



Testing and Evaluation of Energy Storage Devices

DOE Energy Storage Systems Research Program Annual Peer Review

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*Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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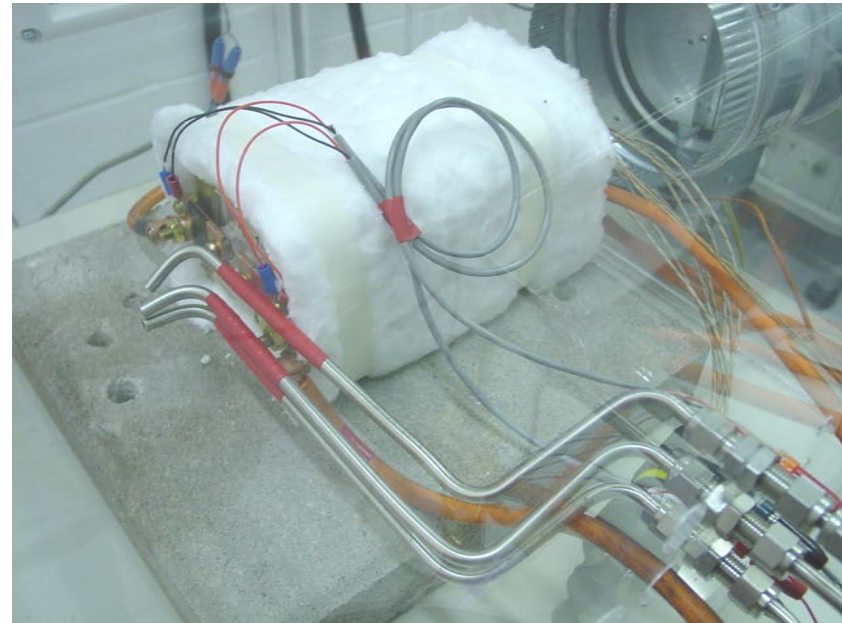
Introduction (Previous Work)

- ◆ **Sandia's Power Sources Component Development Dept. provides unbiased energy storage testing support to the DOE Energy Storage Program.**
- ◆ **Previous work has included supercap testing on ESMA, Maxwell, and Okamura Labs devices, and battery testing on EEI Bipolar NiMH, Cyclon VRLA, and C&D CPV vented deep-cycle lead-acid batteries.**

Introduction

(FY-06 Work)

- ◆ Develop test protocols for energy storage device development funded by the DOE Energy Storage Program
- ◆ Test MeadWestvaco-NorthStar Battery carbon enhanced VRLA batteries
- ◆ Test Electro Energy Bipolar NiMH Battery
- ◆ Abuse test on symmetric carbon/carbon acetonitrile based electrolyte NessCap supercapacitors
- ◆ Test SunGel VRLA battery used in the ILZRO Peru RAPS system



Supercap Abuse Testing

Energy Storage Devices Under Test (FY-06)

- **MeadWestvaco/NorthStar**
(Carbon Enhanced Negative Electrode
VRLA Battery)



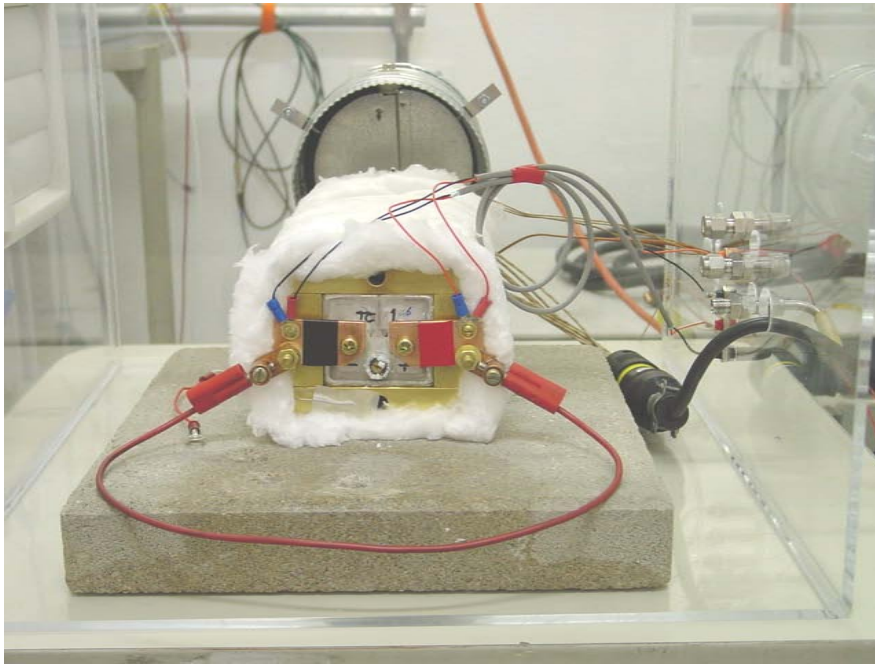
- **Electro Energy**
(Bipolar NiMH Battery)



Energy Storage Devices Under Test (FY-06)

•NessCap

(Symmetric Carbon/Carbon
Acetonitrile Based Electrolyte)



•Battery Energy

(SunGel - VRLA Gel Battery
Used In The ILZRO Peru RAPS)



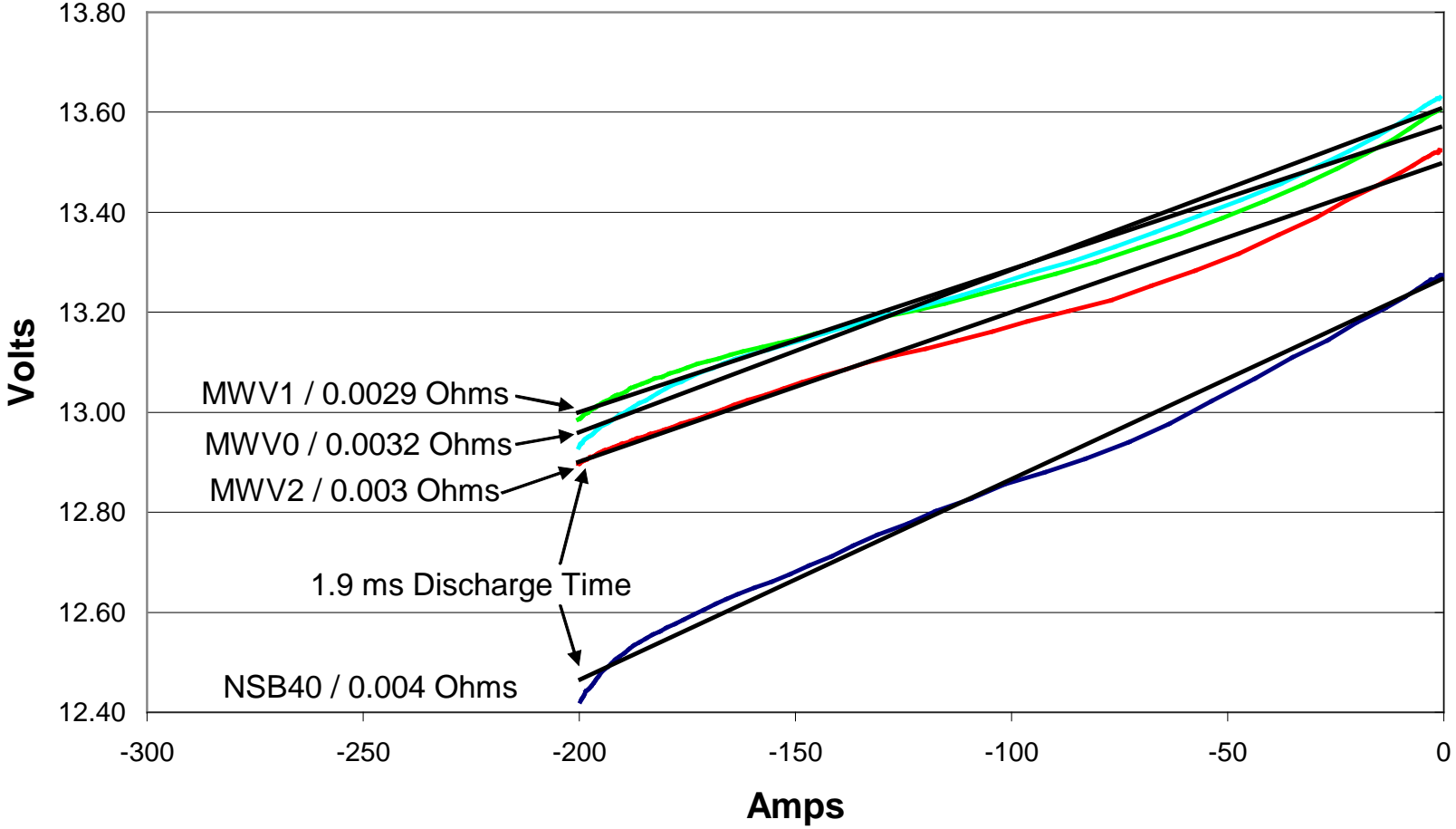


Test Procedures

- ◆ **MeadWestvaco/NorthStar and Electro Energy NiMH**
 - ❖ Battery Ohmic Resistance
 - ❖ Ragone Plot
 - ❖ Utility Cycle Profile (ISOC)
- ◆ **NessCap Supercap**
 - ❖ Abuse Test (Over-voltage and Over-temperature)
 - ❖ Analyze Vented Gases From Supercap
- ◆ **Battery Energy (SunGel/ILZRO Peru RAPS)**
 - ❖ Modified BCI Cycle-Life Test - Evaluate Intermediate State of Charge (ISOC) Cycling

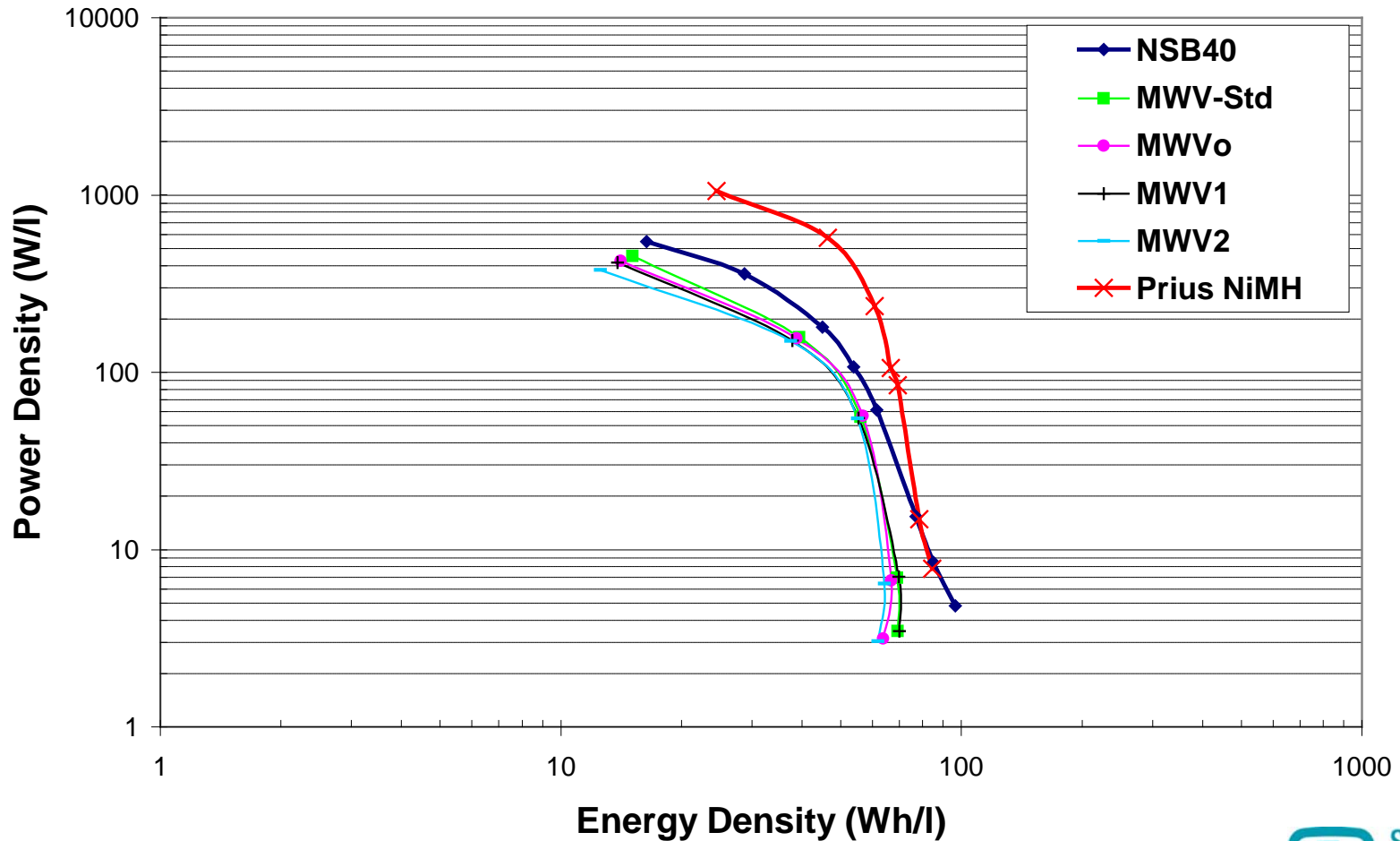
MeadWestvaco/NorthStar Ohmic Resistance

MeadWestvaco/NorthStar Carbon Enhanced VRLA Battery Ohmic Resistance



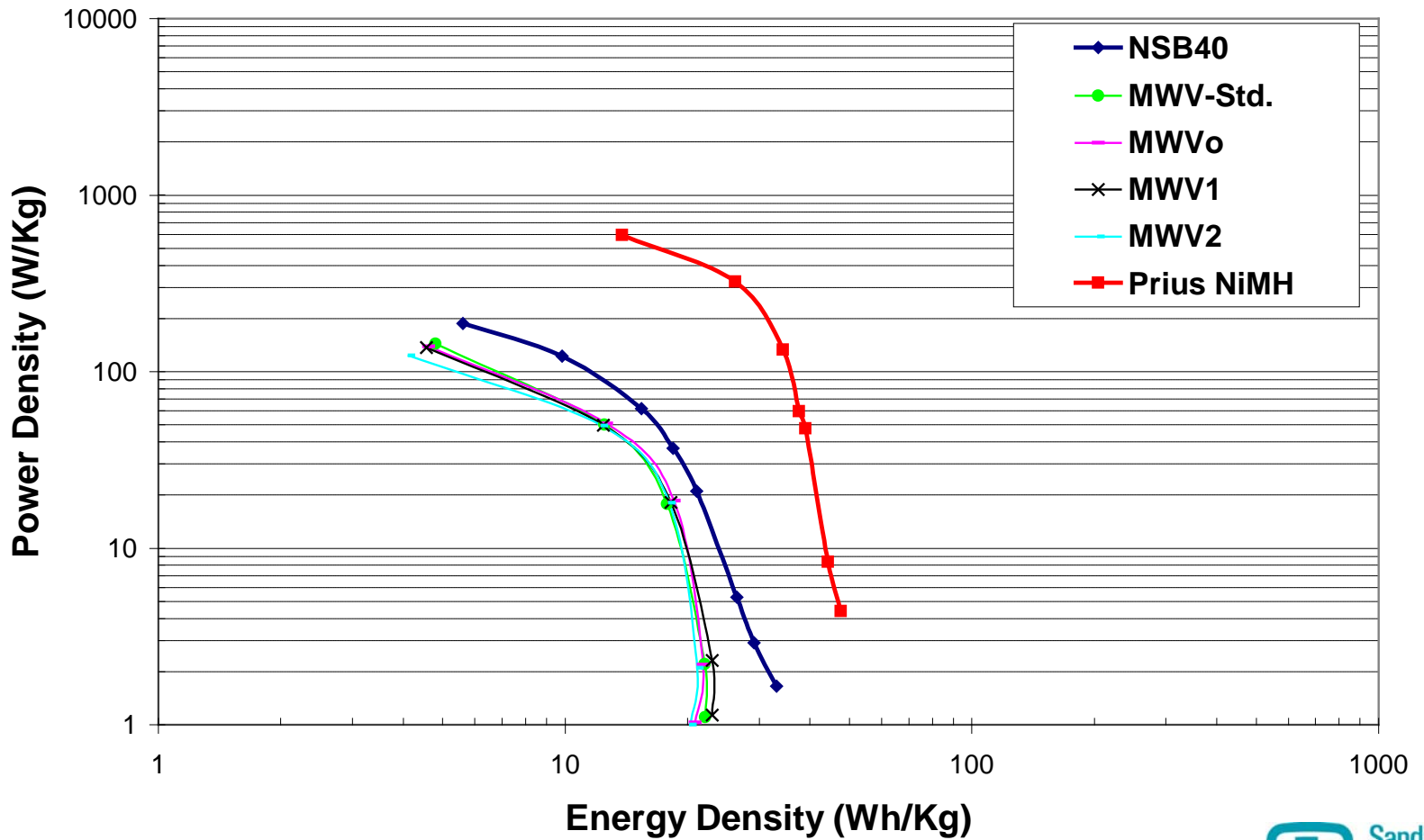
MeadWestvaco/NorthStar Ragone Plot

Ragone Plot For MeadWestvaco/NorthStar Battery



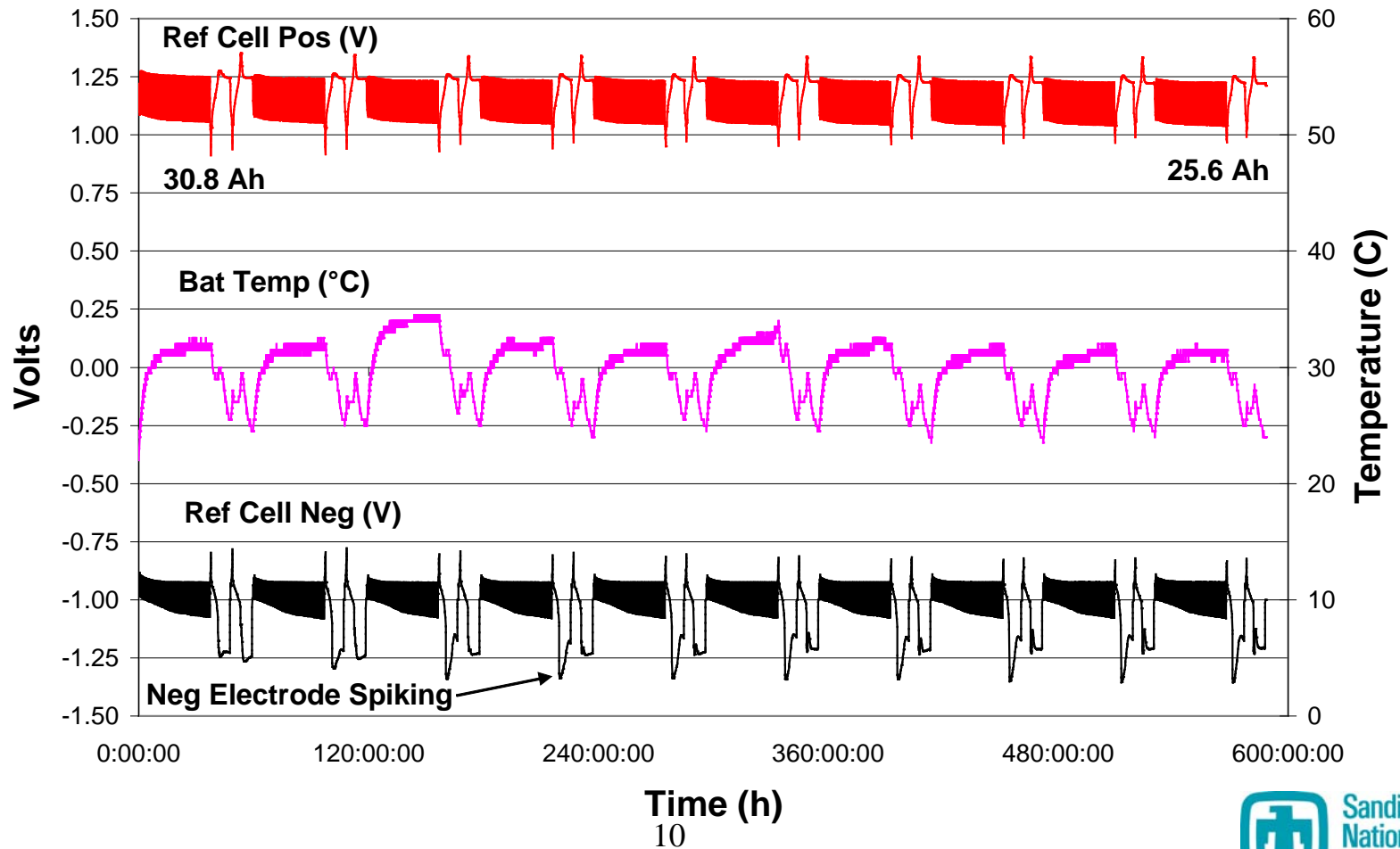
MeadWestvaco/NorthStar Ragone Plot

Ragone Plot For MeadWestvaco/NorthStar Battery



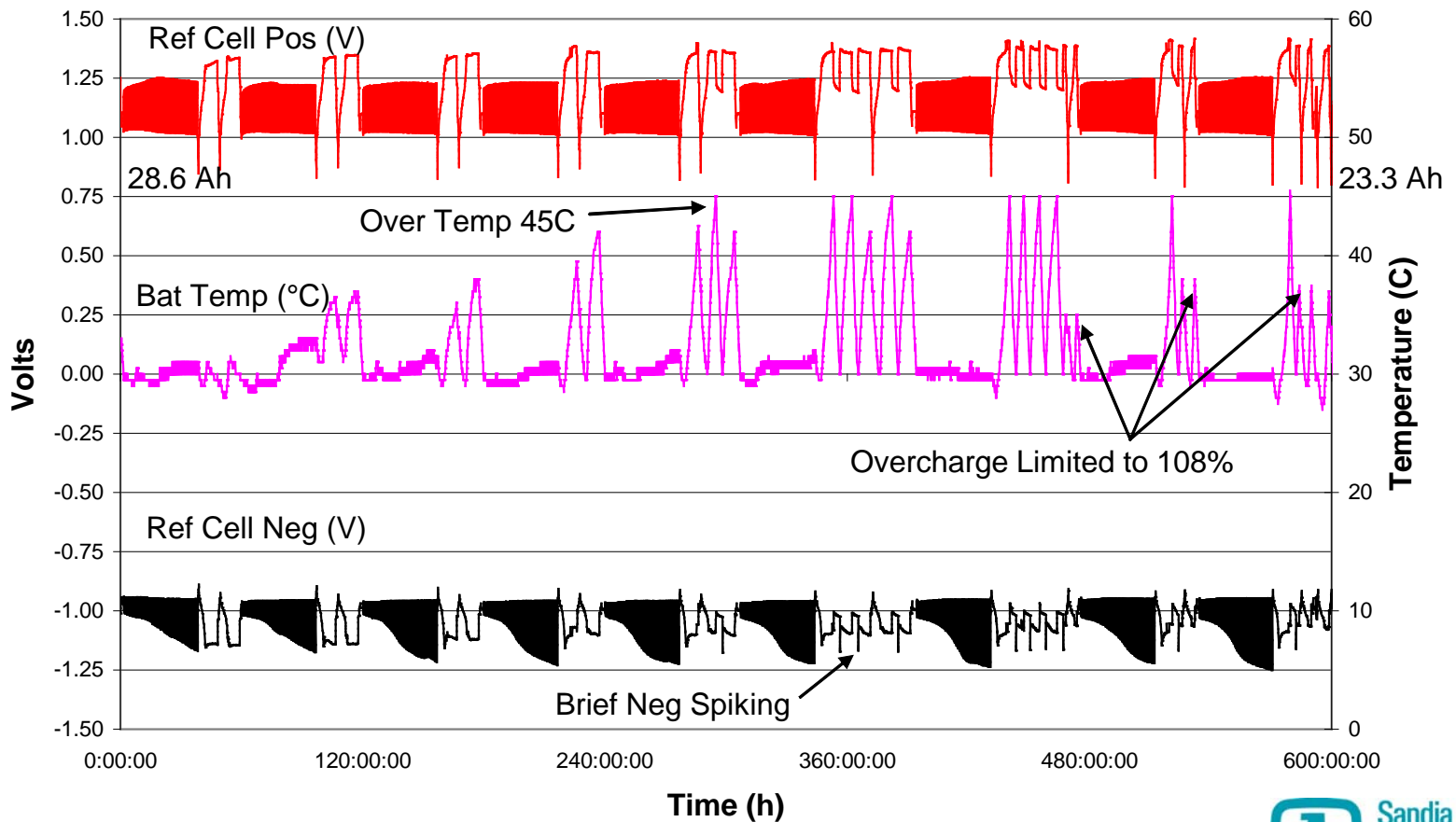
MeadWestvaco/NorthStar Utility Cycling

NSB40 Utility Cycle 1C 6M
8/9/06



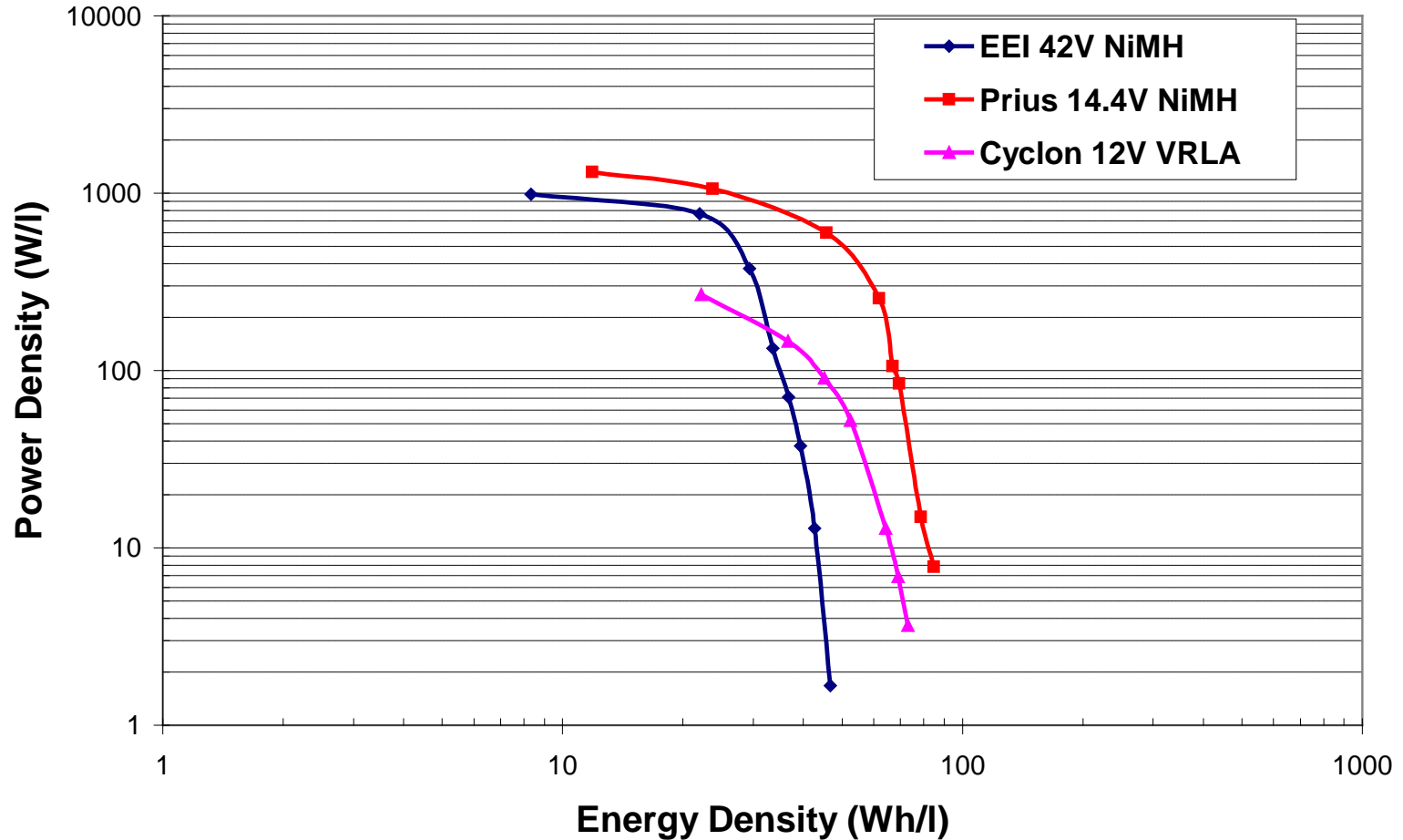
MeadWestvaco/NorthStar Utility Cycling

MWV1 Utility Cycle 1C 6M
9/5/06



Electro Energy Bipolar NiMH

Ragone Plot





NessCap Supercap

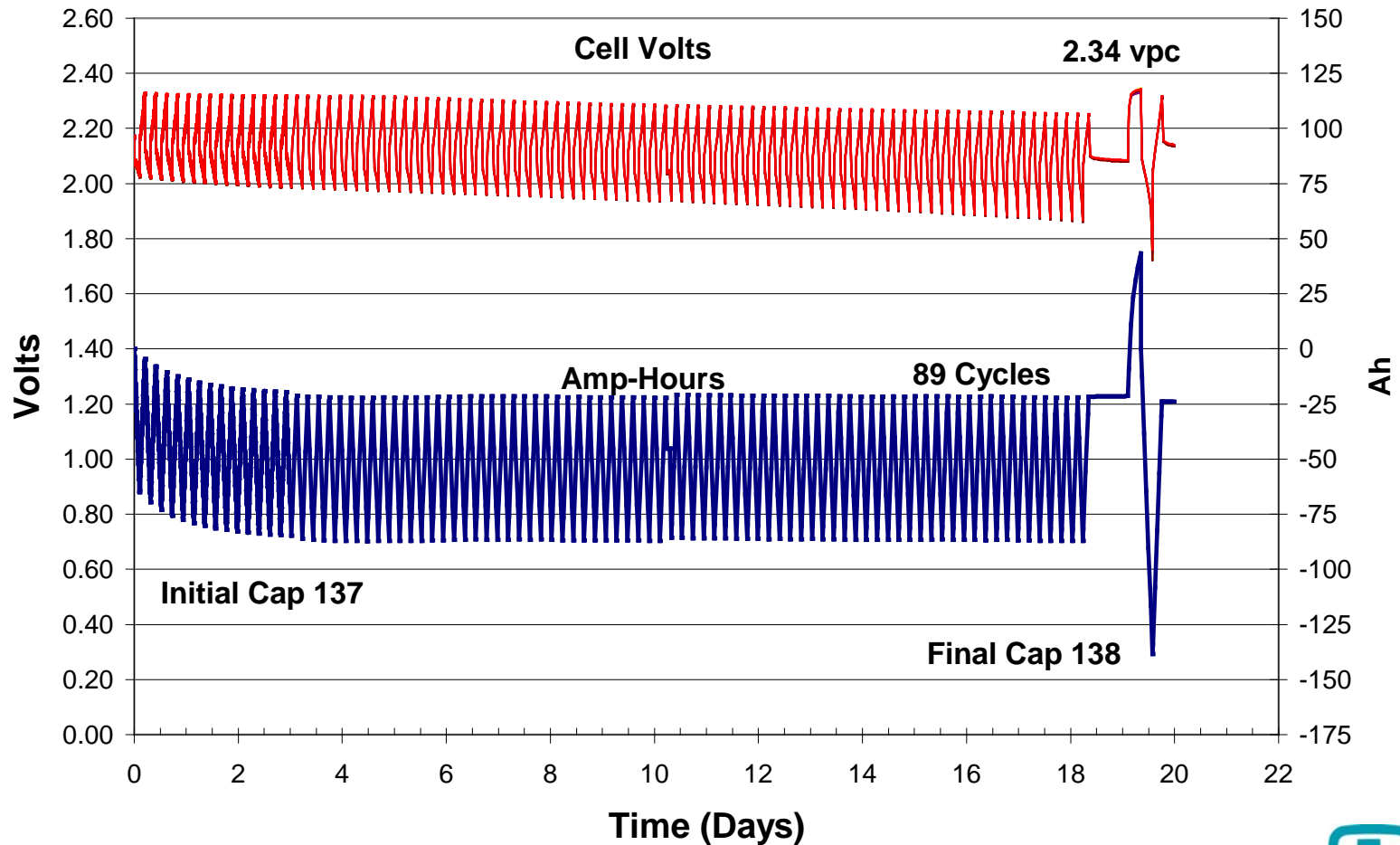
Symmetric Carbon/Carbon Acetonitrile Electrolyte Over-temperature Test With Ignition Source



(Click on image to view video)

SunGel ISOC Cycle Test

SunGel ISOC Cycle-Life Test
50% DOD, 26A, 46C





Summary

- ◆ **The DOE Energy Storage Program funded testing provides an unbiased resource for test information, which can be used at all levels in the decision making process.**
- ◆ **Testing support provides MeadWestvaco/NorthStar and Electro Energy Bipolar NiMH Battery manufacturers with timely performance results for advanced carbon formulations and Bipolar NiMH design considerations.**



Summary

- ◆ **Supercap abuse testing has identified the effects of over-voltage and temperature and the hazardous gases vented from supercaps using acetonitrile. This work is critical for safe design of supercap systems used in utility applications.**
- ◆ **Intermediate State of Charge (ISOC) cycling of the SunGel battery used in the ILZRO Peru RAPS system provides detailed charging requirements and performance measurements that can be transferred to the fielded system.**



Work to Do

- ◆ **Continue development of carbon enhanced negative electrode valve regulated lead-acid (VRLA) batteries**
- ◆ **Publish supercap abuse test results at the 16th International Seminar on Double Layer Capacitors and Hybrid Energy Storage Devices**
- ◆ **Continue testing Electro Energy bipolar NiMH batteries**
- ◆ **Continue testing SunGel VRLA battery. Integrate test results with the ILZRO Peru RAPS system**