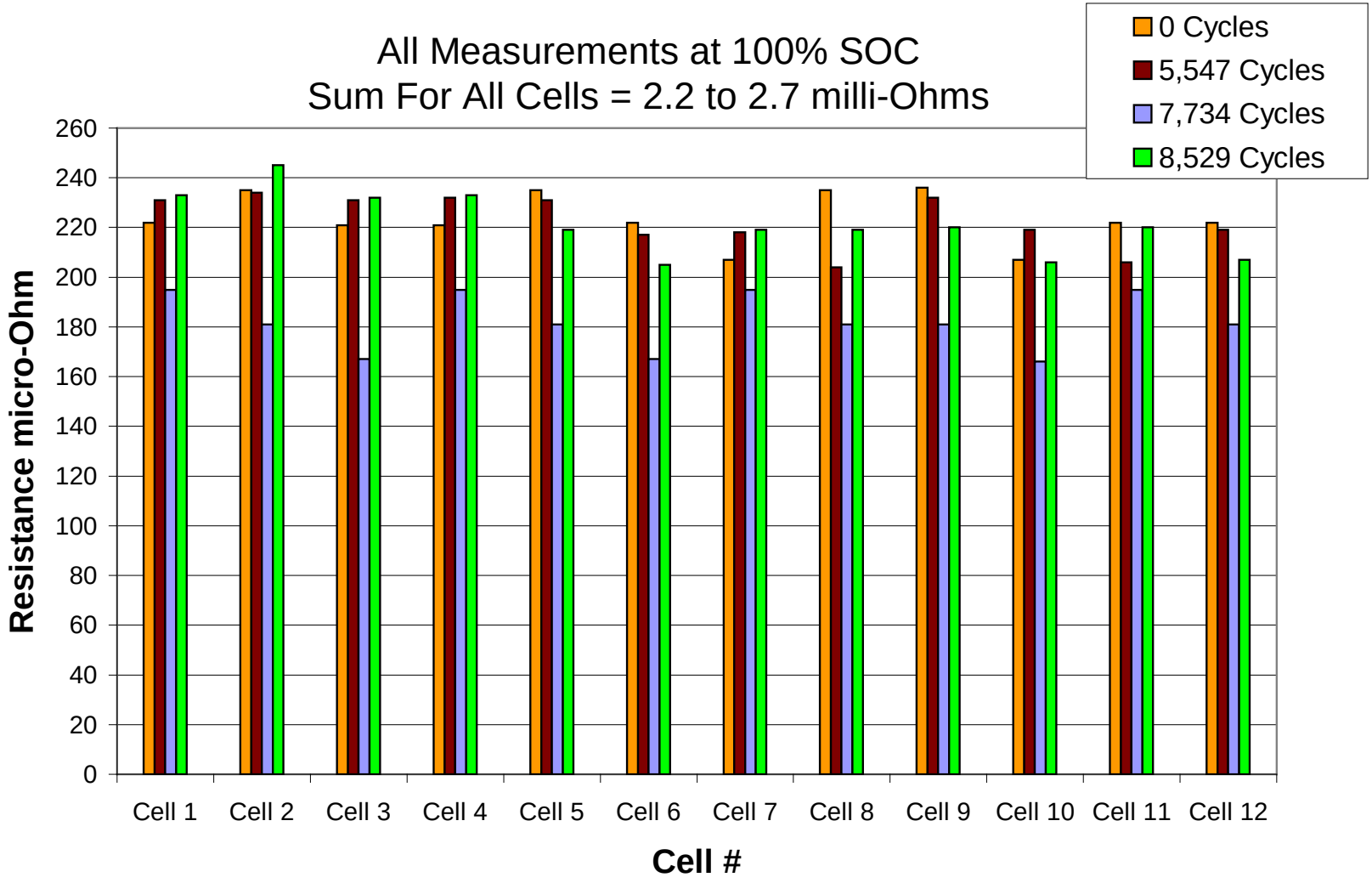
Alber Cell Impedance After Indicated Cycles



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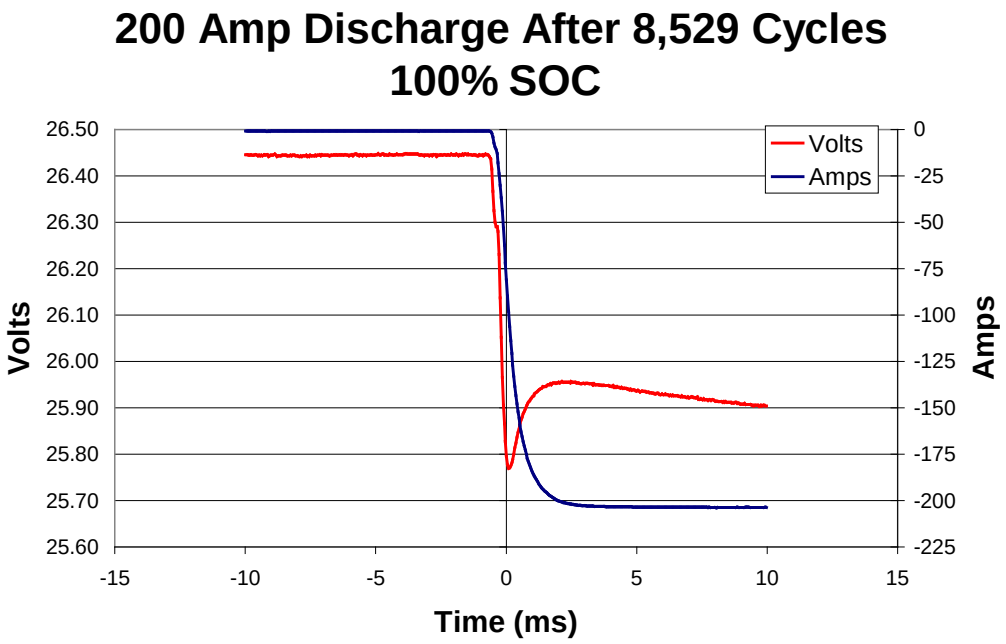
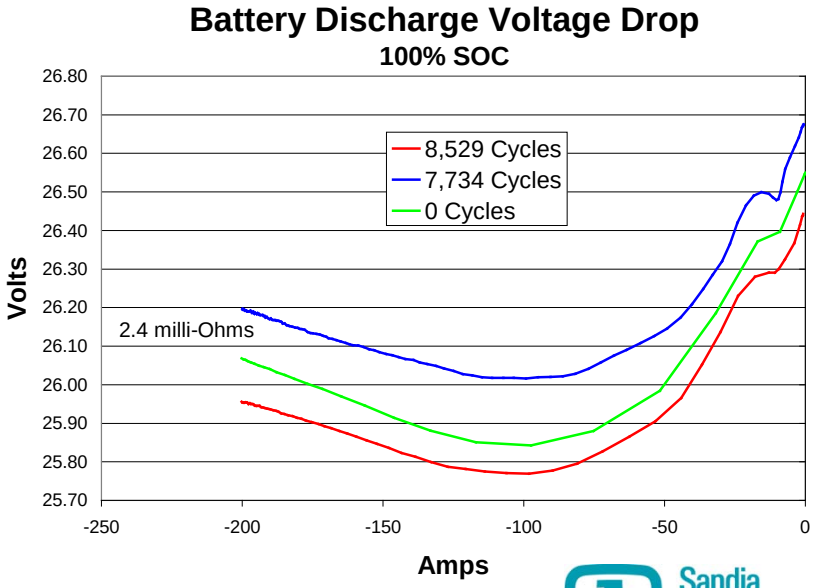
Ohmic Discharge Voltage Drop After Cycling





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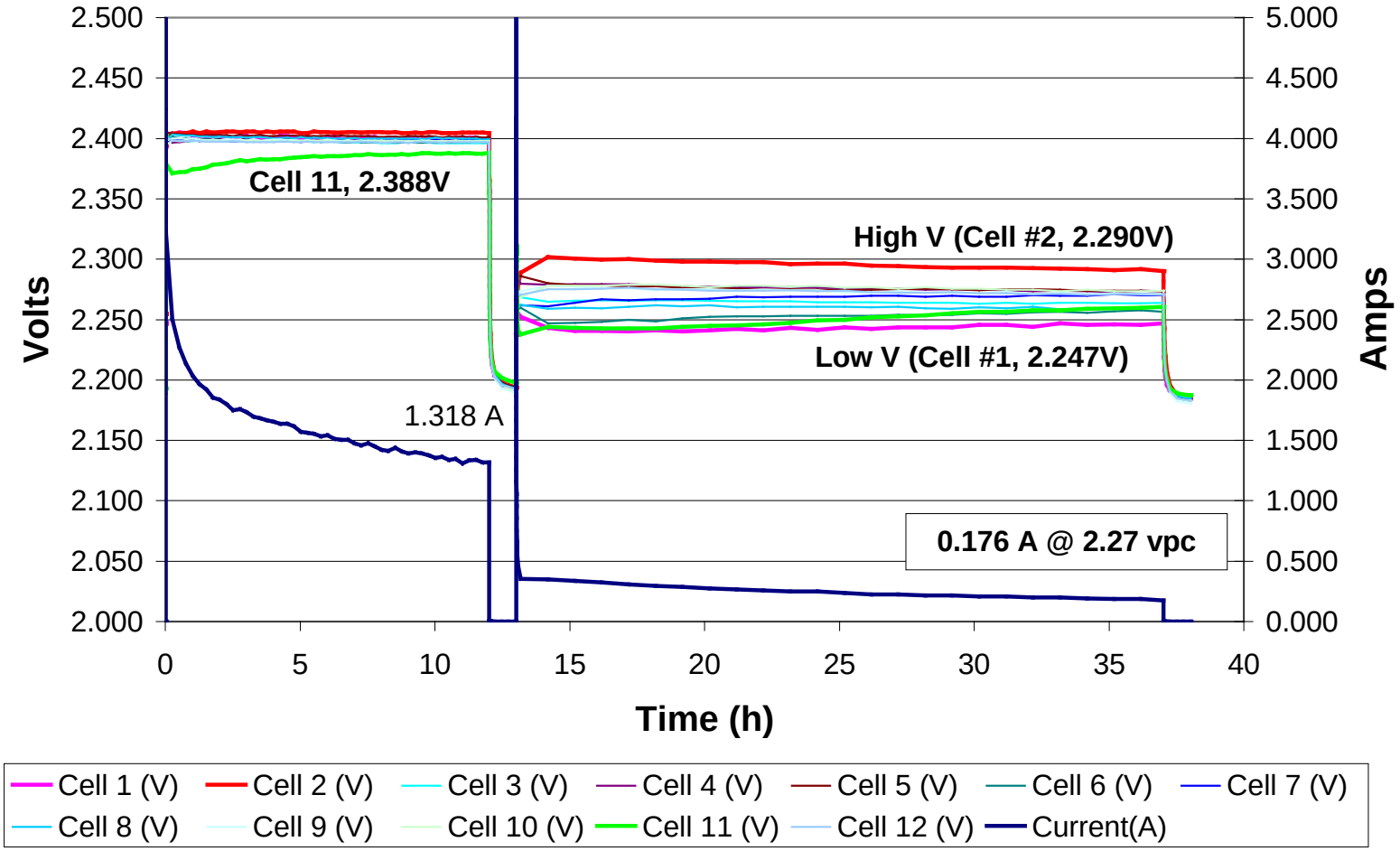
Float Current



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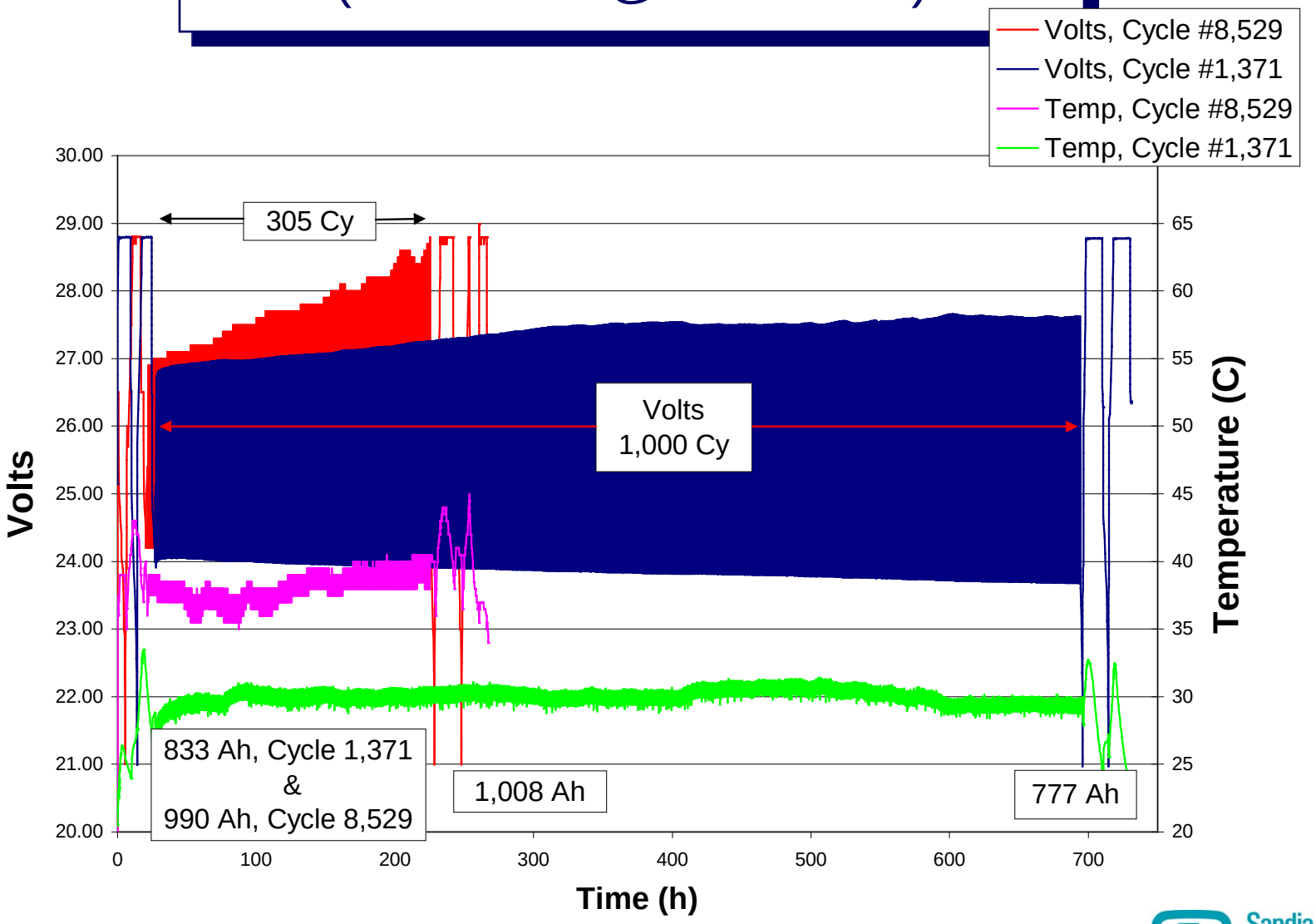
Utility PSOC cycle test at 200A (10% DOD @ 50% SOC)



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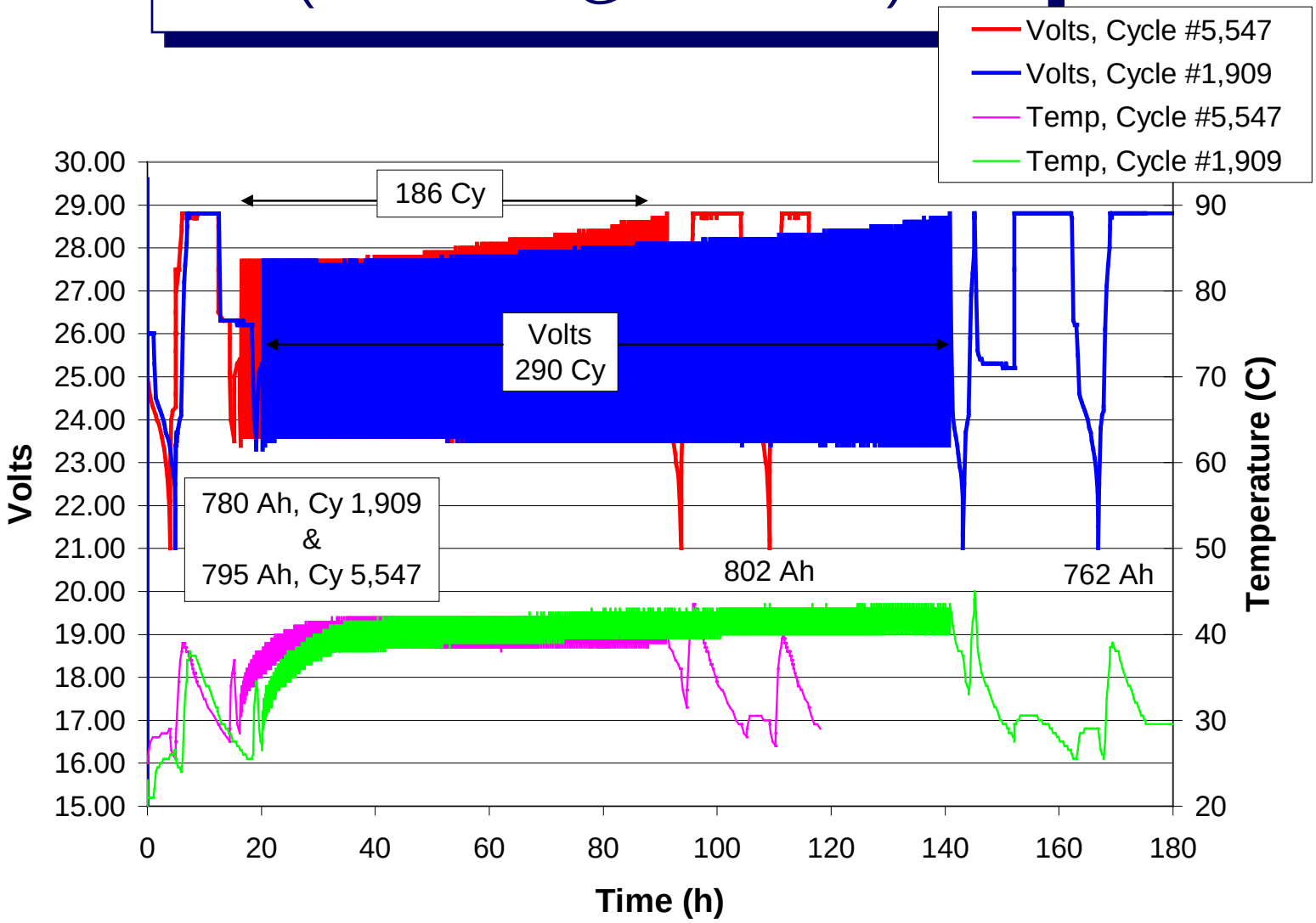
Utility PSOC cycle test at 400 A (10% DOD @ 50% SOC)



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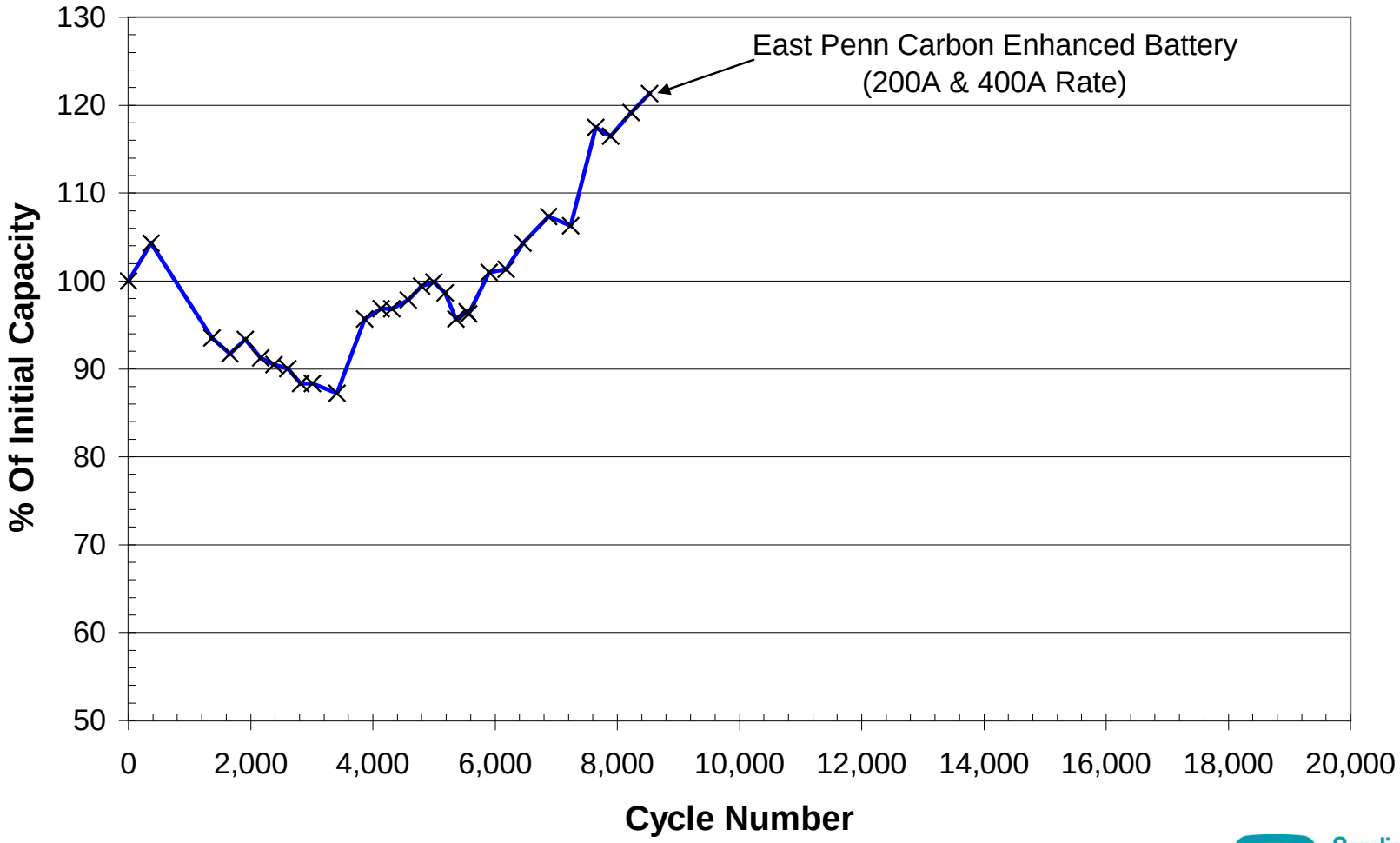
Capacity As A Function of PSOC Cycles



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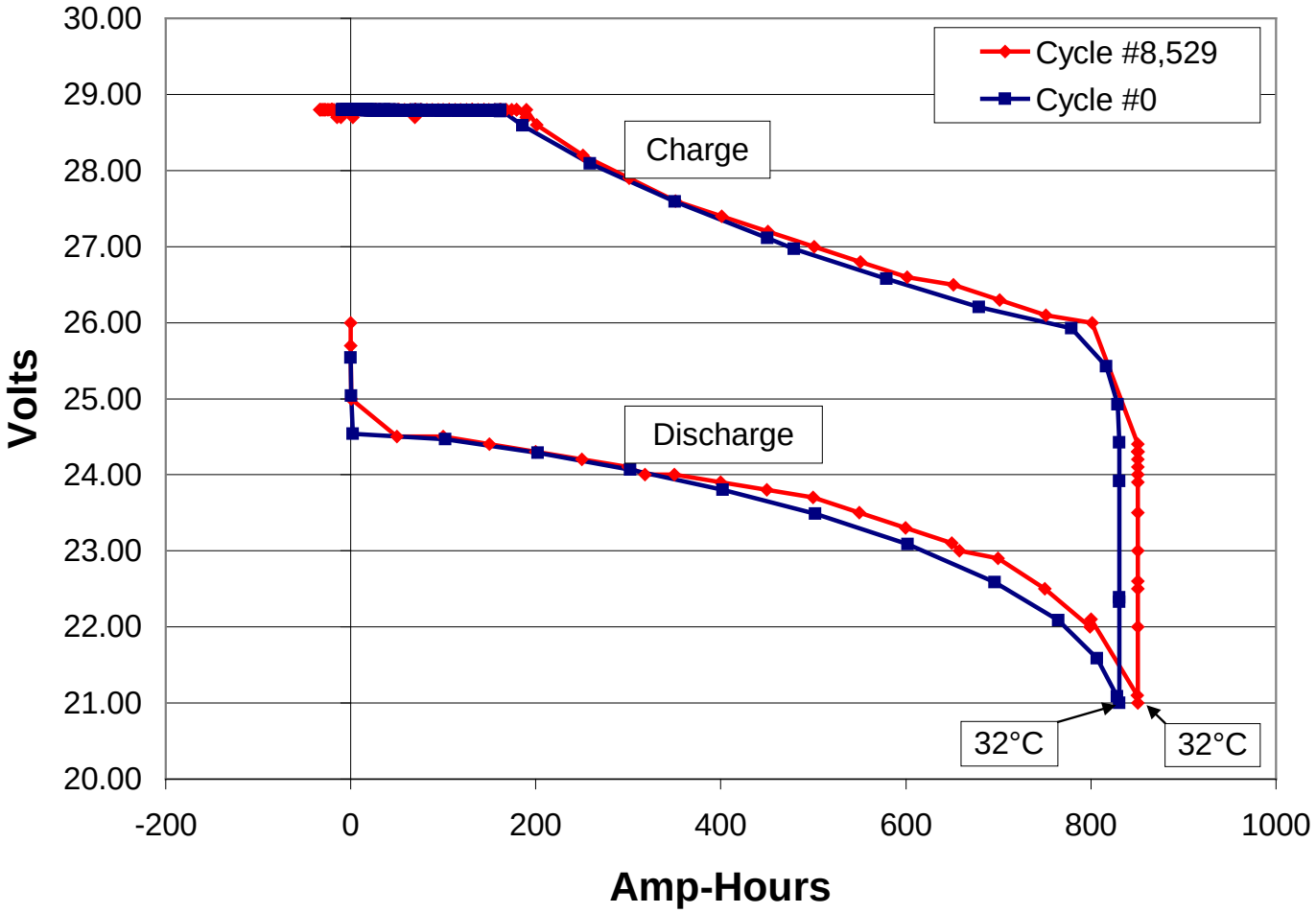
Initial and Final Capacity At 200A



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Summary

- **The East Penn ALABC carbon enhanced large format VRLA has proven to cycle well at a partial state of charge.**
  - **Final capacity at 200A after 8,529 PSOC cycles was measured at 851 Ah at 32 C. This is 102% of initial capacity measured at 32 C.**
  - **During PSOC cycling the capacity exceeded 120% of initial capacity after 8,529 PSOC cycles.**
  - **Capacity increased after 3,400 cycles from a low of 87% of initial capacity to over 120% at 8,529 PSOC cycles**
  - **Capacity measured during PSOC cycling was much higher than capacity after an extended rest**
- **Ageing Performance degradation:**
  - **Higher operating temperature (from 9 to 12 C above ambient)**
  - **Fewer PSOC cycles (about 1/3 to 2/3 of initial number)**
  - **Increased Cell voltage divergence at end of PSOC cycling**
- **Future work will include an energy storage system for photovoltaic grid tied energy smoothing.**