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Battery & Energy Products

Providing power and energy products around the world...

Li/CF_x-MnO_2 Hybrid D-cells Discharged Safely at Elevated Temperatures

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Outline

- Introduction
- Objective
- Performance of Li/CF_x-MnO_2 Hybrid D-Cells
- Summary
- Acknowledgement

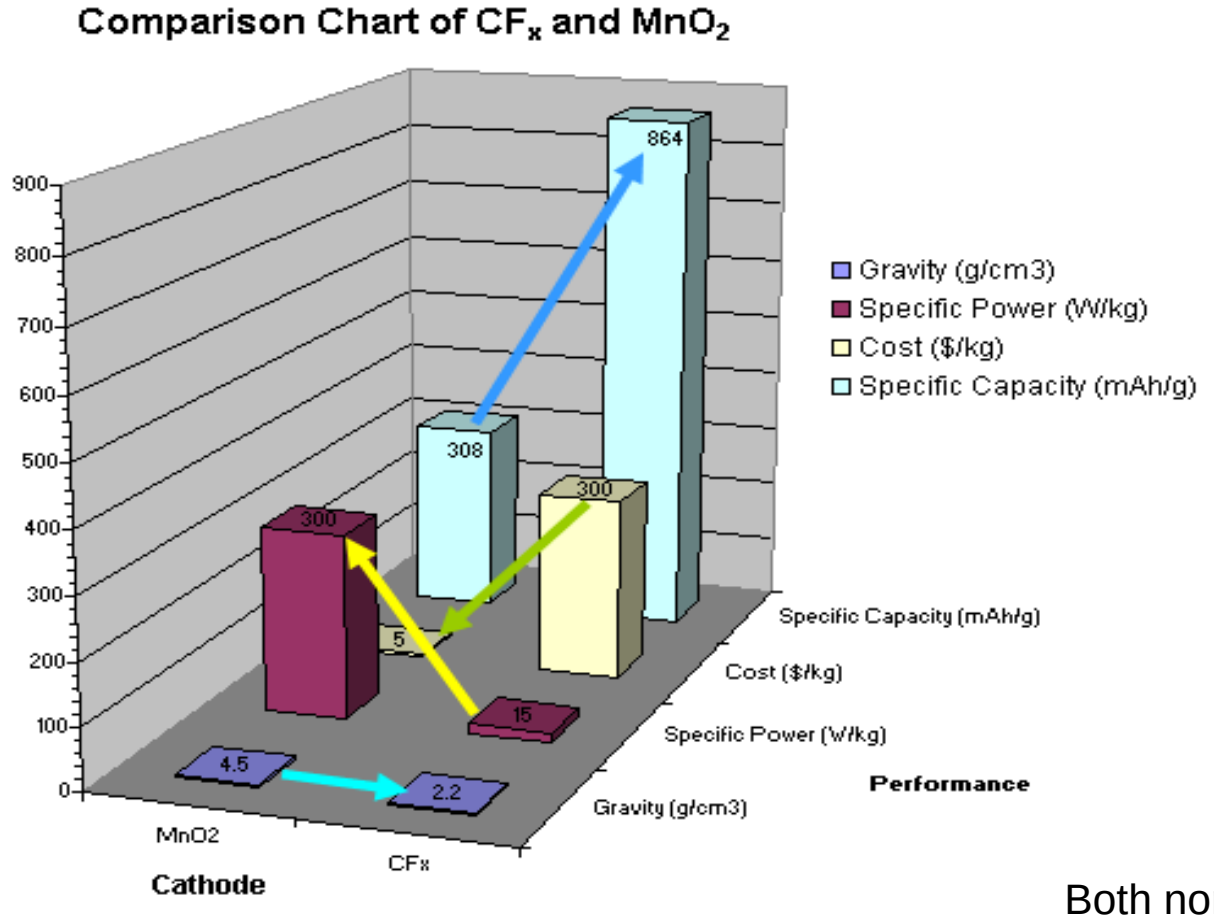
Ultralife Corporation

Design, Manufacture, Install & Maintain High Energy Power and Communications Systems

- Battery & Energy Products
- Communications Systems

- 2008, Ultralife introduced the first Li/CF_x-MnO_2 hybrid cells for military applications in 43rd Power Sources Conference
- 2008, Ultralife presented the Best Battery Pack with Li/CF_x-MnO_2 hybrid cells at WPP competition by DoD
- 2009, Ultralife awarded a R&D contract from US ARMY CERDEC for military battery development using Li/CF_x-MnO_2 hybrid cells
- 2011, Ultralife awarded a STP contract from DLA BATTNET for Li/CF_x-MnO_2 hybrid manufacturing ability study
- 2013, Ultralife launched Li/CF_x-MnO_2 hybrid battery products
- 2014, Ultralife awarded a R&D contract from US ARMY CERDEC for military conformal battery development using Li/CF_x-MnO_2 hybrid cells

Li/CF_x-MnO_2 Hybrid Chemistry



Both nominal 3V
Solid cathode
Electrolyte compatible

Hybrid Advantages

Lower cathode expansion
Lower self-discharge rate
Higher energy density

Lower overall **thermal signature**
Without voltage delay at LT
Relatively low cost

- **Developed Full-size 5790 (UB0032) & Half-size 5795 (UB0031) Batteries with Li-CF_x/MnO_2 Hybrid Chemistry**

Full-size 5790 & Half-size 5795 Battery as well as D-size 3V battery

Battery Type	UB0032	UB0031	UHR-XR34610
Energy	≥ 400 Wh	≥ 200 Wh	43 Wh
Voltage Mode	12V & 24V	12V only	3V
Energy Density	≥ 306 Wh/kg	≥ 306 Wh/kg	380 Wh/kg
Operating Temp	-30°C to 55°C		
Storage Temp	-40°C to 80°C		
Shelf Life	≥ 15 years		
Safety	Safe & Robust		

Half-size 5795 battery
Ultralife P/N: UB0031

Full-size 5790 battery
Ultralife P/N: UB0032

D-size battery
Ultralife P/N:
UHR-XR34610

Develop Li-CF_x/MnO_2 Hybrid D-cell which can be used in wide range of temperatures, especially at elevated temperatures

Further lead to 5790 and 5795 batteries with wider operating temperature range and safety improvement

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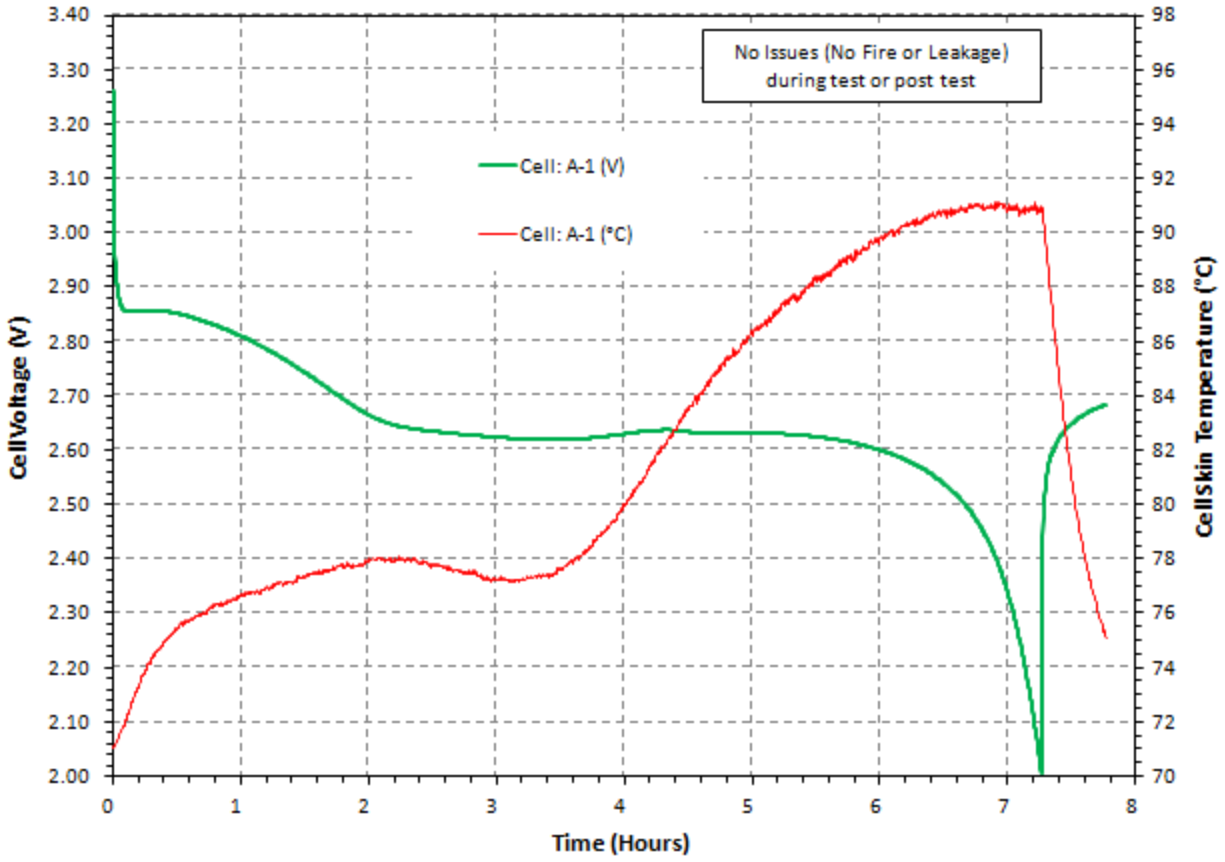
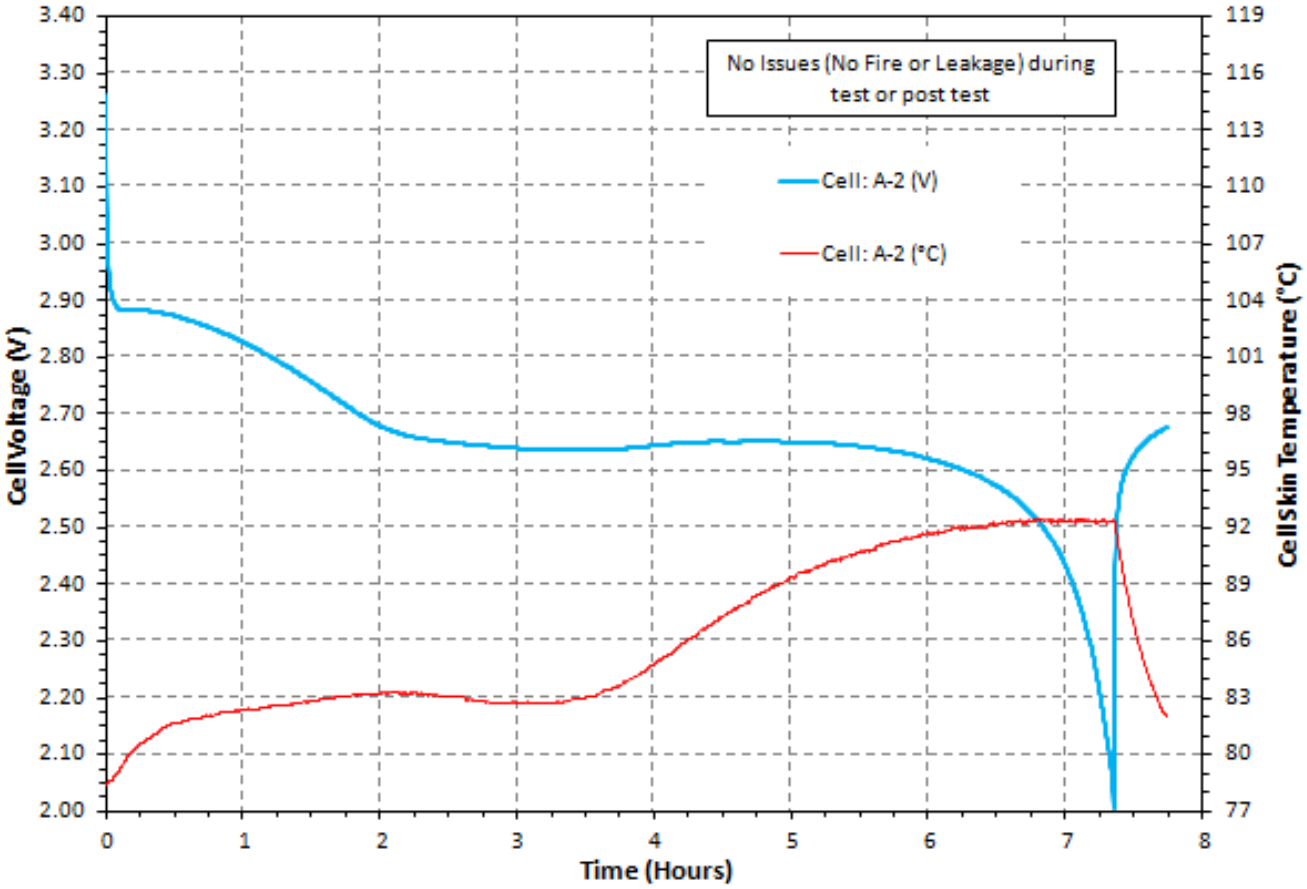
Li/CF_x-MnO_2 Hybrid D-Cell 2A Constant Current Discharge at 72°C After 3 Hours of Soaking



Li/CF_x-MnO_2 Hybrid D-Cell 2A Constant Current Discharge at 80°C After 3 Hours of Soaking



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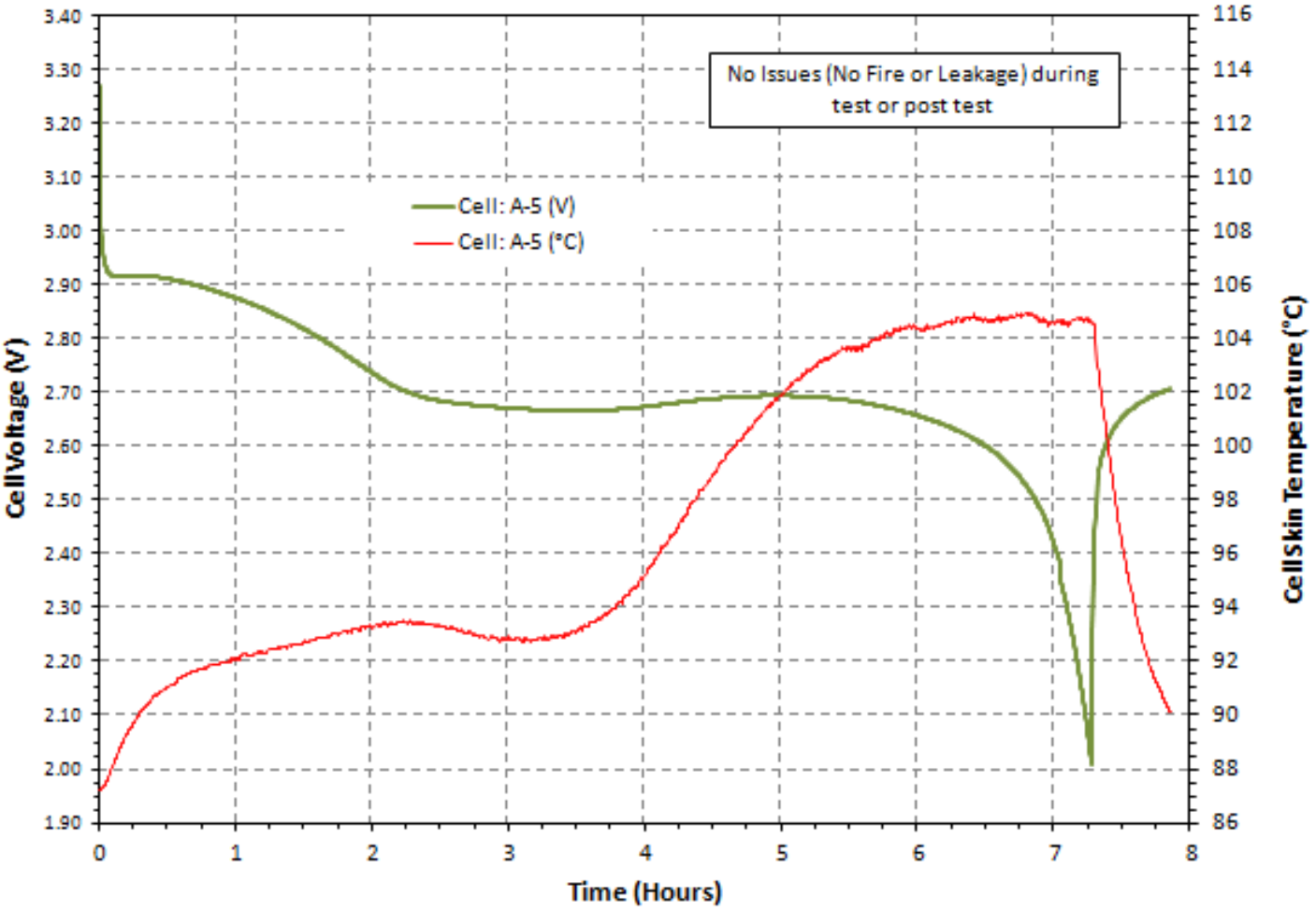
Li/CF_x-MnO_2 Hybrid D-Cell 2A Constant Current Discharge at 90°C After 3 Hours of Soaking



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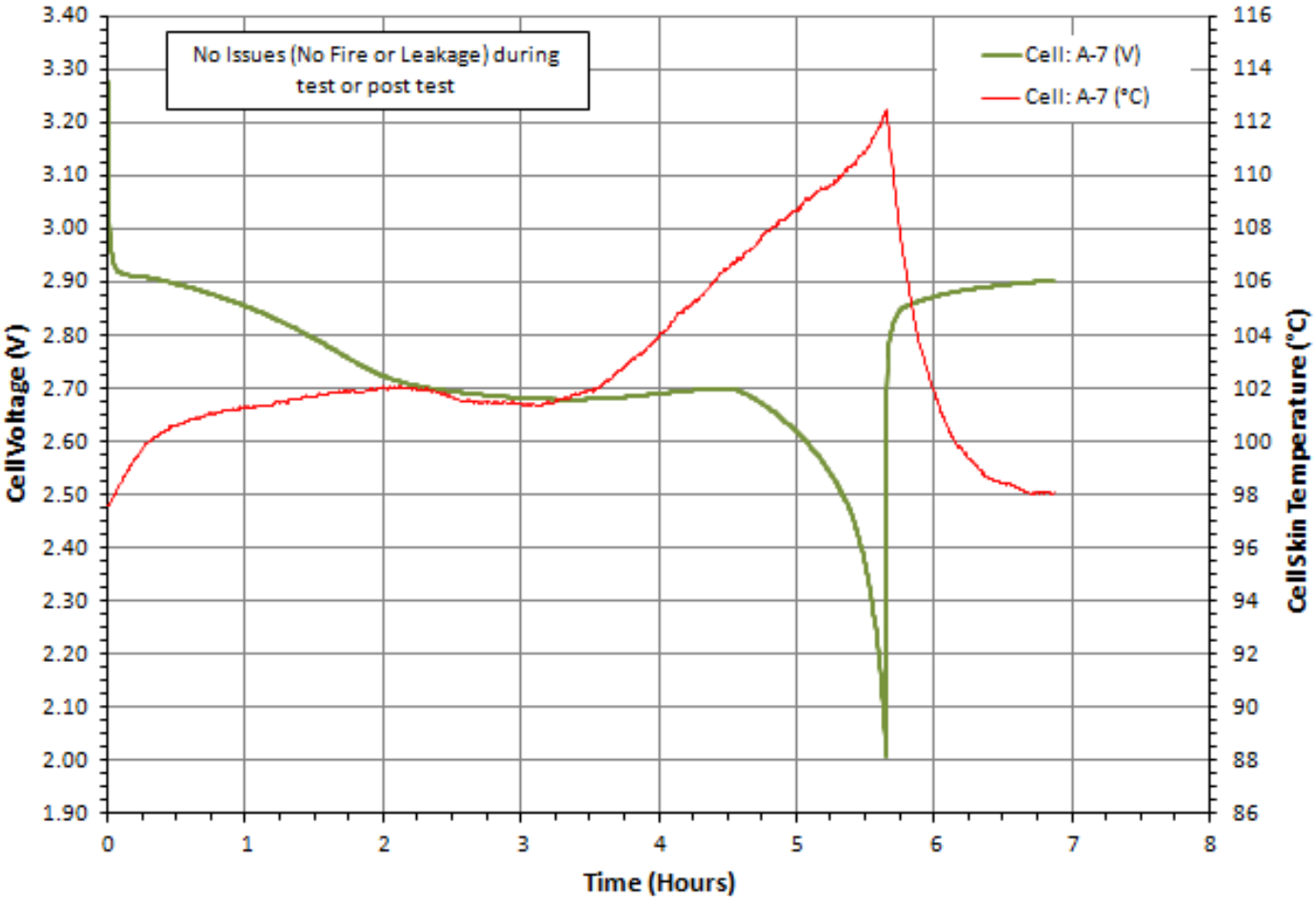
Li/CF_x-MnO_2 Hybrid D-Cell 2A Constant Current Discharge at 100°C After 3 Hours of Soaking

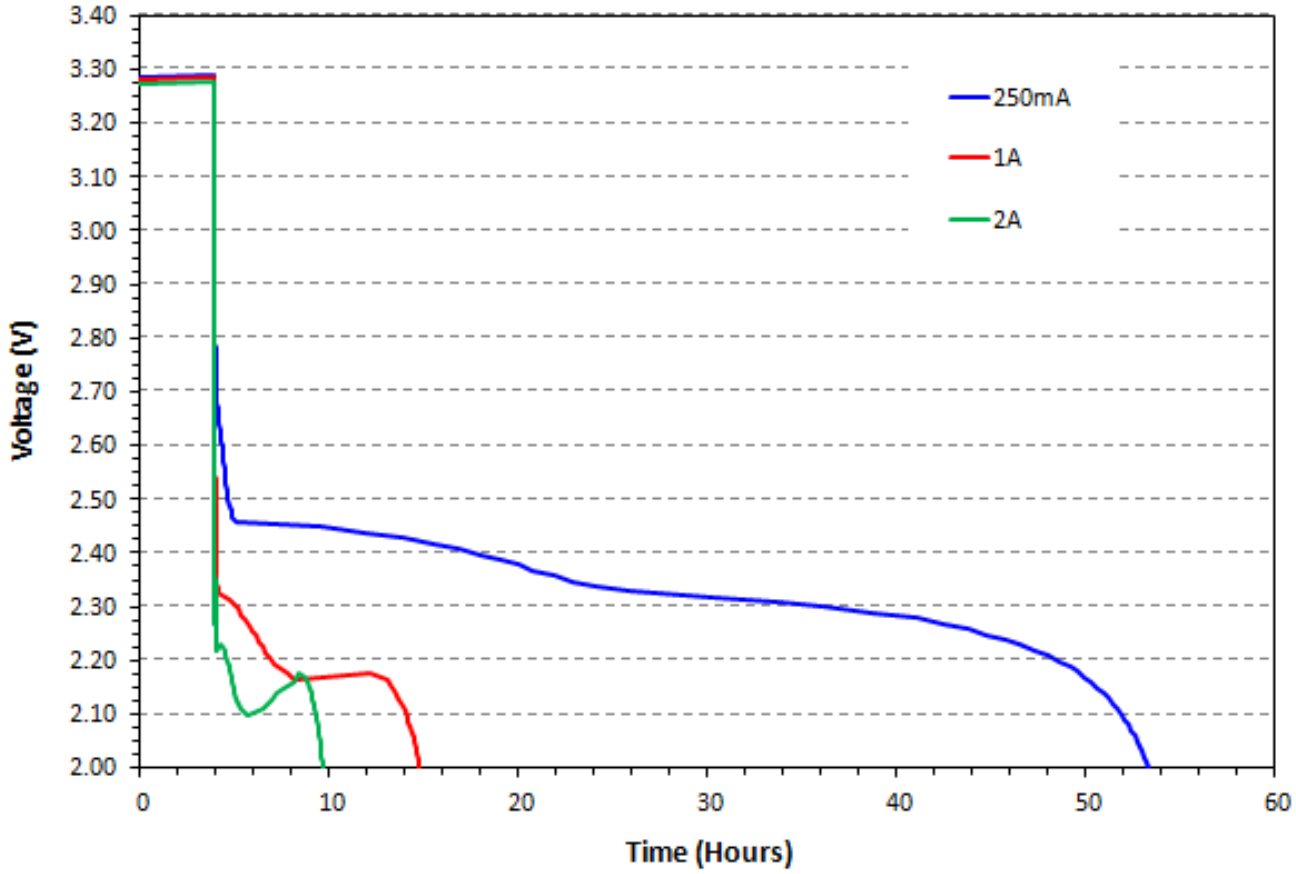


Performance of Li/CF_x-MnO_2 Hybrid D-Cells

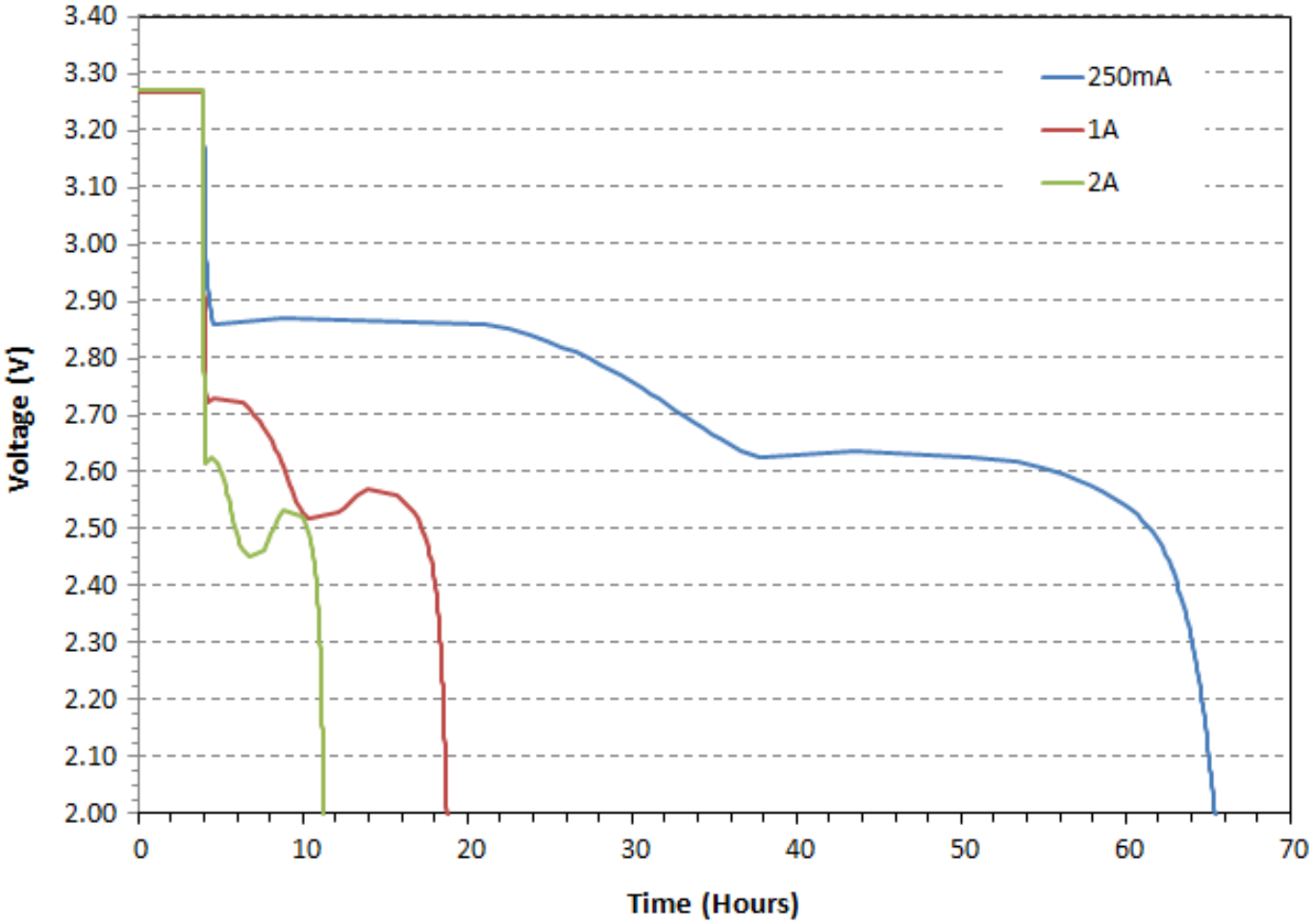
- 2A Discharge Performance of Li/CF_x-MnO_2 Hybrid D-Cells at Elevated Temperatures

Chamber Temp. (^oC)	Cell ID	Result	Max. cell skin Temp. (^oC)
72	A-1	7.26h and 14.52Ah, Pass, No Fire/No Leakage	91.1
80	A-2	7.36h and 14.72Ah, Pass, No Fire/No Leakage	92.4
90	A-5	7.28h and 14.56Ah, Pass, No Fire/No Leakage	105.0
100	A-7	5.65h and 11.30Ah, Pass, No Fire/No Leakage	112.5

Li/CF_x-MnO_2 Hybrid D-Cells Discharge under Different Currents at -20°C after 4 Hours of Soaking

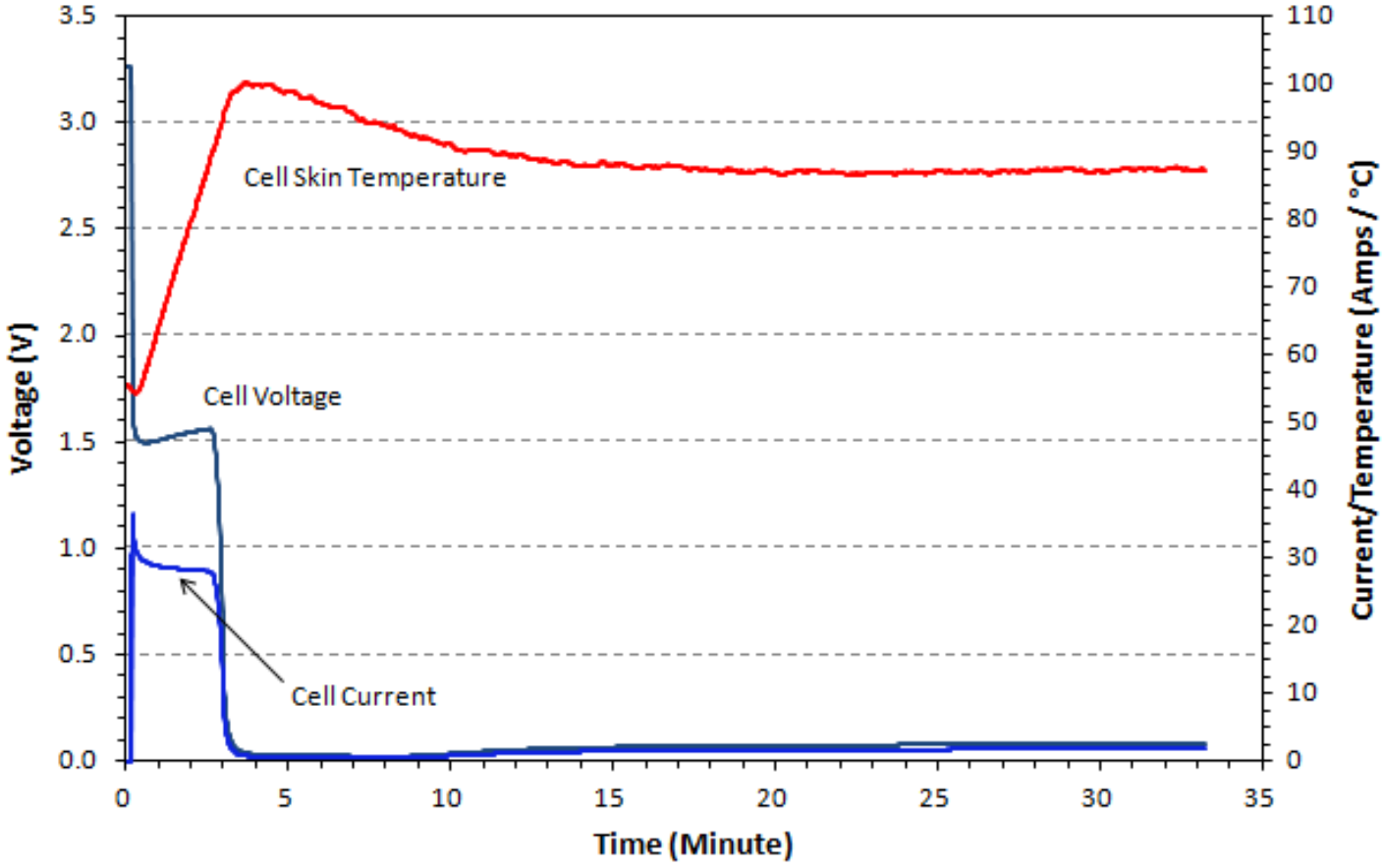


Li/CF_x-MnO_2 Hybrid D-Cells Discharge under Different Currents at 23°C after 4 Hours of Soaking



Performance of Li/CF_x-MnO_2 Hybrid D-Cells

Li/CF_x-MnO_2 Hybrid D-Cell External Short Circuit Test at 55°C after 2 Hours of Soaking (Max. cell skin temp: 100°C)



Li/CF_x-MnO_2 Hybrid D-Cell has potential to pass UN T5 and other tests

New Li/CF_x-MnO_2 hybrid D-cell Development

- Typically the cells provide 16.0Ah of capacity and 43Wh under 250mA constant current discharge at 23°C.
- Extended operating temperature range from -30°C to 55°C to -30°C to 100°C.
- Potentially pass UNTR tests
- Potentially extend 5790 and 5795 battery operating temperature range
- Potentially improve 5790 and 5795 battery safety performance

- Ultralife wants to acknowledge the US Army CERDEC for the continuous support to CFx hybrid improvement effort.

Special Thanks

to

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Mr. Anthony DeAnni and Mr. Michael Brundage

of the US ARMY CERDEC

- Questions
- See you at booth #316

Thank you for your attention !