Safety Evaluation of AN-PRC Radio Battery for Crew Survival Equipment

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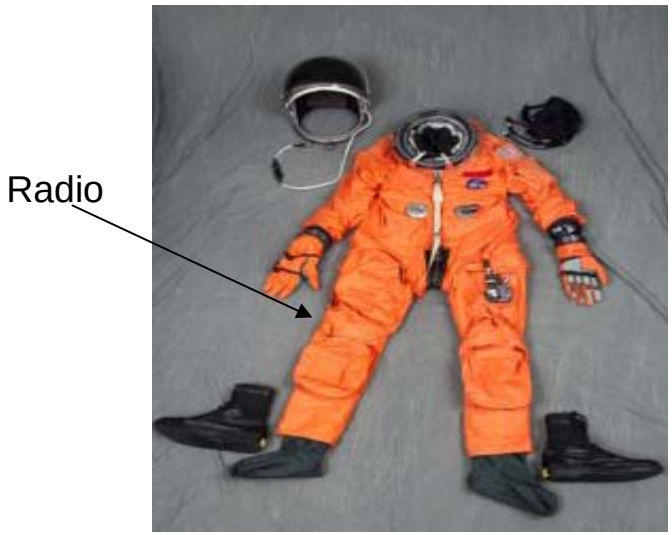
AN-PRC Crew Survival Radio



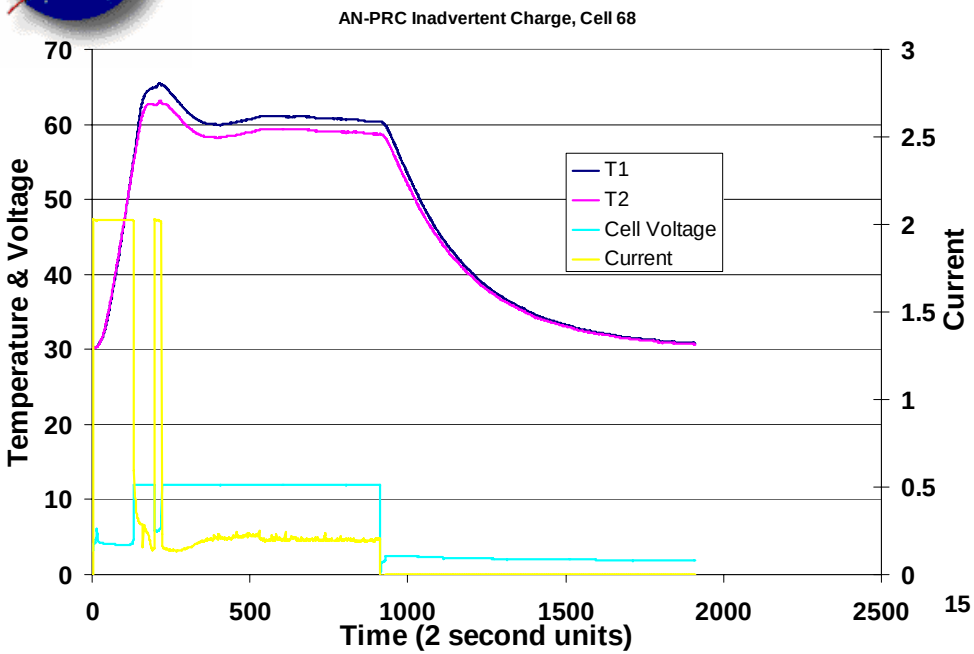
Performance Testing of the Radio with $LiMnO_2$ 12 V battery

Preliminary Observations

- Equipment does not turn off by itself when voltage drops to a certain value.
- Radio transmission is turned off when voltage falls to a certain value (end of pulse voltage ~ 5.0 V)
- Parasitic load on battery pack all the time.
- One cell string is lower in voltage than the other two (independent discharge on cells and strings showed lesser capacity)
- Removal of label from the pack activated an automatic discharge on the cells (light-activated LED triggers discharge)

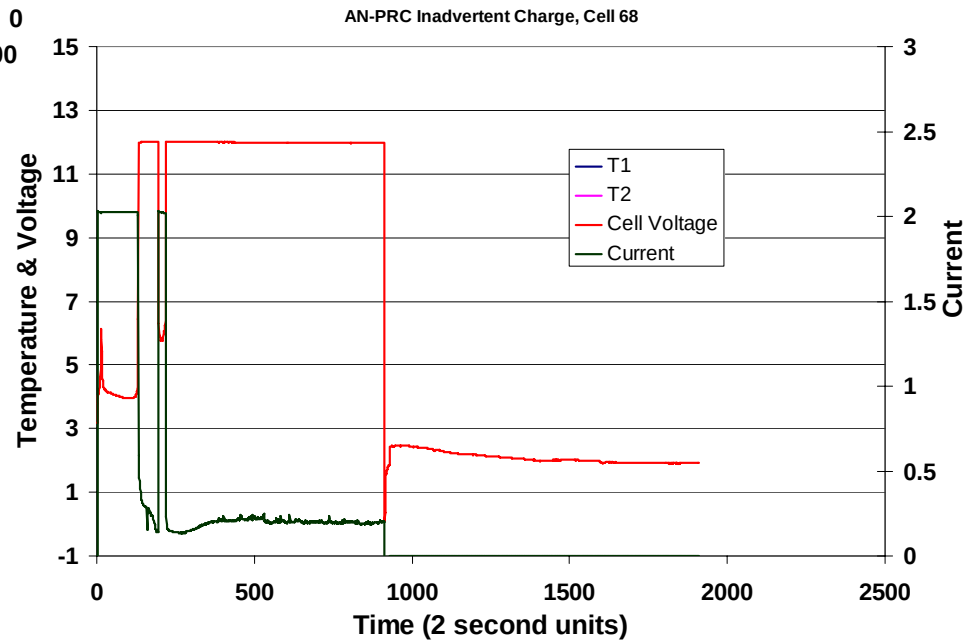
1. Preliminary Characterization
2. External Short – cells and strings (3 cells, 3 strings)
3. Cell Reversal – cells and strings (4 cells, 3 strings)
4. Inadvertent charge – cells and strings (3 cells, 3 strings)
5. High temperature and heat-to-vent – cells (4 cells)
6. Crush (simulated internal short) – Cells (3 cells)

Inadvertent Charge Test on Cell

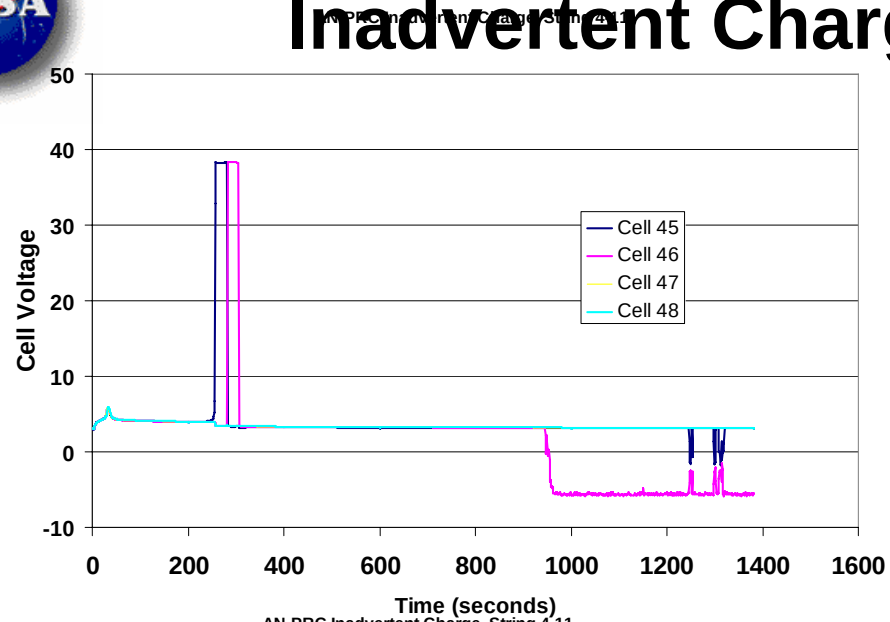


2 A; 12 V limit

No fire or flame

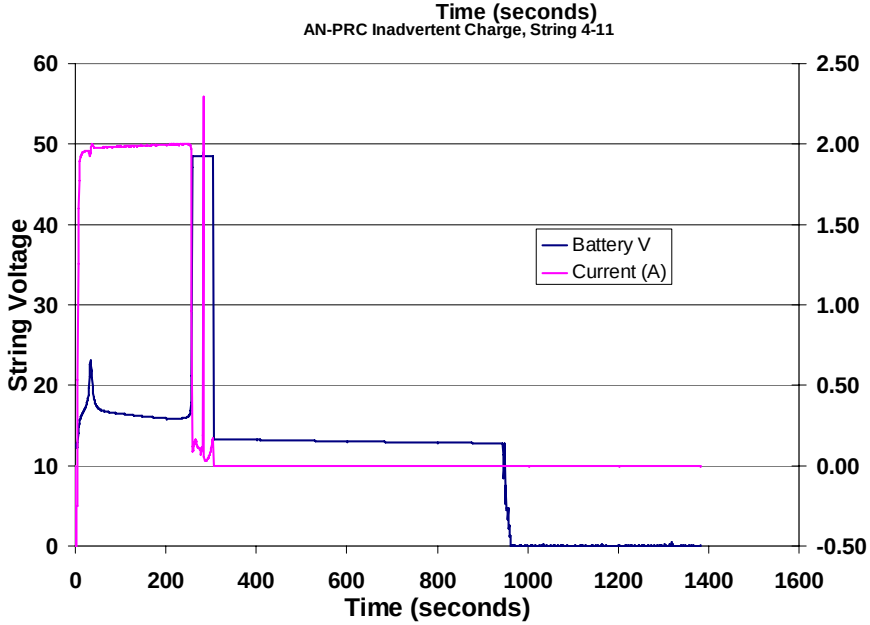


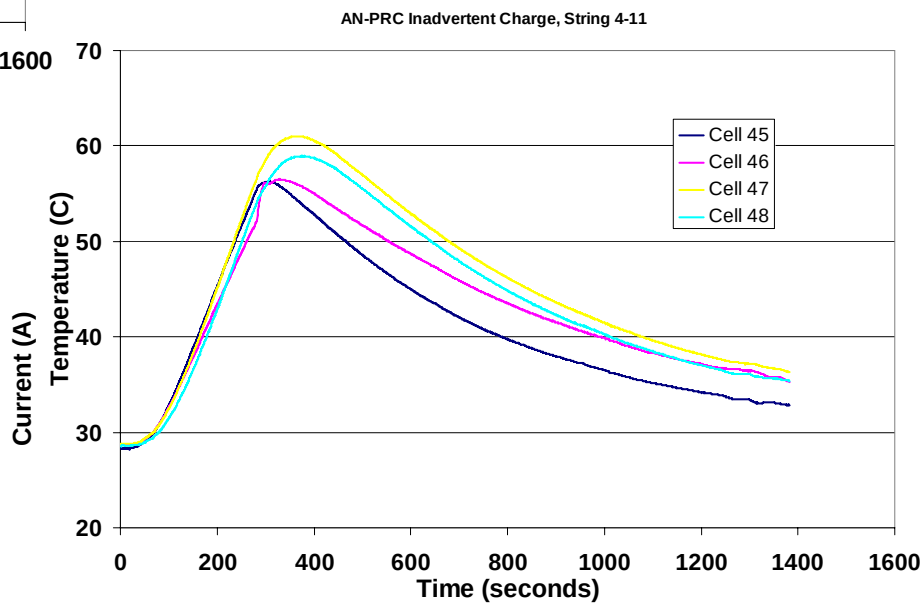
Inadvertent Charge String Level



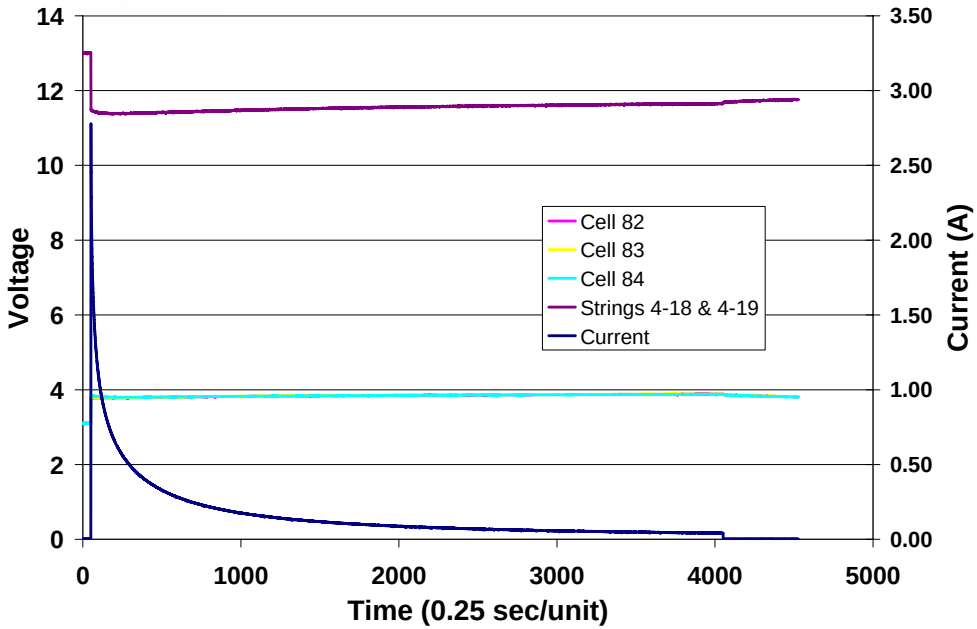
48 V limit

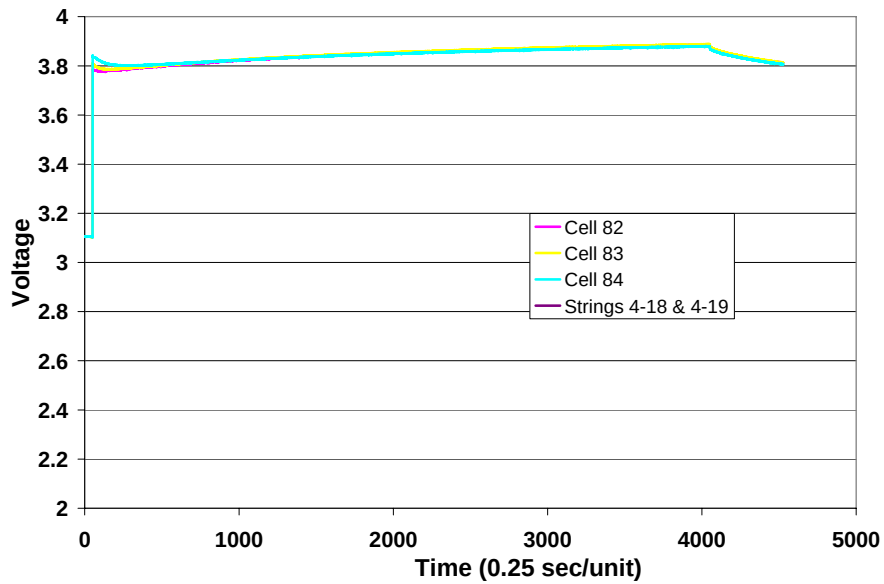
Some cells vented; no flame

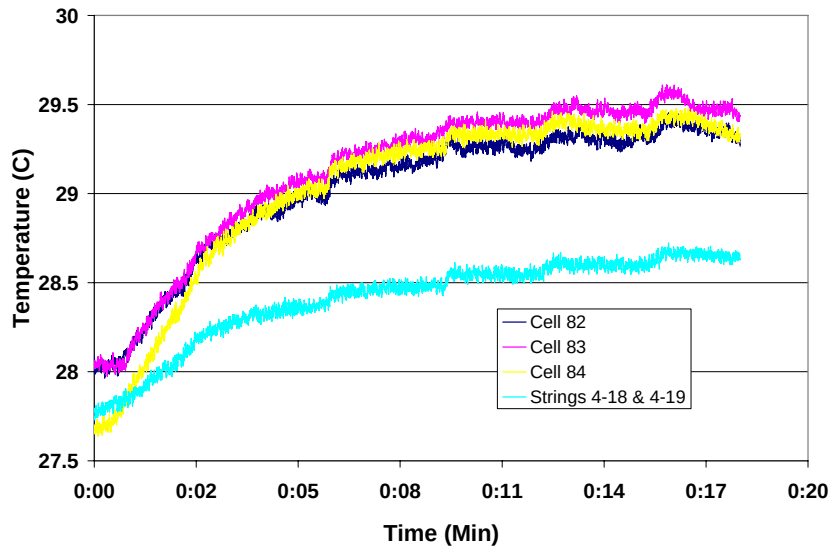




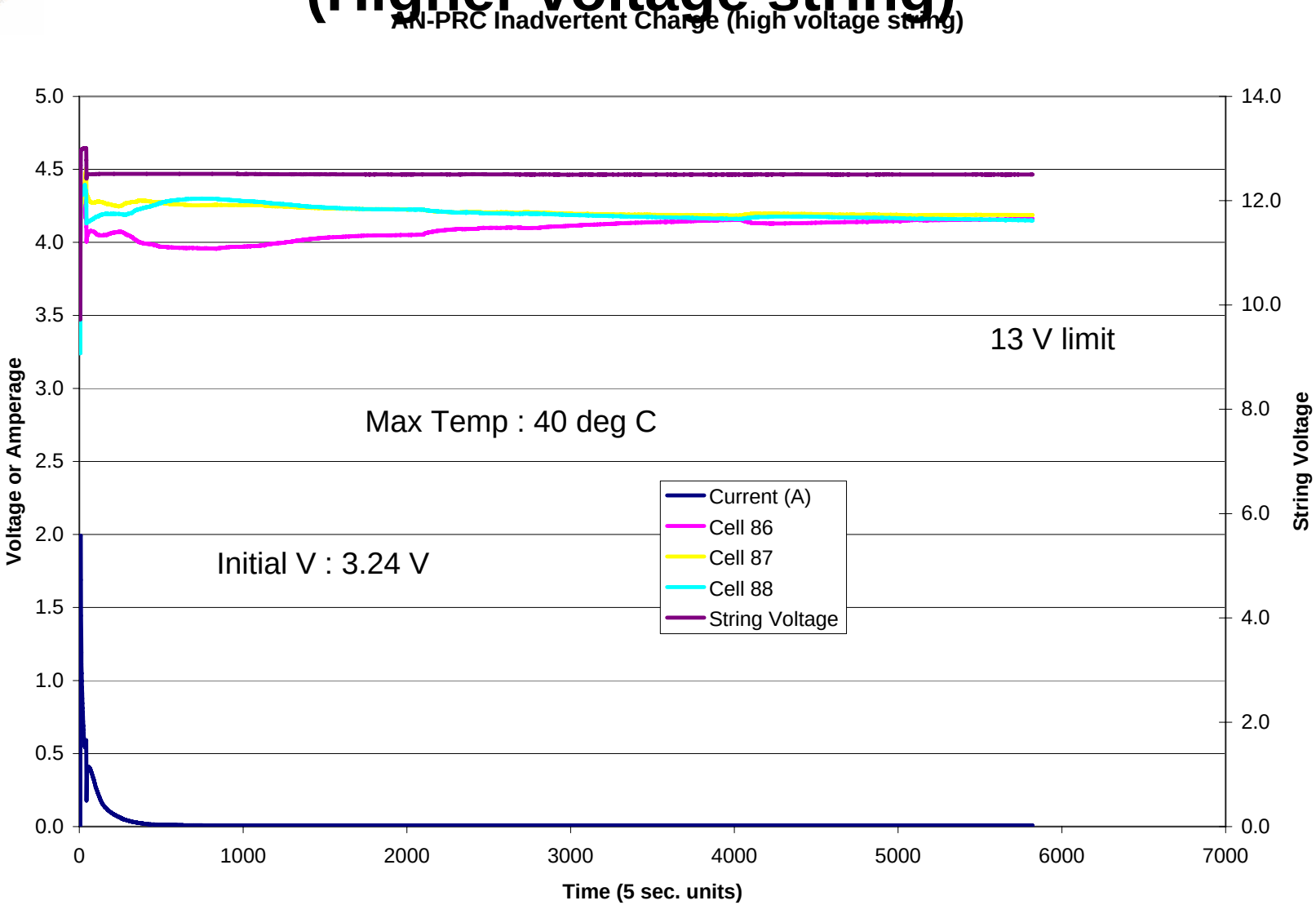
Inadvertent Charge in Unbalanced Parallel Strings without Diodes



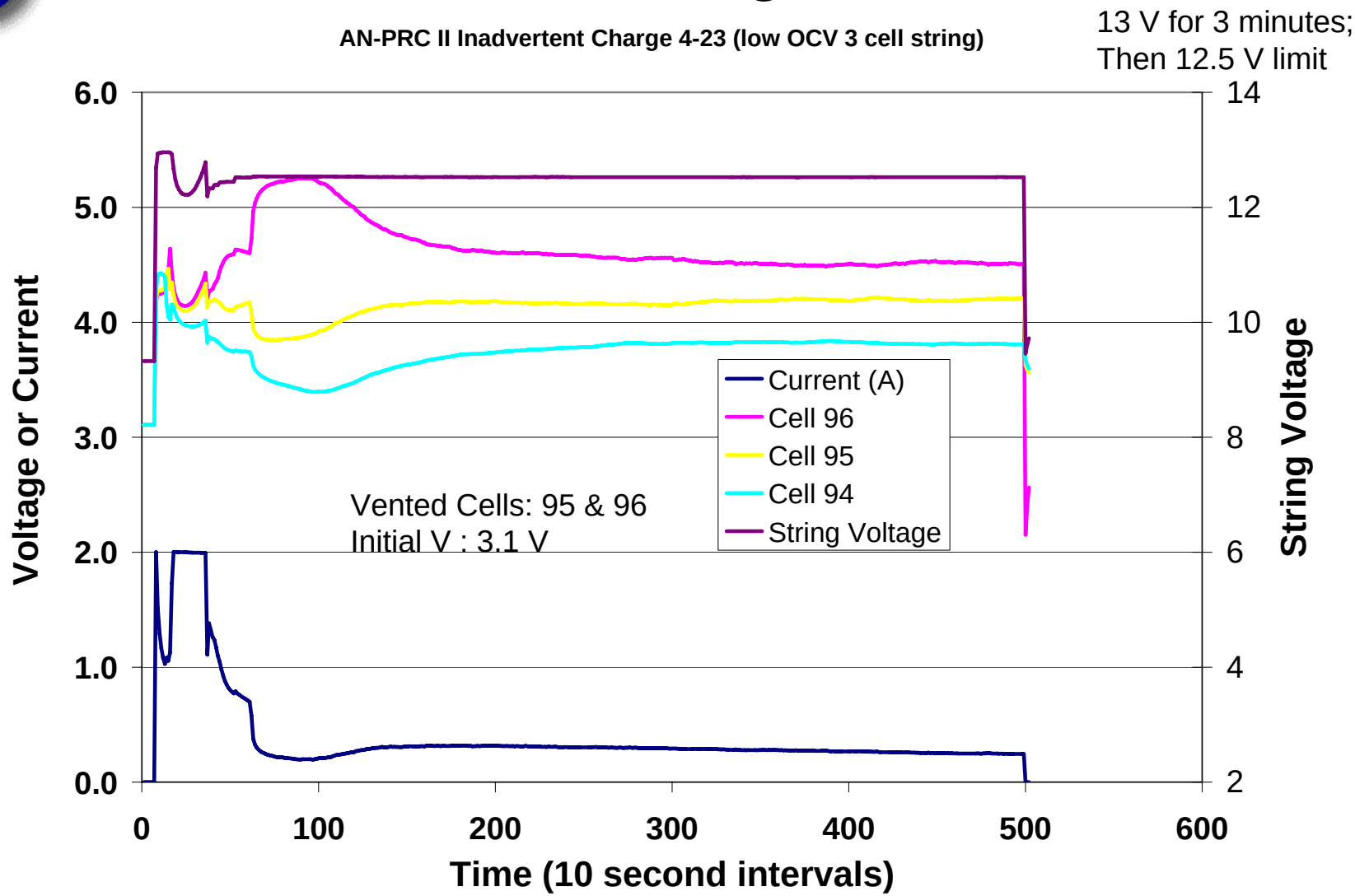




Inadvertent Charge on Single String (Higher voltage string)

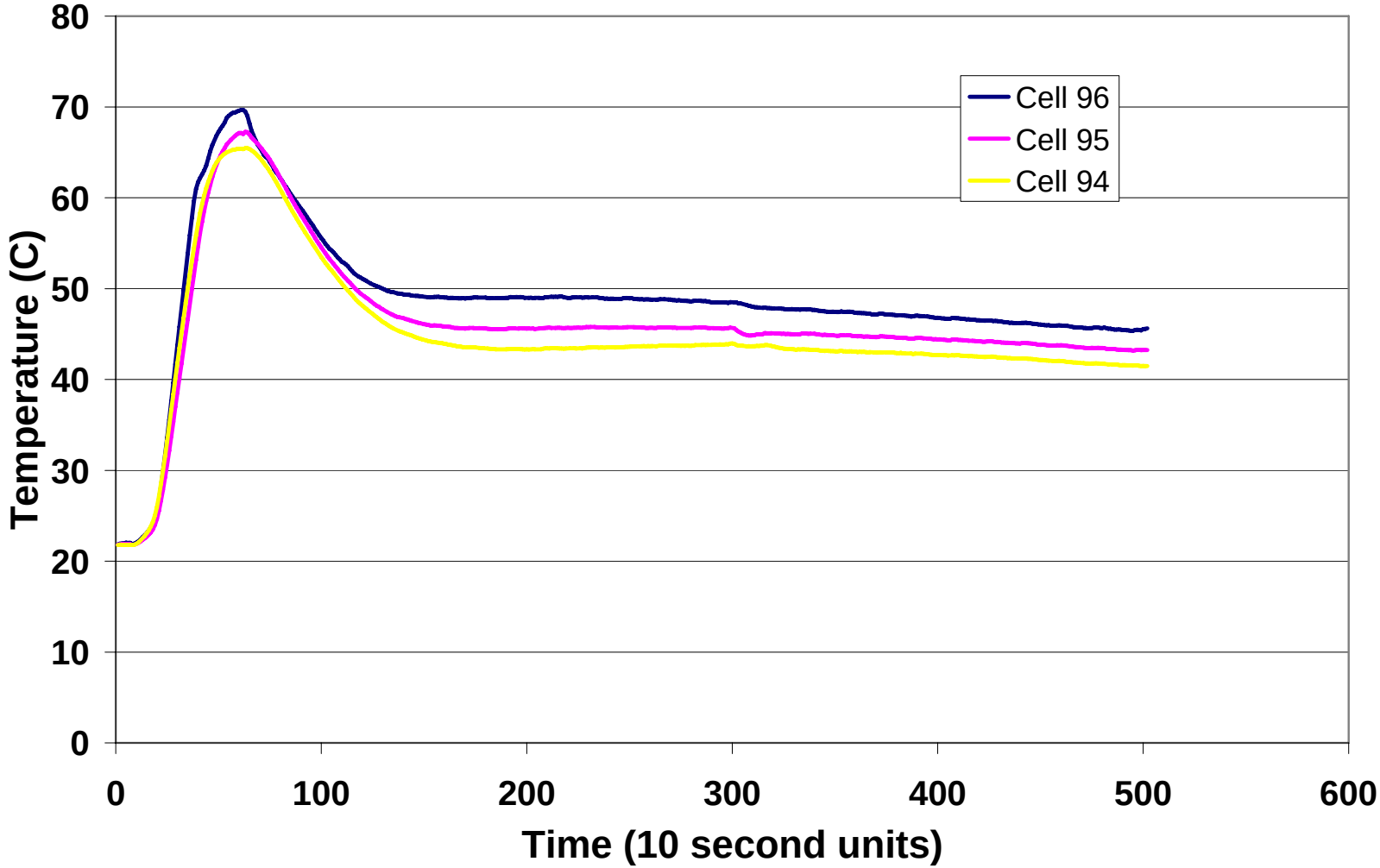


Inadvertent Charge Test on Lower Voltage String



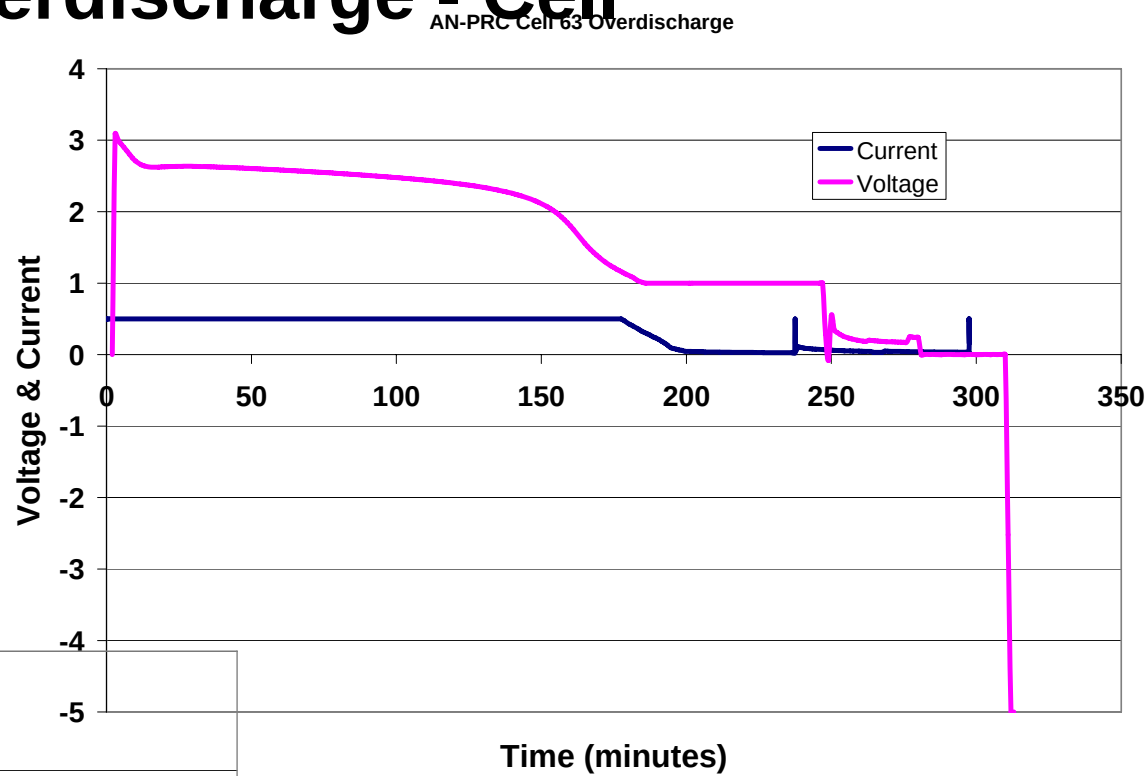
Temperature Profile for Inadvertent Lower Voltage String Test

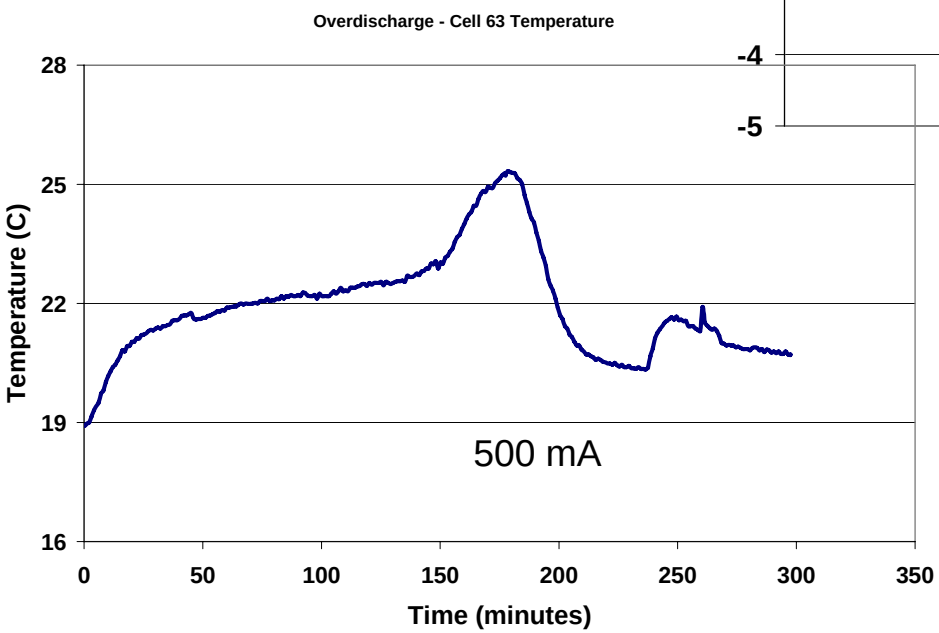
AN-PRC II Inadvertent Charge 4-23, 3 cell (low OCV string)



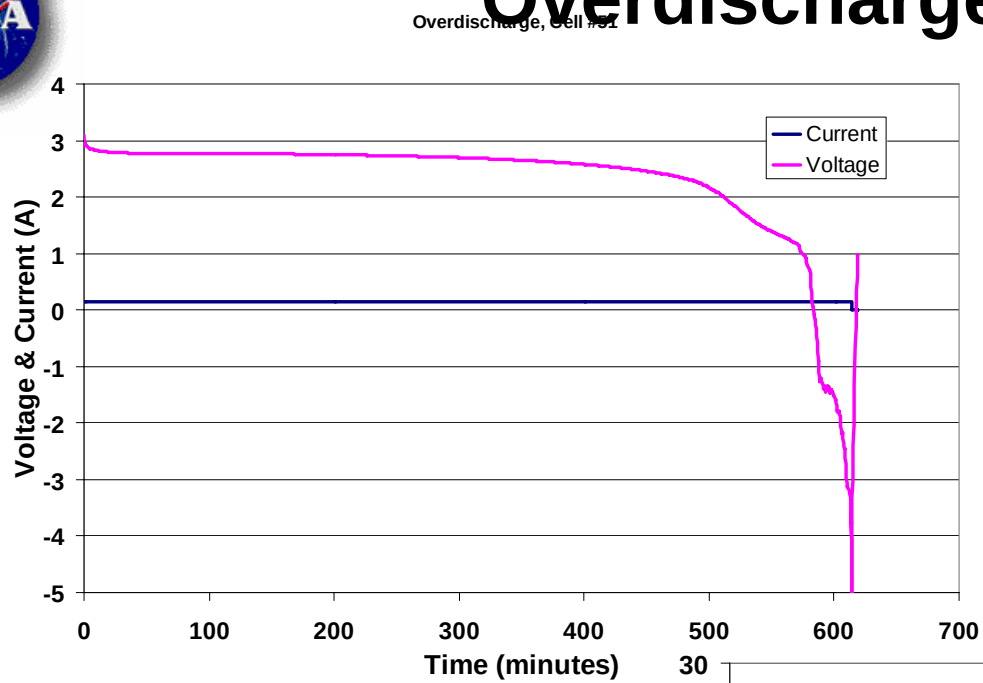
Overdischarge - Cell

500 mA
Discharge current

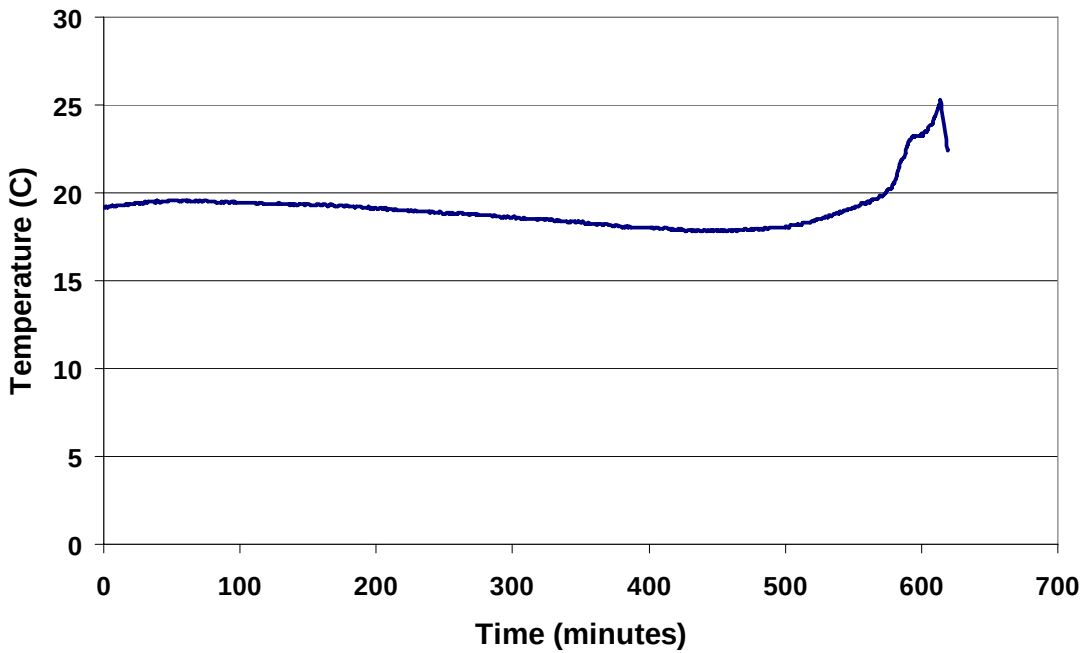




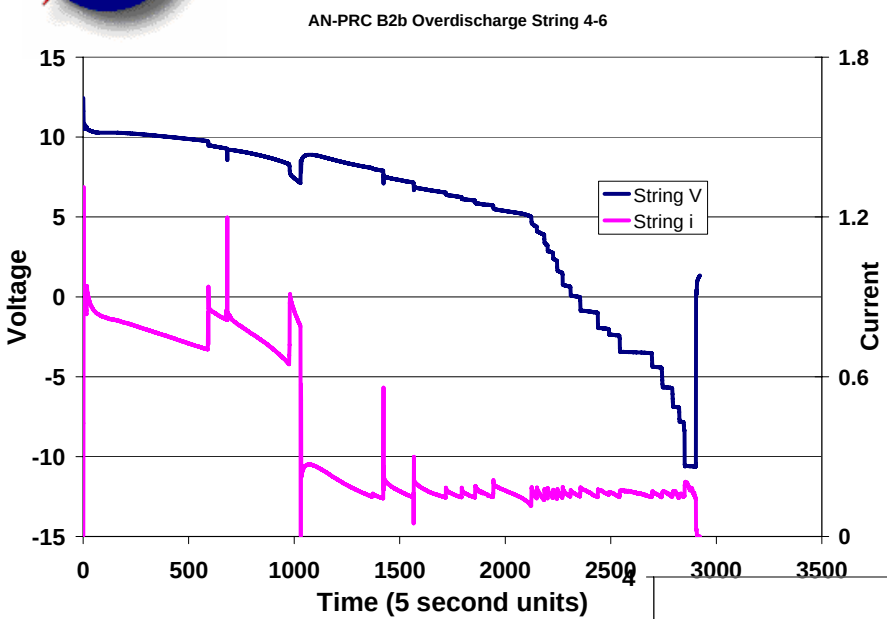
Overdischarge - Cell

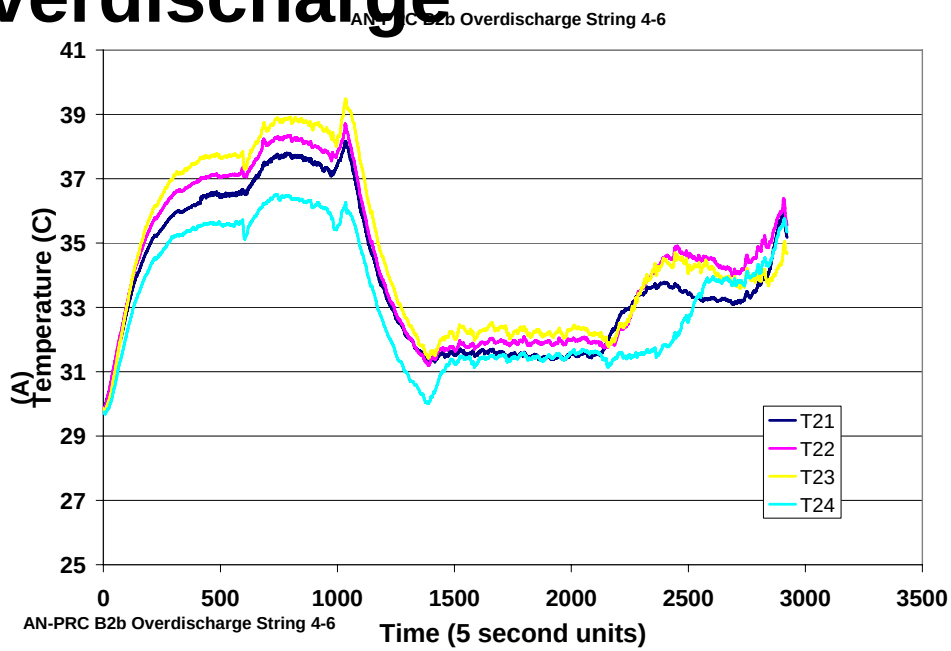


150 mA

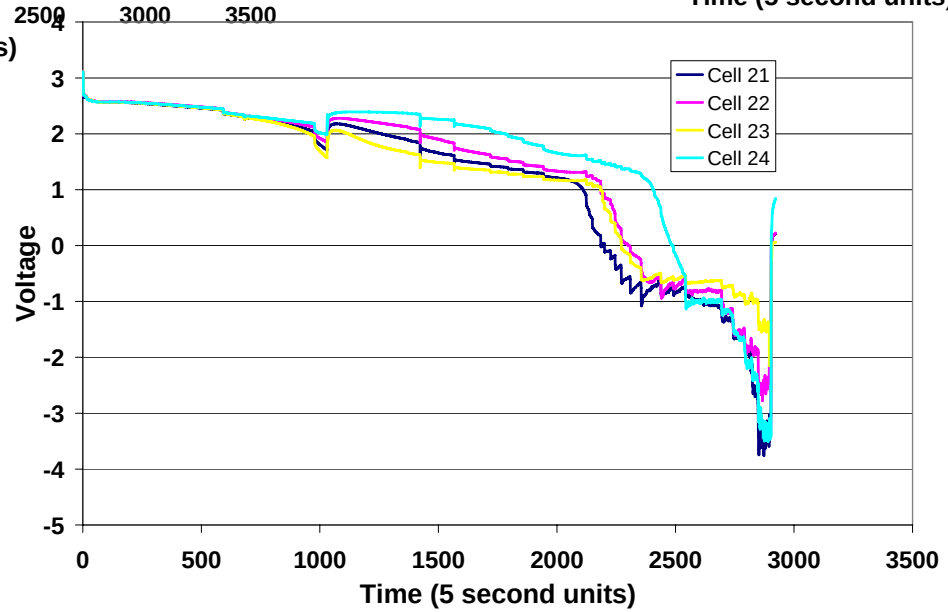


String Overdischarge

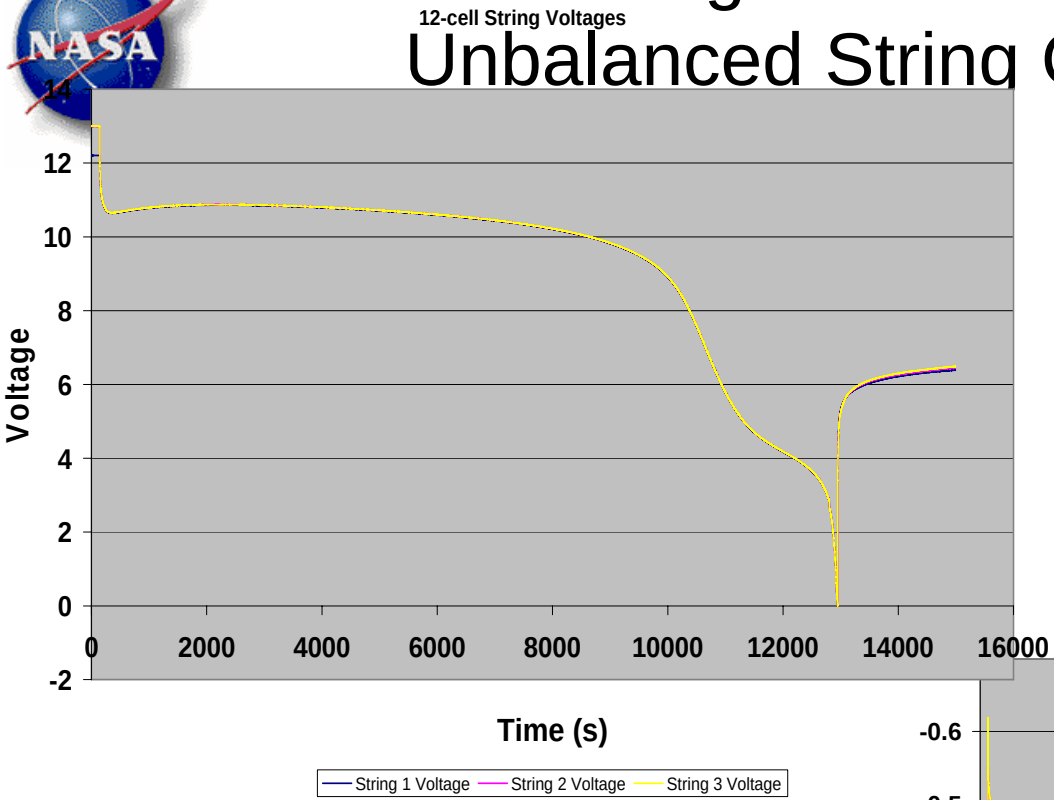




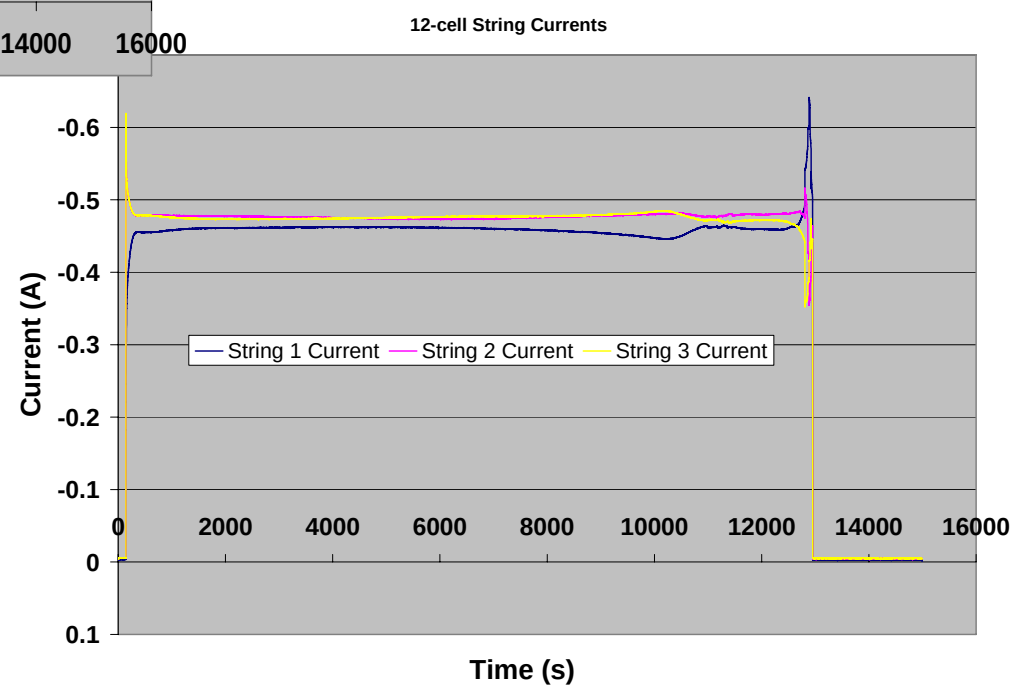
150 mA load



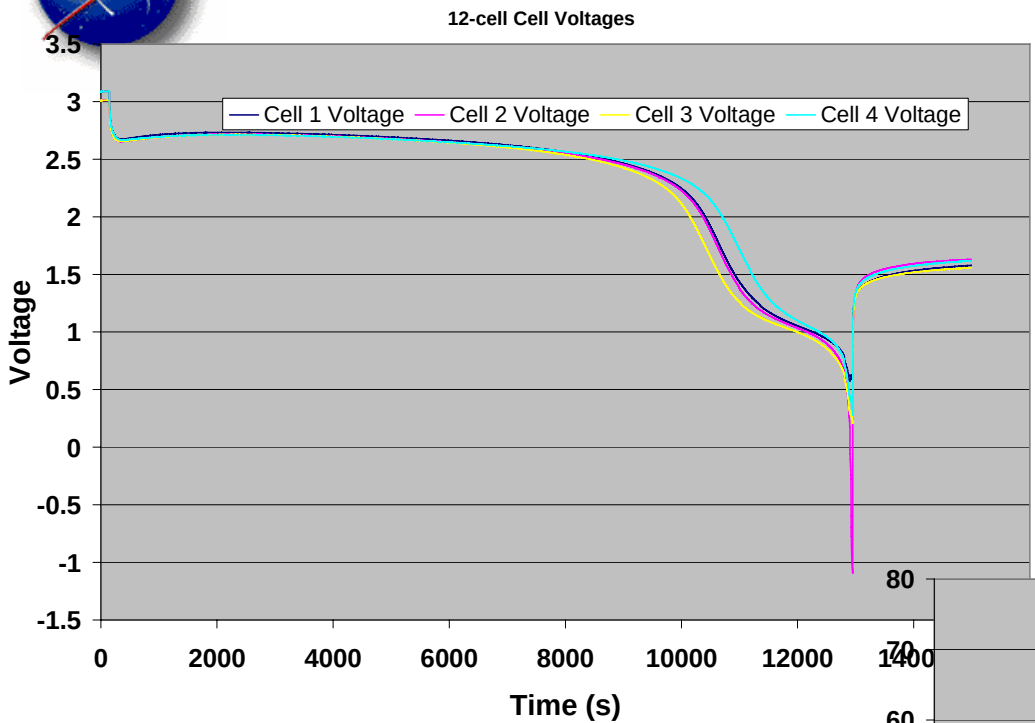
Overdischarge on Pack in as Received
Unbalanced String Configuration

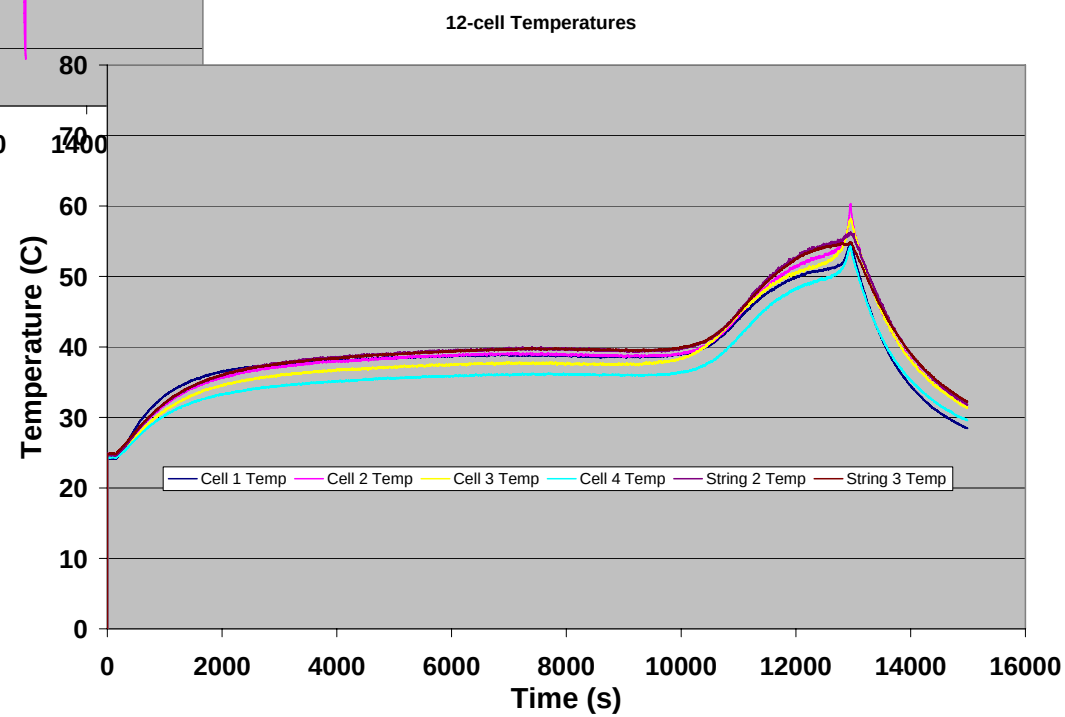


12 – Cell Config.

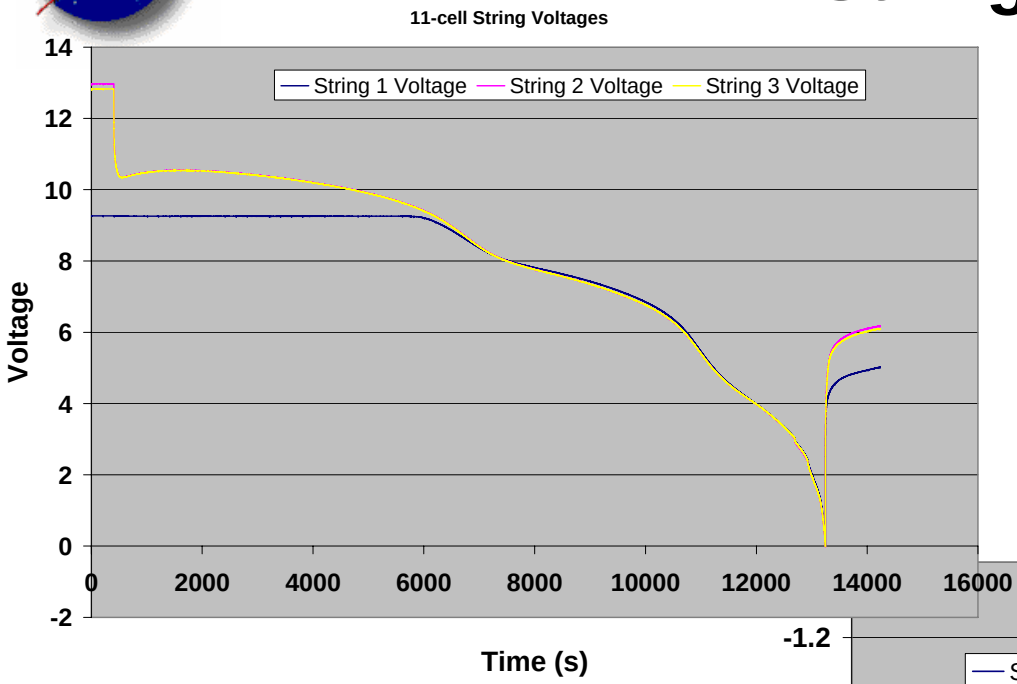


Overdischarge on Pack in as Received Unbalanced String Configuration

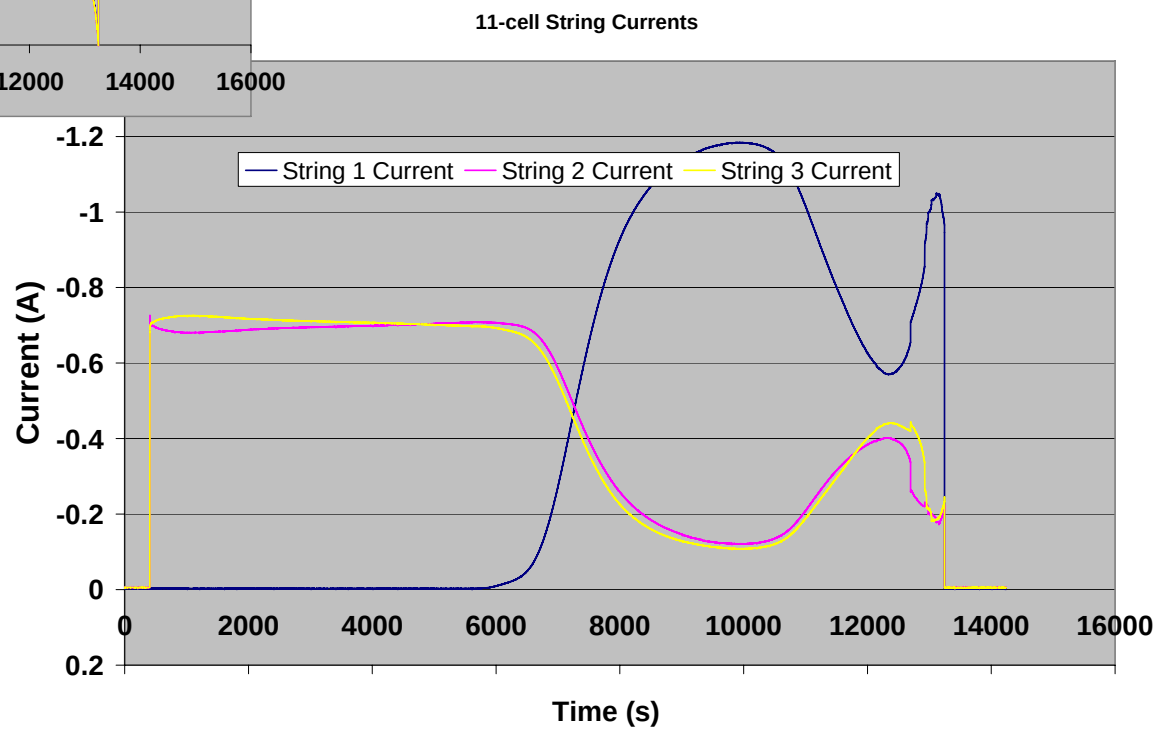




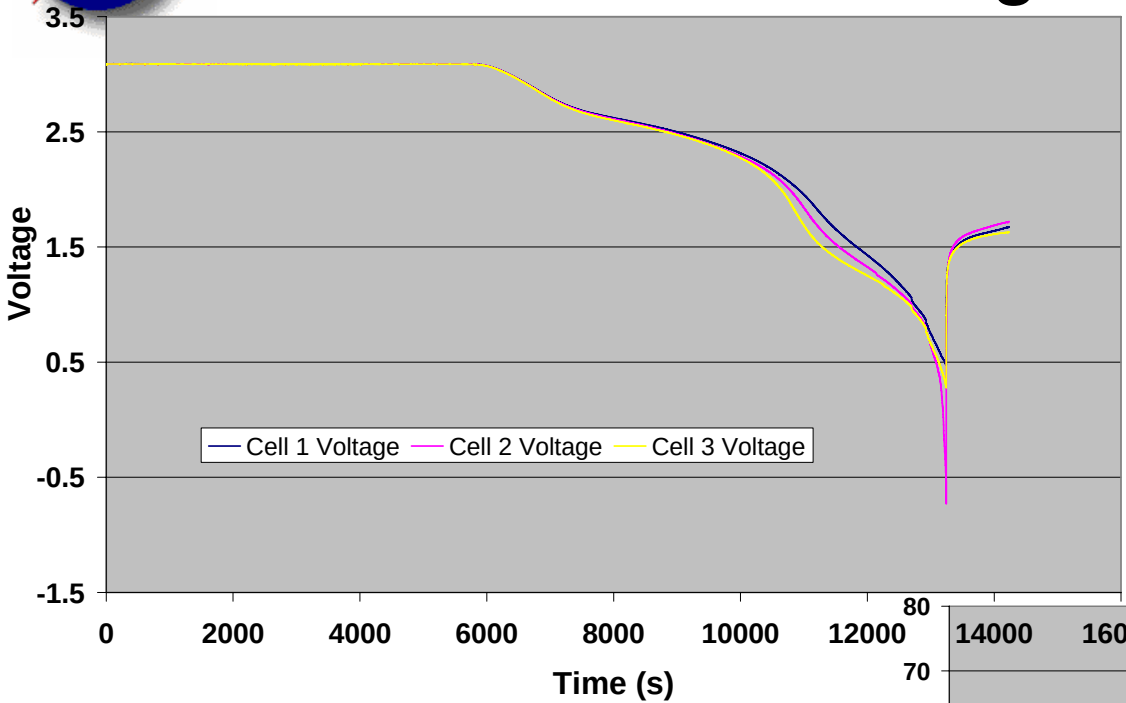
Overdischarge Test for Unbalanced Cell Strings



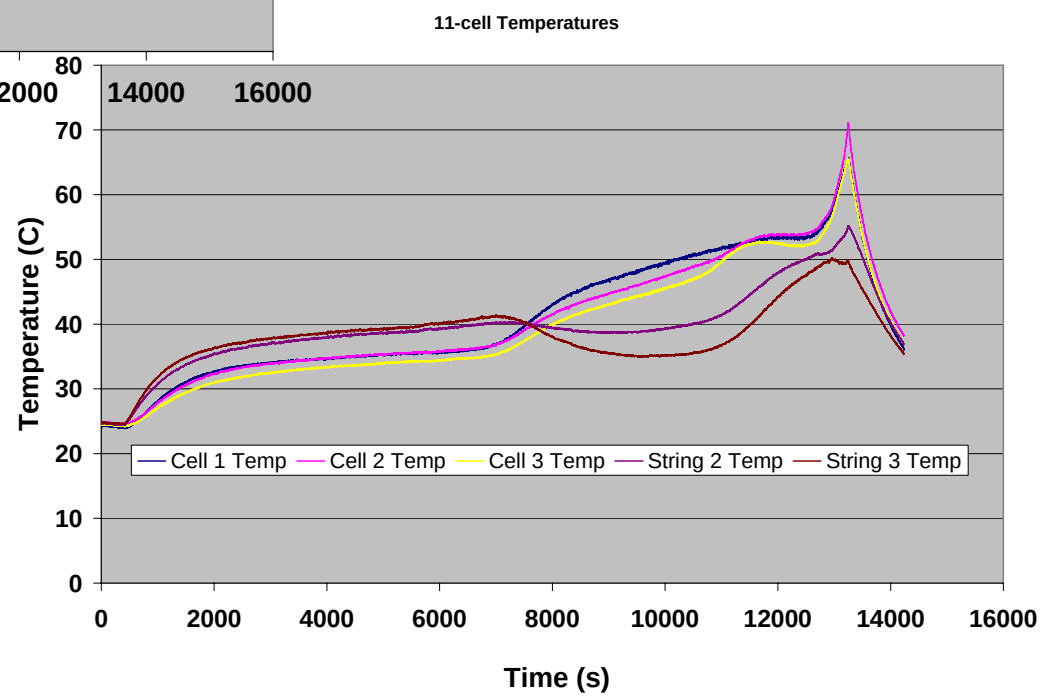
11- Cell Case



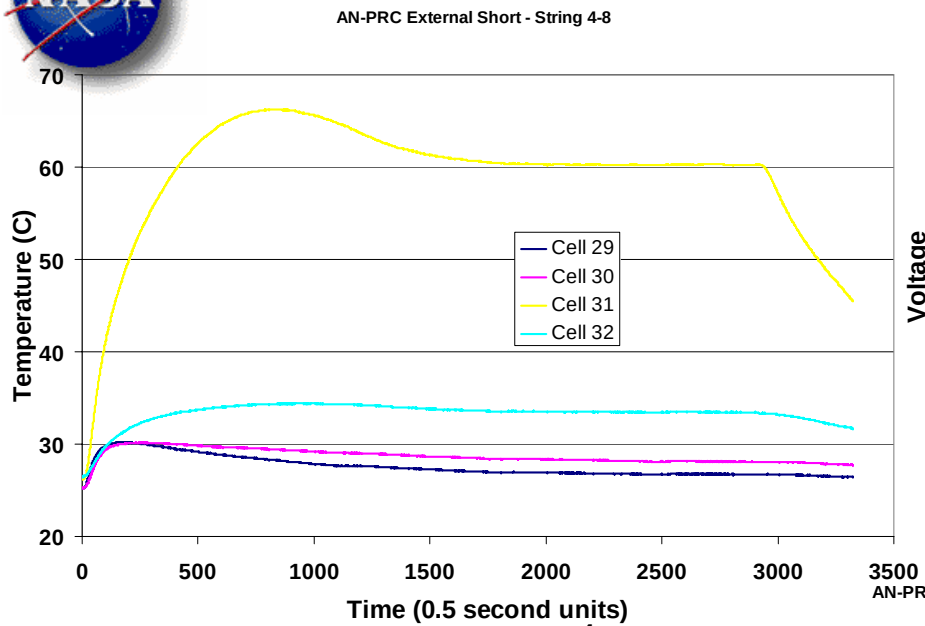
Overdischarge Test for Unbalanced Cell Strings

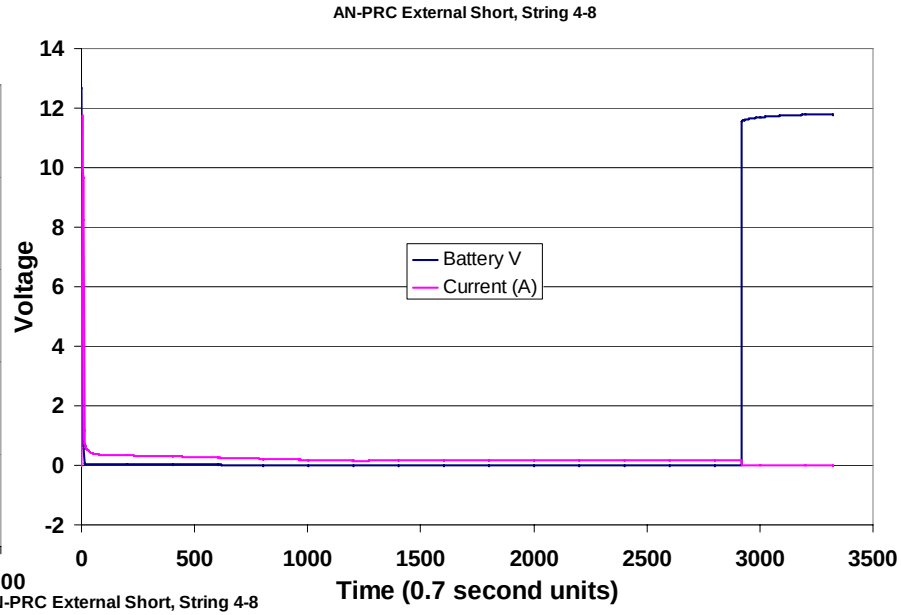


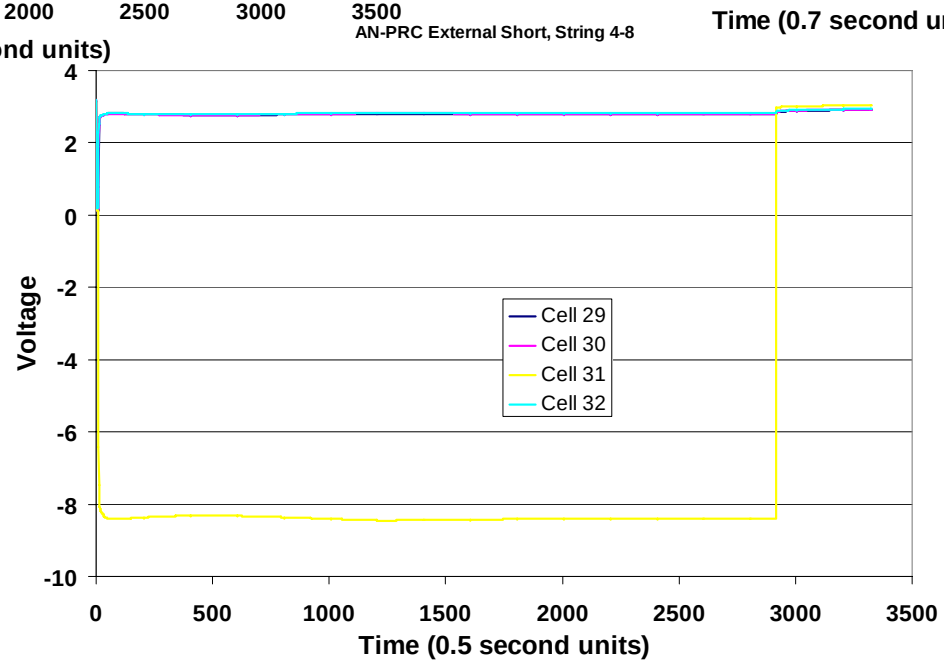
11- Cell Case



External Short - String





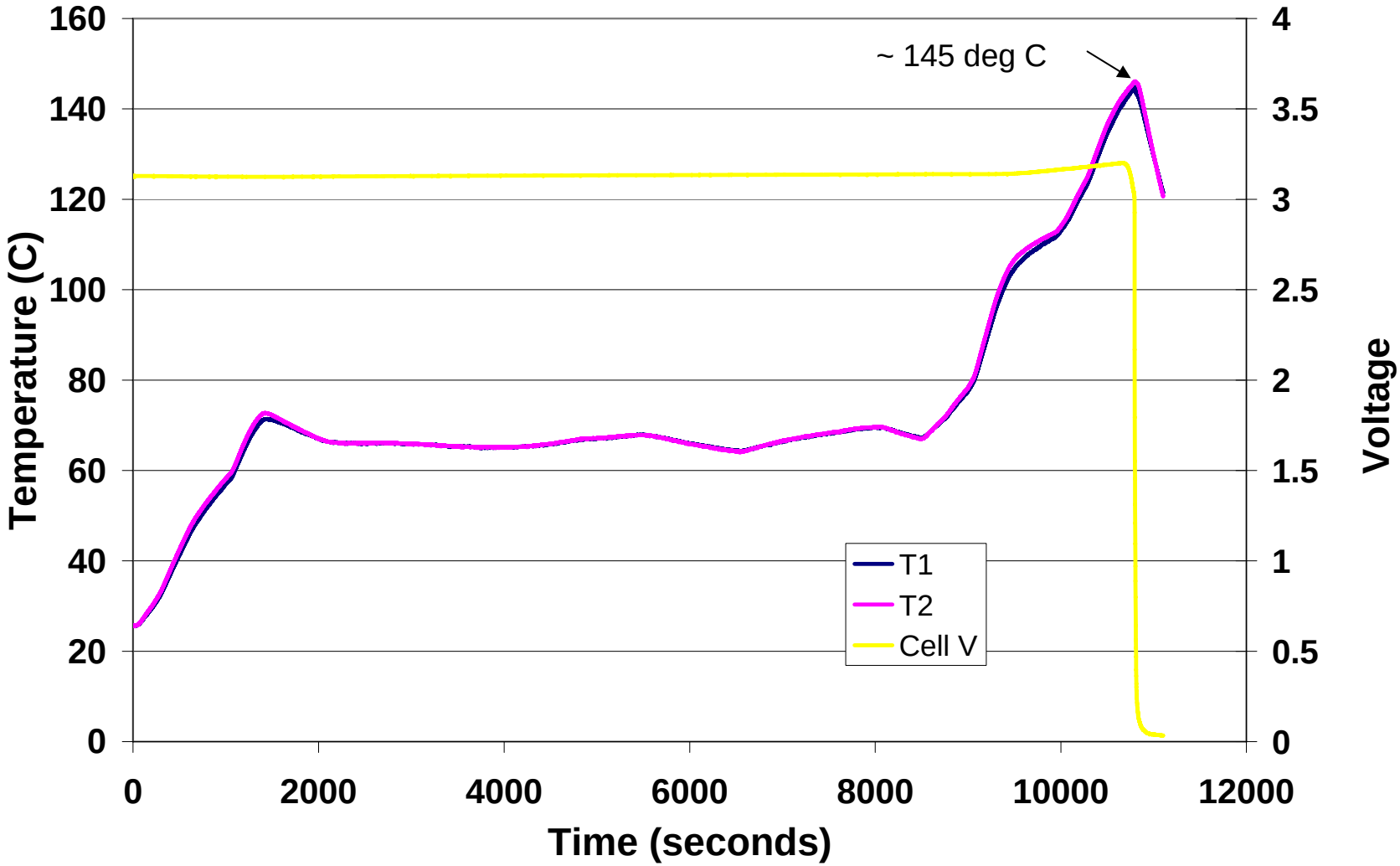


Internal Short (Crush)

- Venting with flame; peak temps 270-290 ºC.

Heat-to-Vent Test on Single Cells

AN-PRC B3 Heat-to-Vent Cell 28



Weld Issue

CR123A Lithium
LITHIUM BATTERY
sapphire

LITHIUM BATTERY
DO NOT RECHARGE
CR123A

Shrink-wrap damage

Nicks in shrink wrap

Summary

- One cell string voltage lower than the other two. Capacity discharges performed and determined that the cells in string of lower voltage have much less capacity than the other cells.
- Radio does not turn itself off when battery voltage cannot support pulses, the volume is still on and draws battery power until the radio is manually turned off. Load on battery decreases and remains steady for the additional 48 hours tested.
- Battery is discharged when the label is removed or when the string powering the board is tapped. For string sensing, only two strings could be sensed.
- Battery voltage increases with increased current loads (opposite of normal battery performance; done by diodes/switches.
- Only inadvertent charge and internal short are concerns at this point.
- Cells and strings to be screened stringently and matched; insulation between cells and board will be added.

Acknowledgment

- API
- NASA-JSC Test Area also conducted other sections of the battery certification tests