

Safety and Abuse Testing of Energizer LiFeS₂ AA Cells

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INTRODUCTION

- **The LiFeS₂ test program was part of the study on state-of-the-art batteries/cells available in the commercial market.**
- **It was carried out in an effort to replace alkaline AA cells for Shuttle and Station applications.**
- **A large number of alkaline cells are used for numerous Shuttle and Station applications as loose cells.**
- **Other government agencies reported good performance and abuse tolerance of the AA LiFeS₂ cells.**
- **In this study, only abuse testing was performed on the cells to determine their tolerance.**
- **The tests carried out were overdischarge, external short circuit, heat-to-vent, vibration and drop.**

Energizer LiFeS₂ Cells



L91



e² Lithium

Energizer L91 Cell Characteristics

Cell: **Height** **Diameter**
 1.988 in. **0.5 in.**

Weight: 14.5 g

OCV: 1.8 V

Capacity: 2.6 Ah

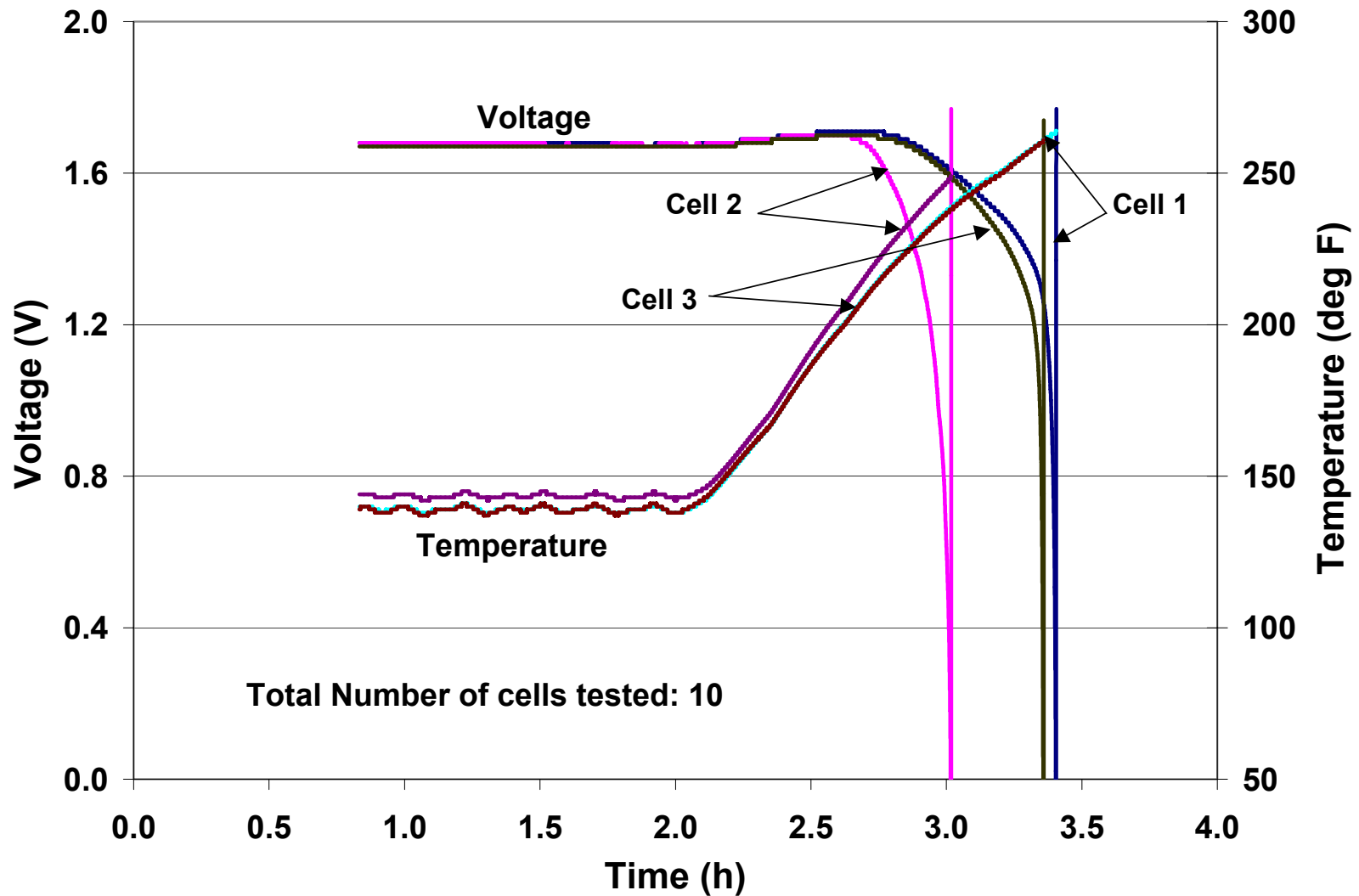
PTC : Operates between 85 to 95 °C (continuous drain allowed 1.4 A)

Pressure Relief Vent: Operates between 120 to 130 °C

Heat-to-Vent Test Setup for the Energizer LiFeS₂ Cells



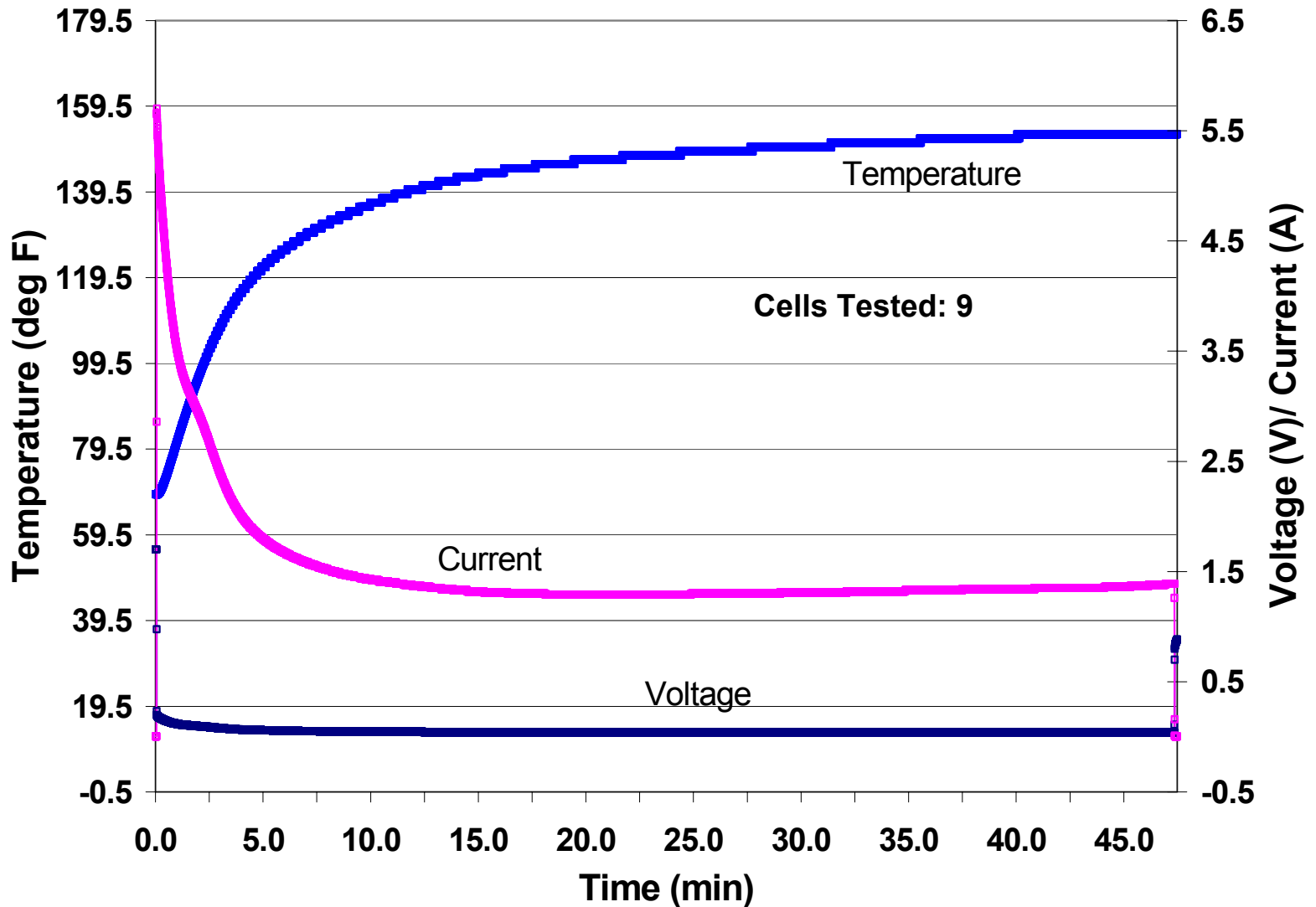
Heat-To-Vent Test on the Energizer L91 LiFeS₂ Cells



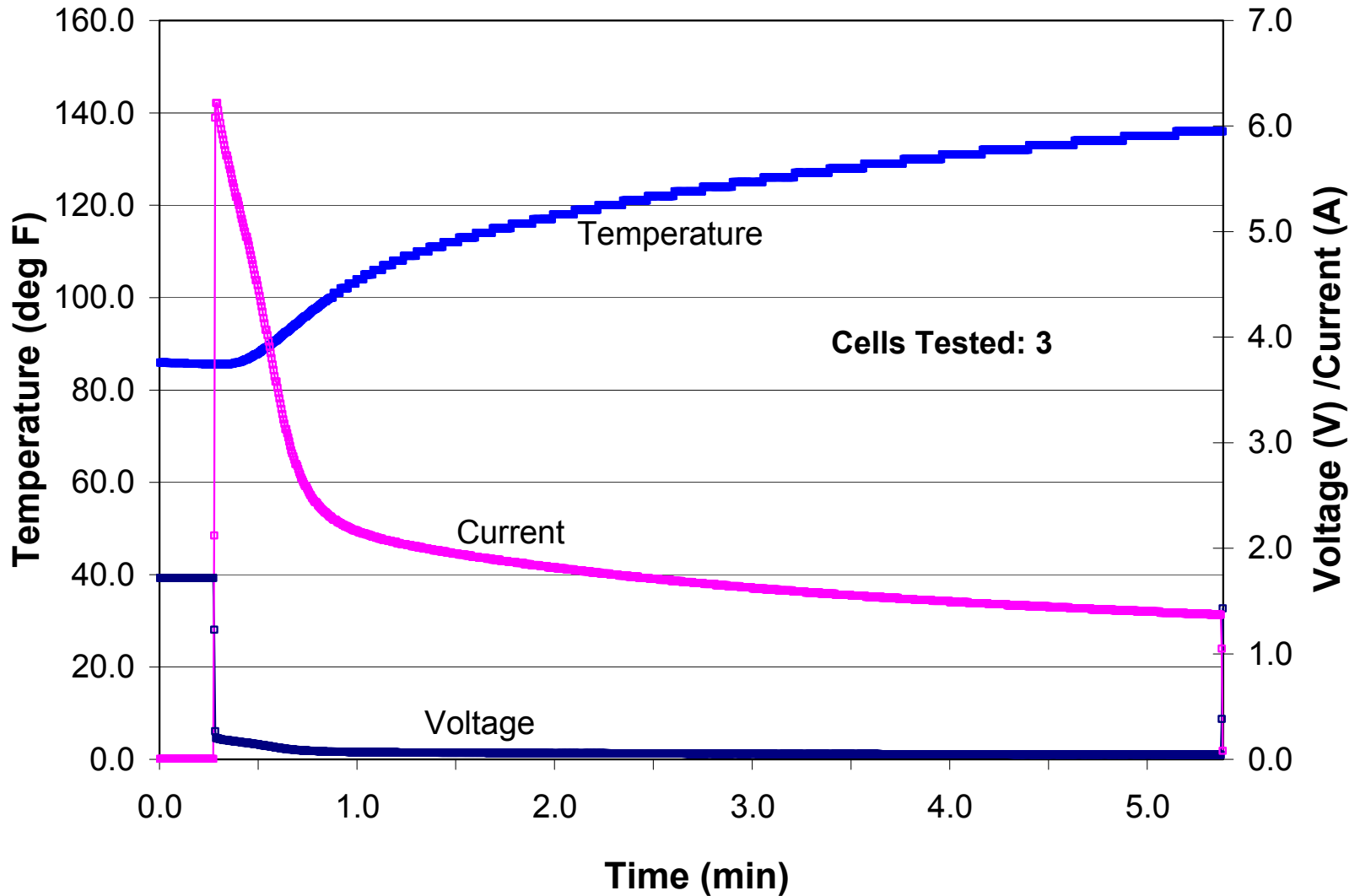
Heat-to-Vent Test on an Energizer LiFeS₂ Cell



Short Circuit Test on the Energizer L91 LiFeS₂ Cell



Short Circuit Test on the Energizer e²Lithium LiFeS₂ Cell



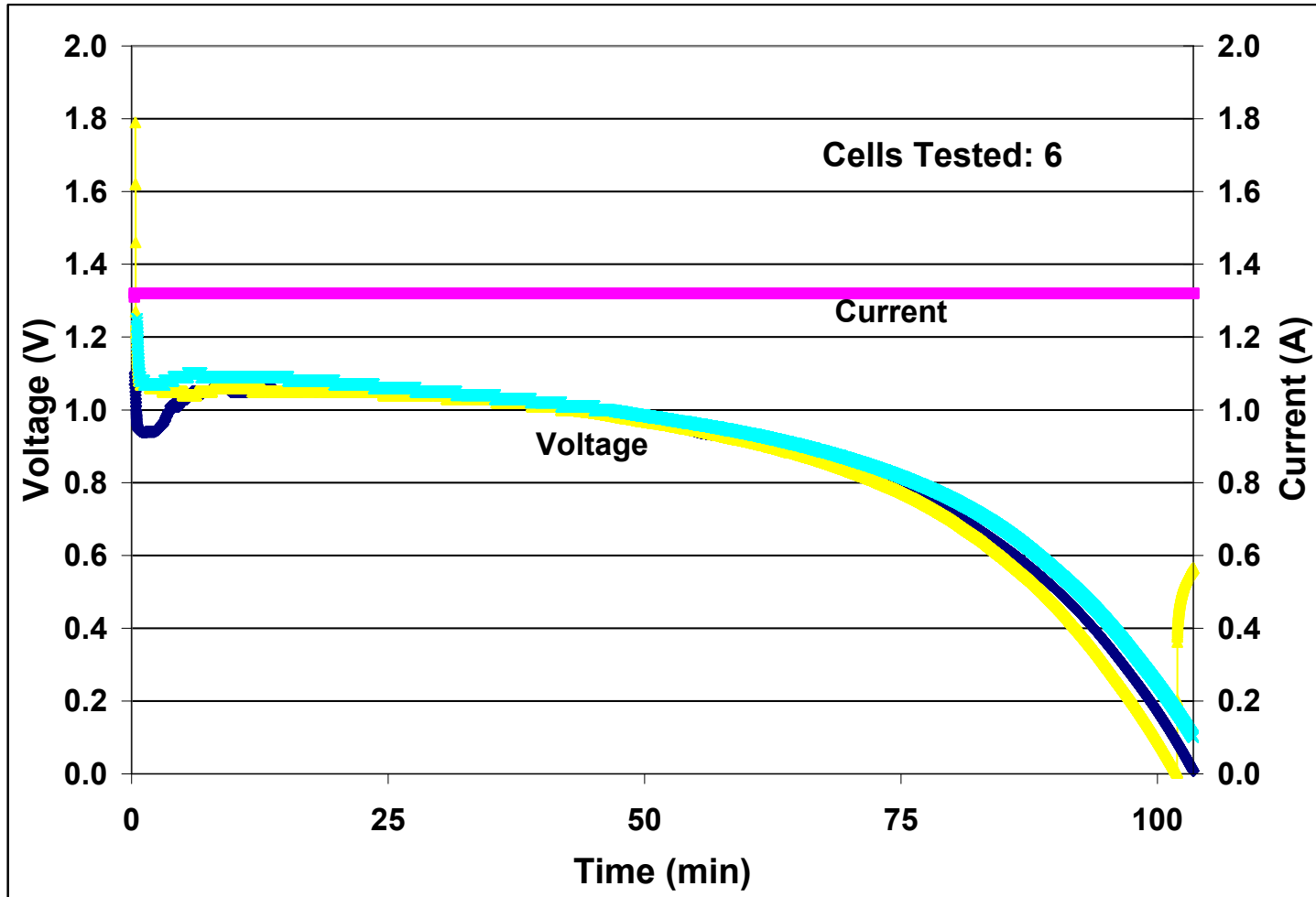
Overdischarge Test on the Energizer L91 and e² LiFeS₂ Cells

Load: 2.6 A

- **Test was completed almost immediately on both models due to the activation of the PTC inside the cell.**
- **Six L91 cells and 3 e² Li cells were tested under this condition.**

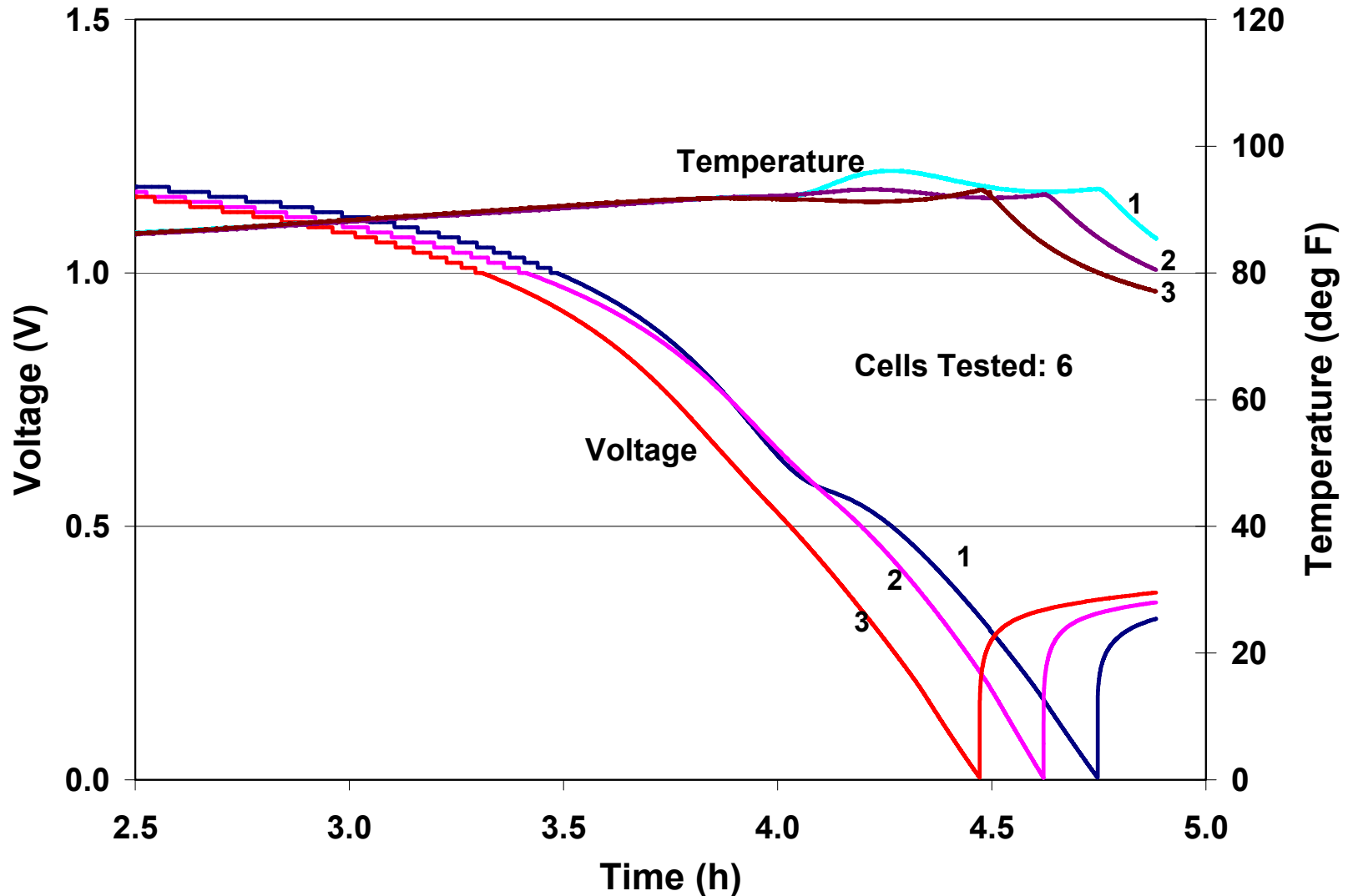
Overdischarge Test on the Energizer L91 LiFeS₂ Cells

Load: 1.3 A



Overdischarge Test on the Energizer L91 LiFeS₂ cells

Load: 0.52 A



Vibration Test for the Energizer L91 LiFeS₂ Cells

<u>Frequency</u>	<u>Level</u>
20-80 Hz	+3 dB/octave
80-350 Hz	0.1 g ² /Hz
350-2000 Hz	-3 dB/octave

- Four cells were vibrated for 15 minutes in each of the three independent axes.
- Post-vibration discharge was performed with 0.5 A to 0.9 V.
- Discharge capacities obtained for the four cells after the vibration in all three axes was 2.25 Ah, 1.75 Ah, 2.0 Ah and 2.0 Ah.

Drop Test on the Energizer L91 LifeS₂ Cells

- **Three cells were dropped randomly from a height of 3 ft onto a concrete surface.**
 - **Post-drop discharge was performed on the cells with 0.5 A to 0.9 V.**
 - **Discharge capacities of 1.9 Ah, 1.95 Ah and 1.95 Ah were obtained from the three cells.**
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- **Three cells were dropped randomly from a height of 6 ft on to a concrete surface.**
 - **Post-drop discharge was performed on the cells with 0.5 A to 0.9 V.**
 - **Discharge capacities of 2.1 Ah, 1.65 Ah and 2.05 Ah were obtained from the three cells.**

CONCLUSIONS

- The Energizer L91 LiFeS₂ cells were evaluated under abusive conditions of overdischarge, heat-to-vent, short circuit, drop and high levels of vibration.
- The PTC in the cells prevents the cells from going into hazardous condition of venting or exploding during the overdischarge or short circuit test.
- The cells did not vent or explode during the heat-to-vent test.
- The cells gave reasonably good capacities after the drop test and vibration test.
- The new model of L91s which are called the e² Lithiums behave similar to the L91s on the short circuit and overdischarge tests.

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