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Johnson Space Center - Houston, Texas

Propulsion and Power Division

Bragg / Johnson

10/29/91

Preliminary Test Results for Li-SOCl₂ High-Rate "D" Cells

by

B.J. Bragg

and

Paul Johnson

NASA Johnson Space Center



Propulsion and Power Division

Bragg / Johnson

10/29/91

AGENDA

- **Background**
- **Test Results**
 - **Weight, OCV, and Load Check**
 - **Shock Test**
 - **Vibration Test**
 - **Capacity Performance**
 - **Uninsulated Short Circuit**
 - **High Temperature Exposure**
 - **Overdischarge**
- **Conclusions**



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BACKGROUND

- Objective - Evaluate the performance and abuse characteristics of 55 D-Size lithium-thionyl chloride (Li-SOCl₂) cells at relatively high rates.
- Cells developed by Electrochem Industries, Inc. under contract to the Jet Propulsion Laboratory.
- Cells manufactured in October 1989.
 - Li wt, - 3.44 g
 - Li anode area - 530 sq. cm
 - 1 anode tab - 0.25" w X 0.005" thk.
 - Electrolyte - 1.8M LiAlCl₄ in SOCl₂ - 44-45 g
- Cells kept in cold storage at NASA-JSC until tested in June 1991.
- 55 cells delivered to JSC
 - 39 used in this test program
 - 14 cells discharged in calorimetry testing
 - 2 held as spares



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TEST RESULTS

- **Weight Check: 121.31 - 122.79 grams**
- **Open Circuit Voltage: 3.658 - 3.662 VDC**
- **Load Check Voltage (5 ohm load for 90 sec.): 3.045 - 3.176 VDC**
 - None of the cells met 3.50 VDC minimum.
 - Cells were almost two years old.
- **Shock Test (2 Cells)**
 - Sawtooth shock pulse, 20 g peak with a 11 ± 1 millisecond rise and a 1 ± 1 millisecond decay.
 - Results: No change in OCV



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- **Vibration Test (3 Cells)**
- **Random vibration for 15 minutes in each of 3 mutually perpendicular axes according to the following spectrum:**

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

- **Results: No change in OCV.**



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- Capacity Performance (32 Cells)

- Ah to 1.5 VDC

-40°F, 2 ohm load

- 5 Cells
- 4.10 - 4.98 Ah
- Avg. 4.52 Ah

Room Temperature, 1 ohm load

- 7 Cells
- 10.38 - 10.75 Ah
- Avg. 10.57 Ah

160°F, 1 ohm load

- 5 Cells
- 9.48 - 9.61 Ah
- Avg. 9.55 Ah

Room Temperature, 2 ohm load

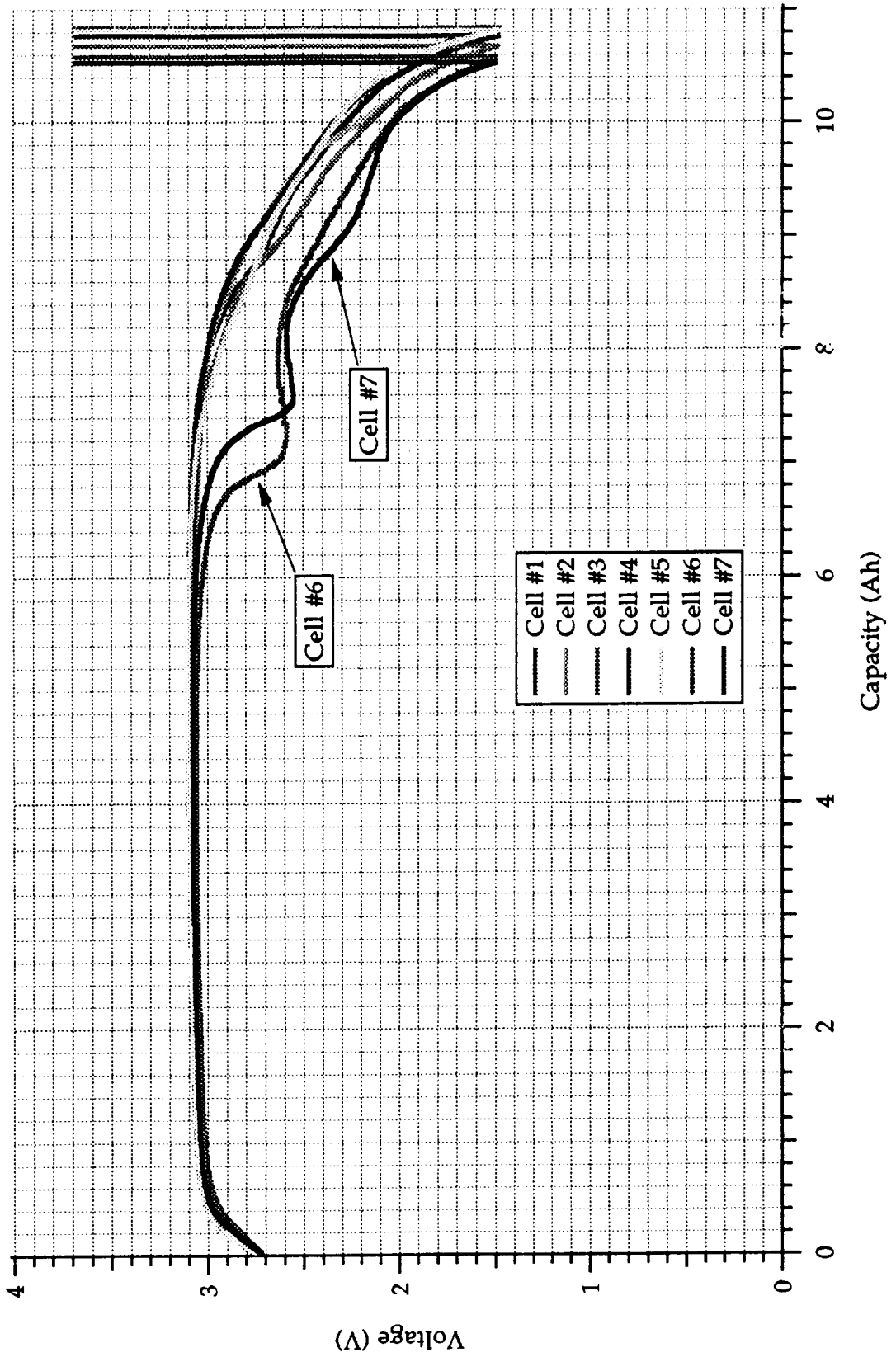
- 11 Cells
- 10.42 - 11.11 Ah
- Avg. 10.7 Ah

160°F, 2 ohm load

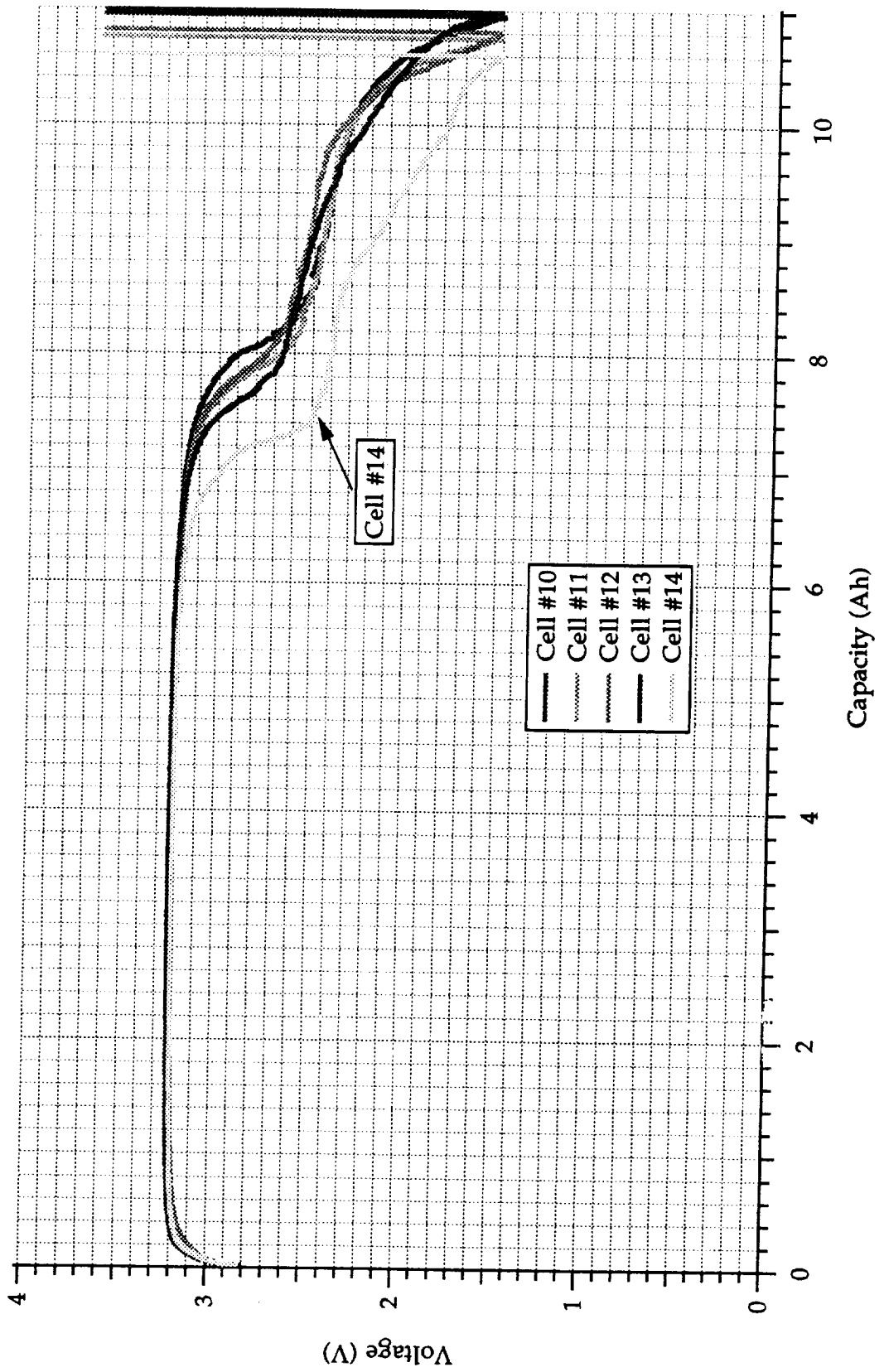
- 4 Cells
- 9.45 - 9.75 Ah
- Avg. 9.61 Ah

Li-SOCl₂ High Rate "D" Cell

One ohm discharge at room temperature to 1.5 volt

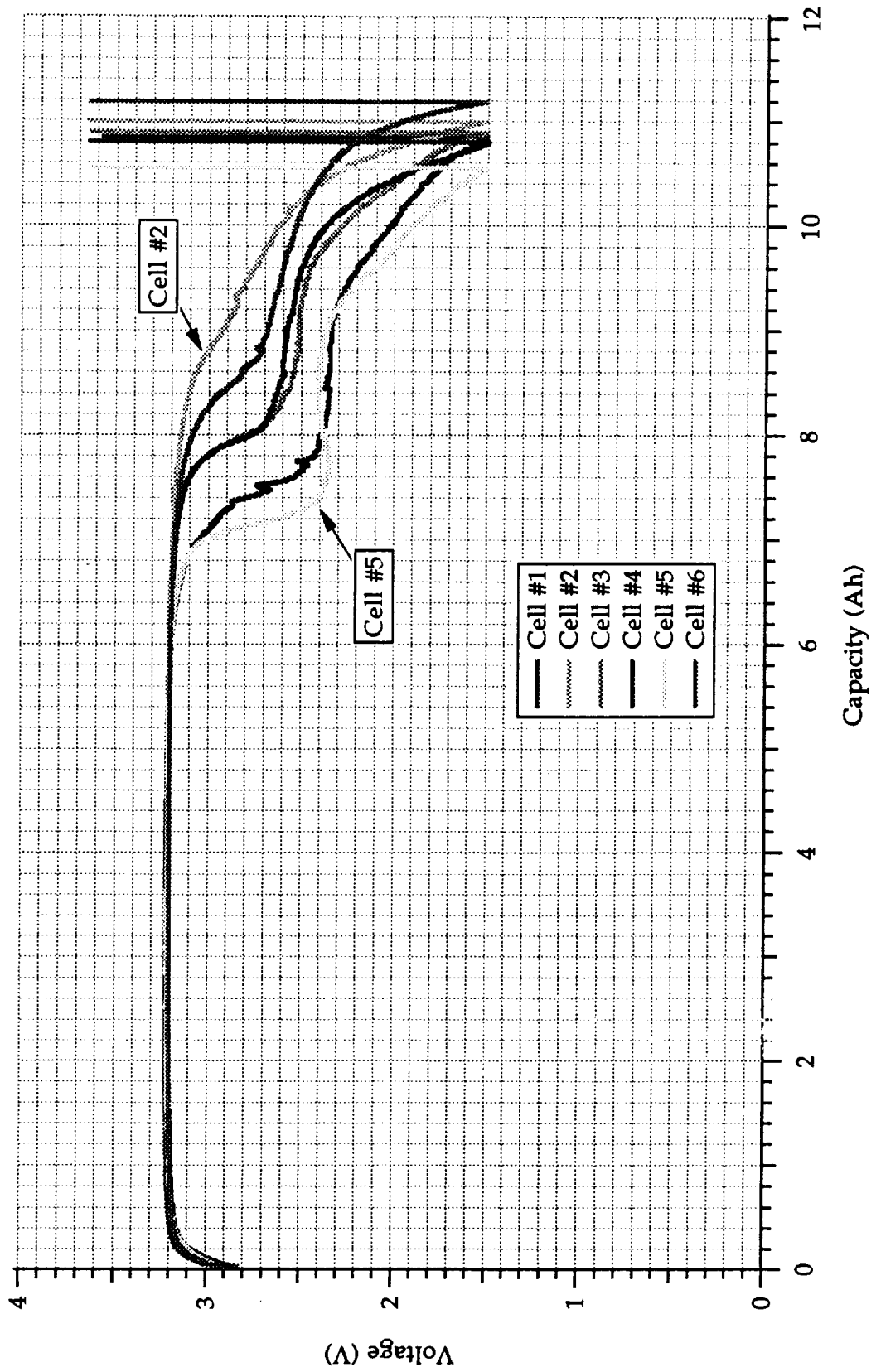


Li-SOCl₂ High Rate "D" Cell
 Two ohm discharge at room temperature to 1.5 volt

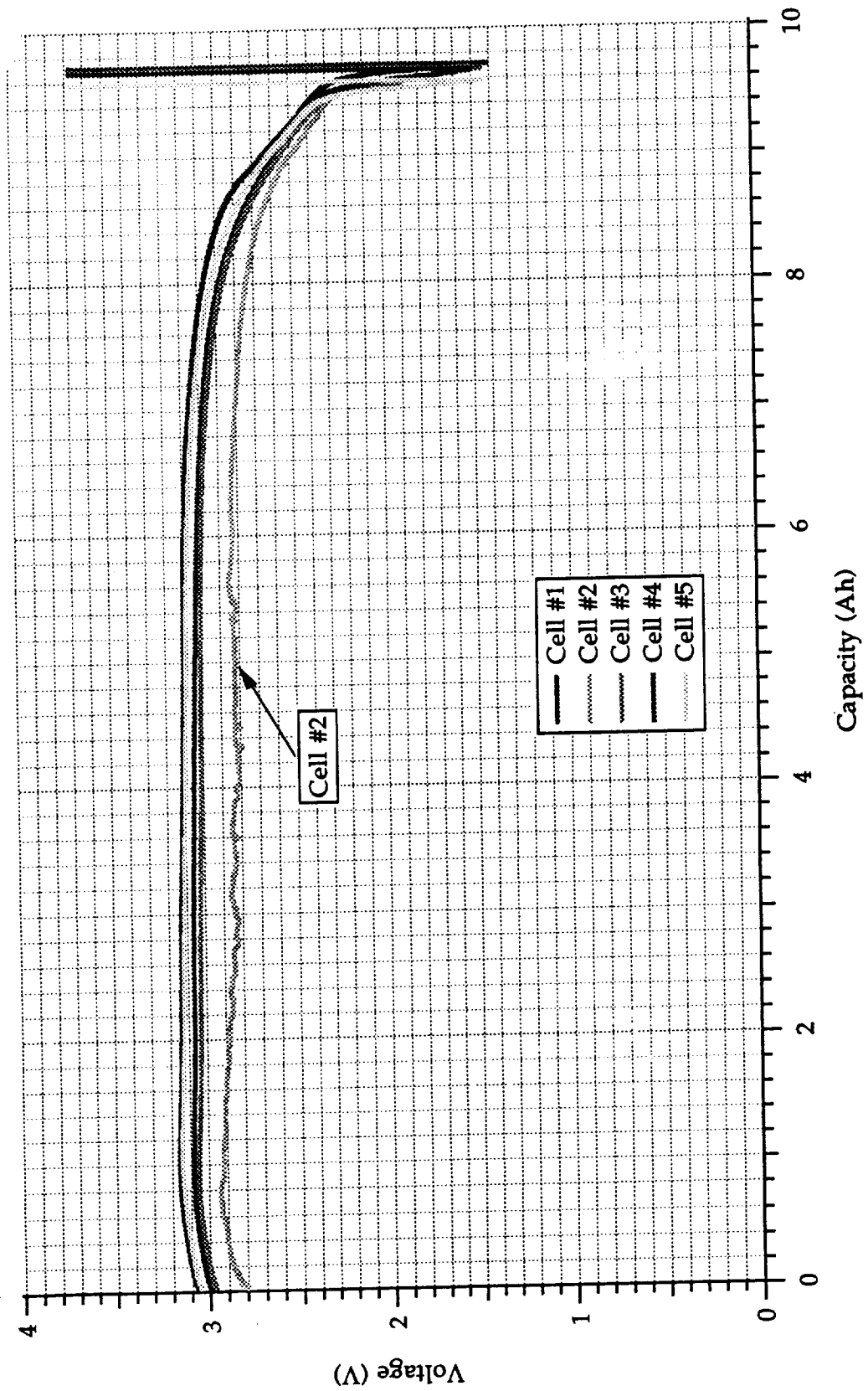


Li-SOCl₂ High Rate "D" Cell

Two ohm discharge at room temperature to 1.5 volt

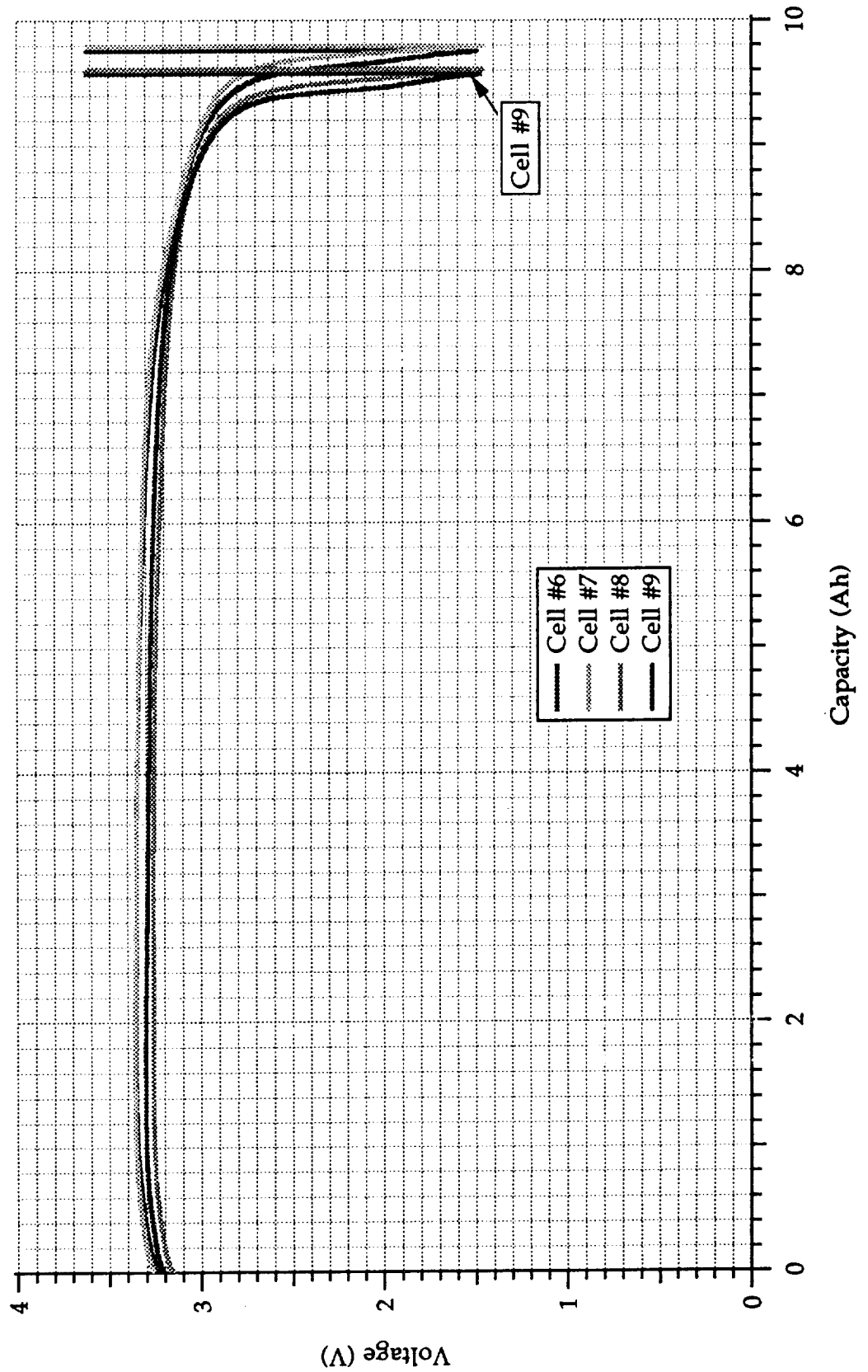


Li-SOCl₂ High Rate "D" Cell
One ohm discharge at 160°F to 1.5 volt



Li-SOCl₂ High Rate "D" Cell

Two ohm discharge at 160°F to 1.5 volt

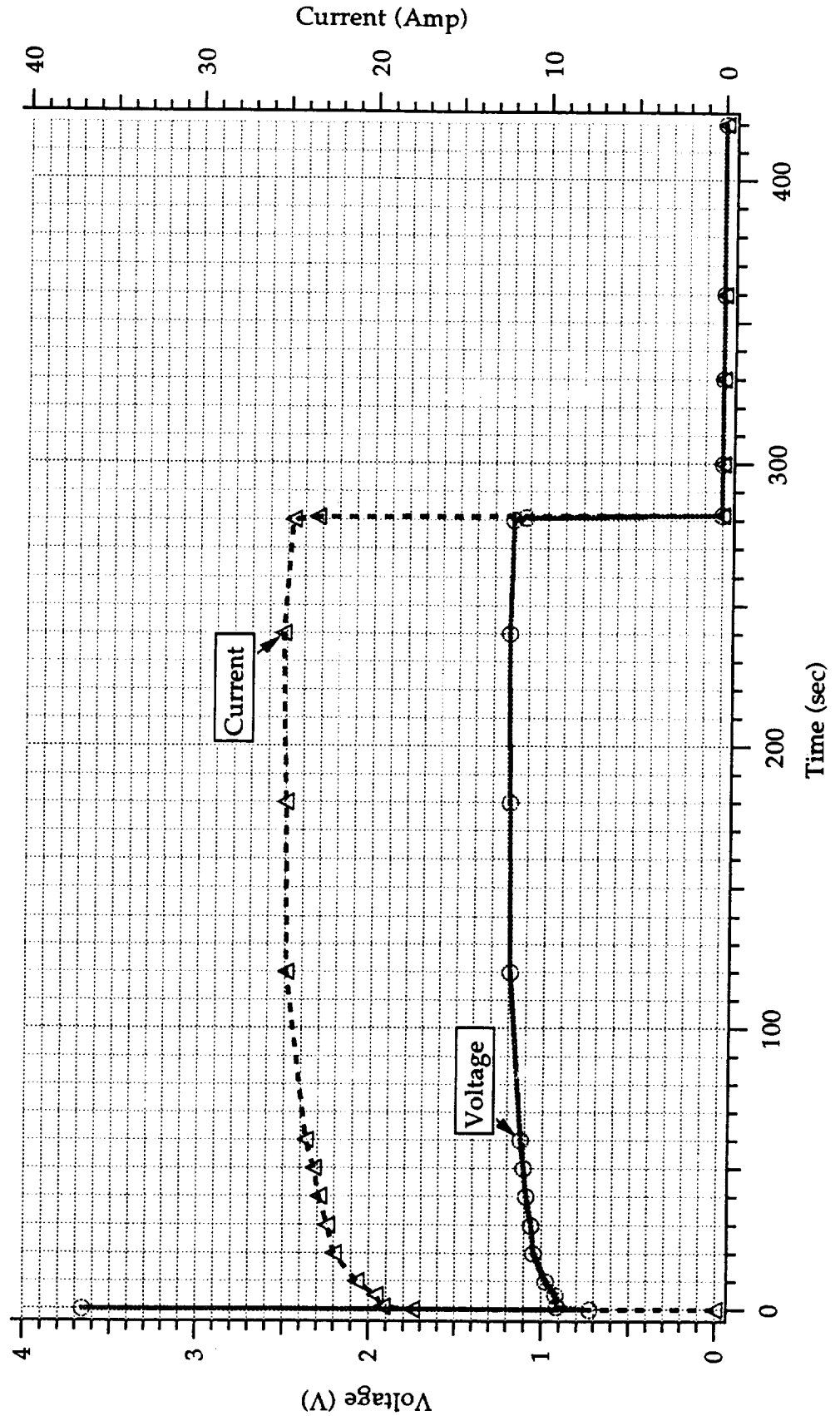




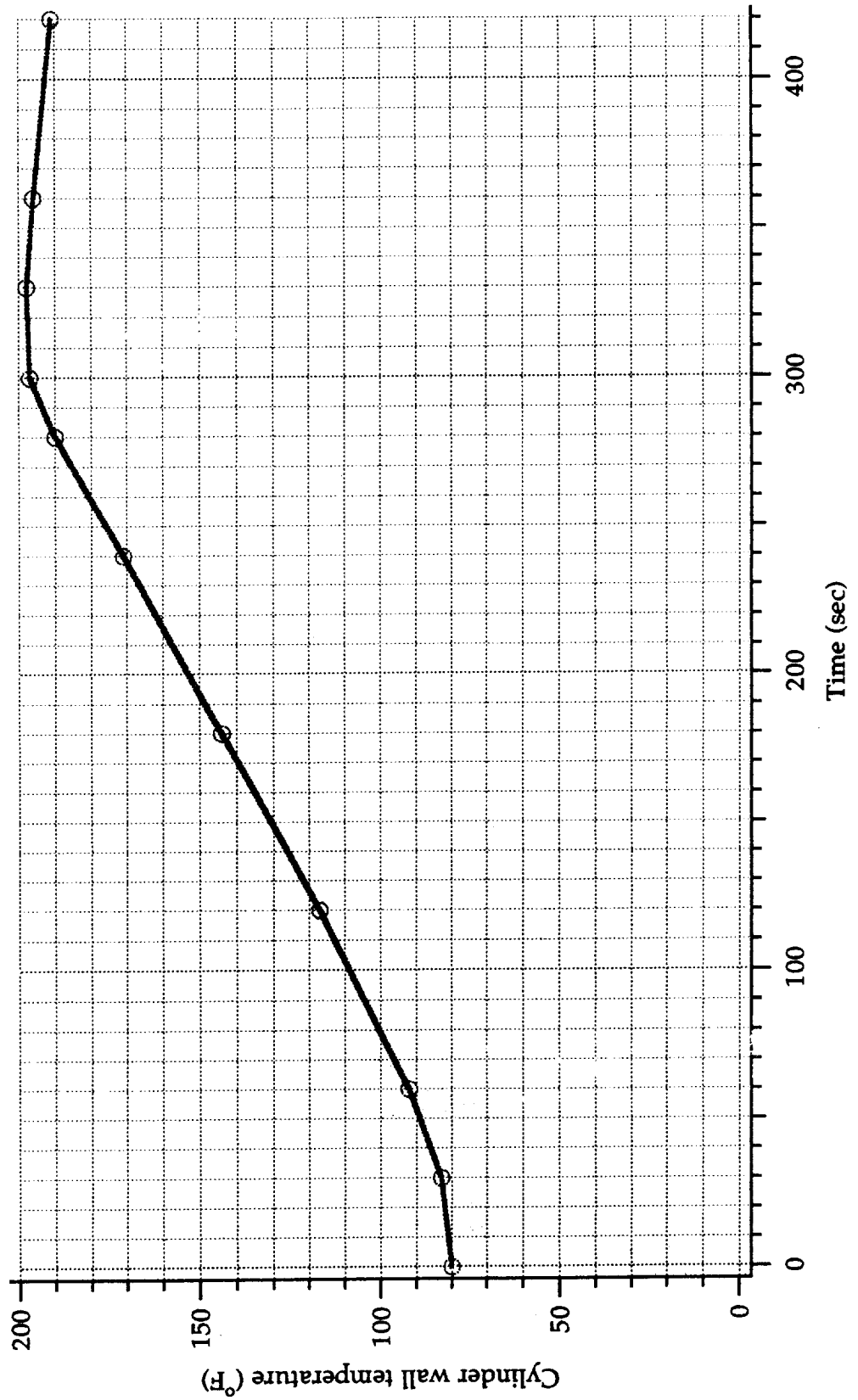
Preliminary Test Results for Li-SOCl ₂ High-Rate "D" Cells	Propulsion and Power Division	
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- Uninsulated Short Circuit (3 Cells)
 - Cell S/N 048396
 - Load : .075 ohm
 - Maximums: 0.27 VDC, 30 Amp, 118°F
 - Duration: 11 seconds until internal lead fused.
 - Post-test: 0.396V on 100 ohm load
 - Cell S/N 048422
 - Load: .120 ohm
 - Maximums: 1.21 VDC, 25.2 Amp, 198°F
 - Duration: 4 min 42 sec until internal lead fused.
 - Post-test: 0.18 V on 20 ohm load

Li-SOCl₂ High Rate "D" Cell
 Uninsulated short circuit test
 Cell S/N 048422 on 0.12 ohm load



Li-SOCl₂ High Rate "D" Cell
Uninsulated short circuit test
Cell S/N 048422 on 0.12 ohm load





Preliminary Test Results for Li-SOCl₂ High-Rate "D" Cells	Propulsion and Power Division	
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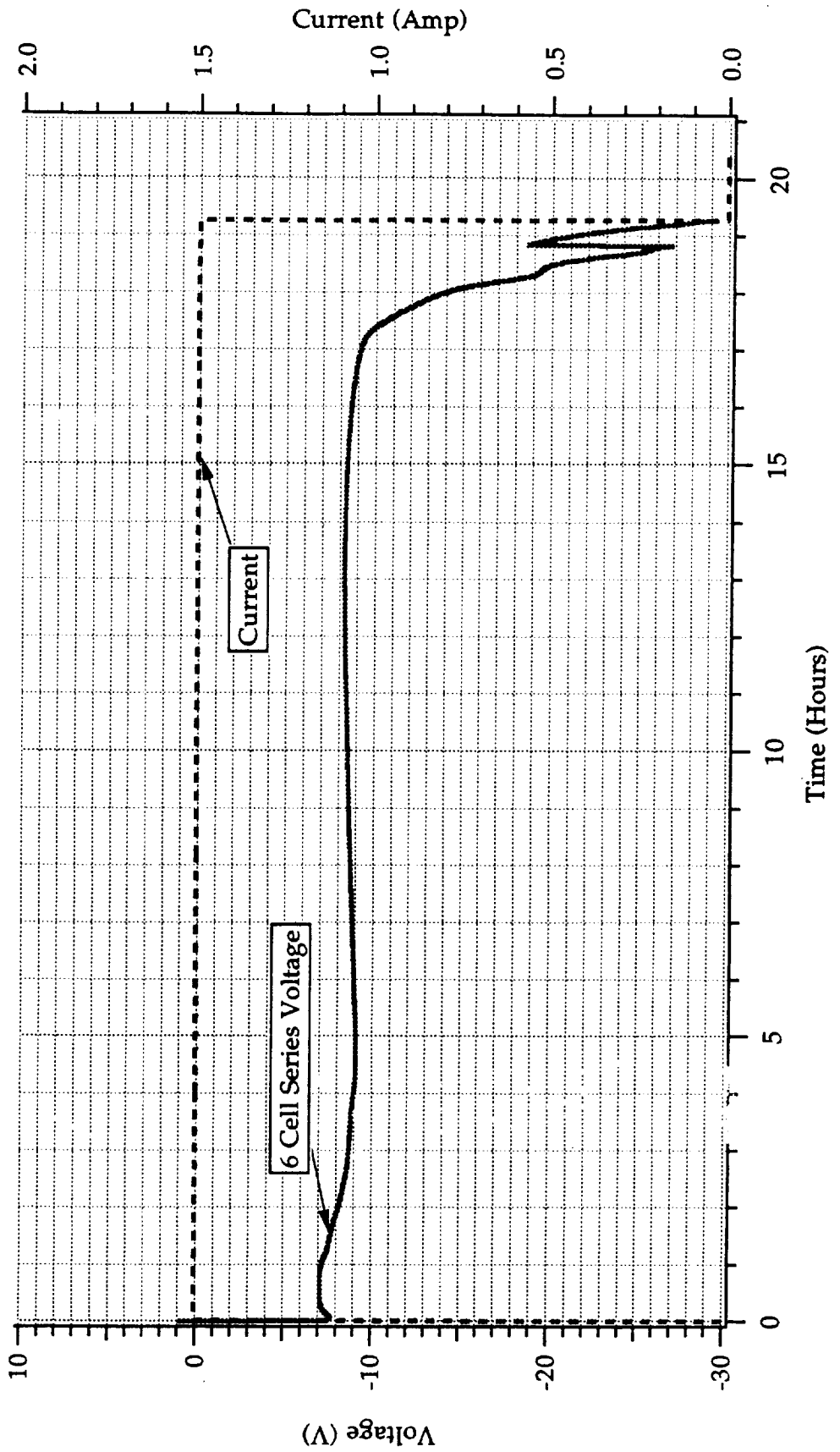
- Cell S/N 048439
 - Load: .120 ohm
 - Maximums: 1.21 VDC, 25 Amp, 130°F
 - Duration: 1 min 43 sec until internal lead fused.
 - Post-test: No OCV
- High Temperature Exposure
 - Cells tested for one hour at 225, 250, 275, and 300°F.
 - No leakage was found on any of the cells one week after high temperature exposure.



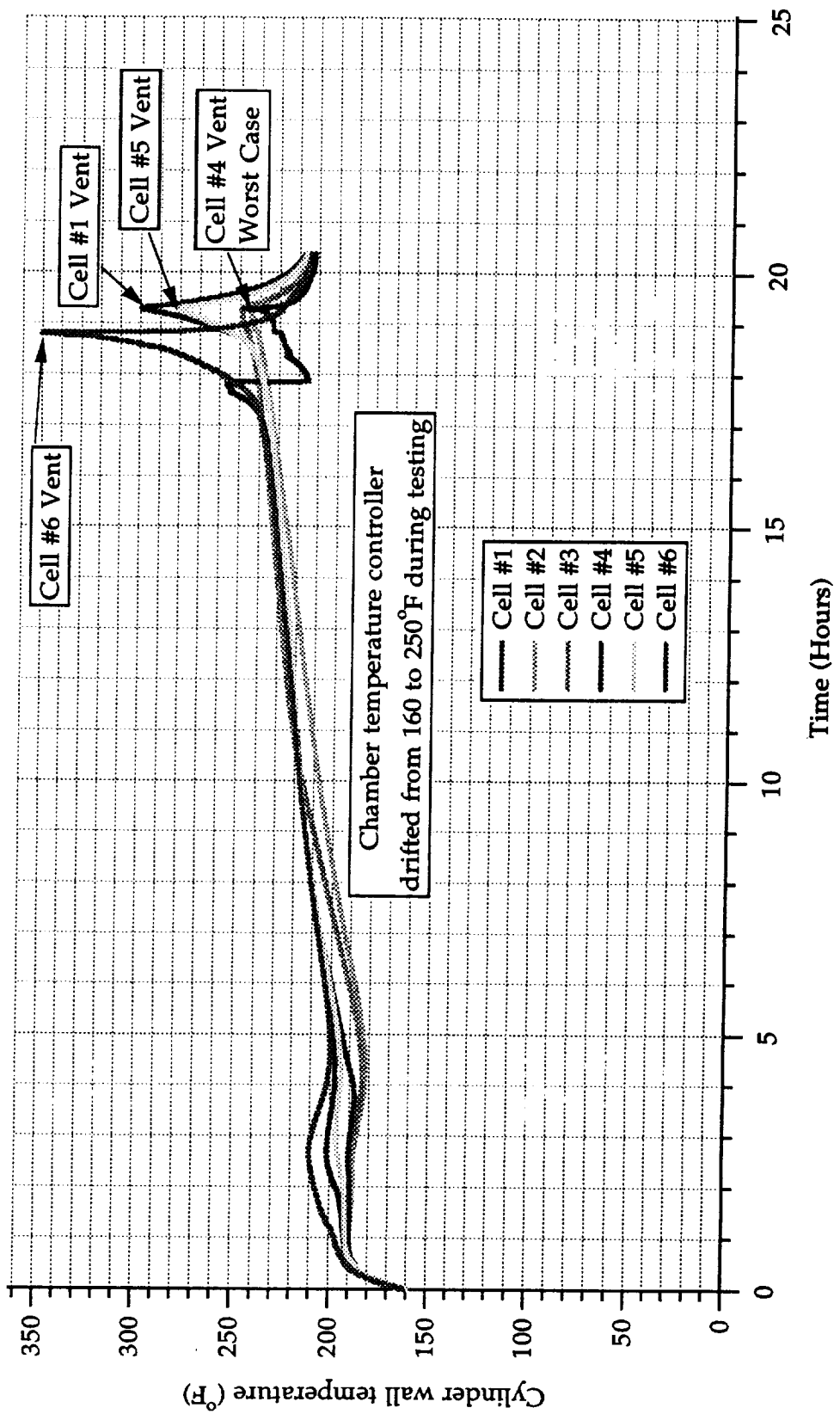
Preliminary Test Results for Li-SOCI2 High-Rate "D" Cells	Propulsion and Power Division
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- **Overdischarge; 2 Weeks Post-Discharge (6 Cells)**
 - **With Shunt Diodes**
 - **1.5 A at 160°F**
 - **No cells vented, max temperature 209.4°F**
 - **Without Shunt Diodes**
 - **1.5 A at 160°F to 245°F: Chamber temp. control drifted during test.**
 - **One cell vented at 19 hours and 3 cells at 19.25 hours, max temperature 348.7°F**
- **Overdischarge; 4 Weeks Post-Discharge (6 Cells)**
 - **With Shunt Diodes**
 - **1.5 A at 160°F**
 - **No cells vented, max temperature 226.4°F**
 - **Without Shunt Diodes**
 - **1.5 A at 160°F**
 - **One cell vented at 1.6 hours, max temperature 328.8°F**

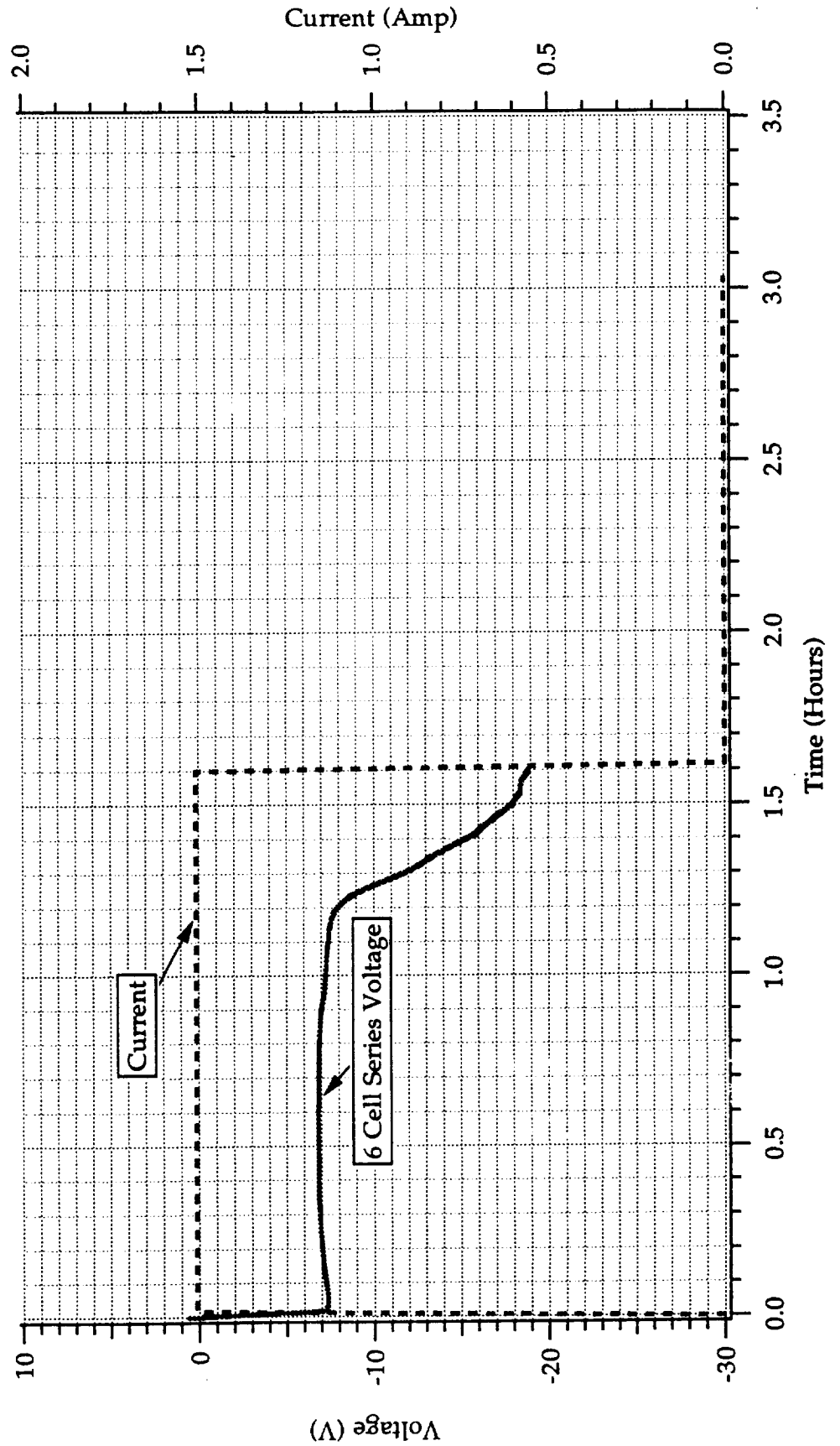
Li-SOCl₂ High Rate "D" Cell
 Two week post-discharge overdischarge without shunt diodes
 1.5 A at 160° F



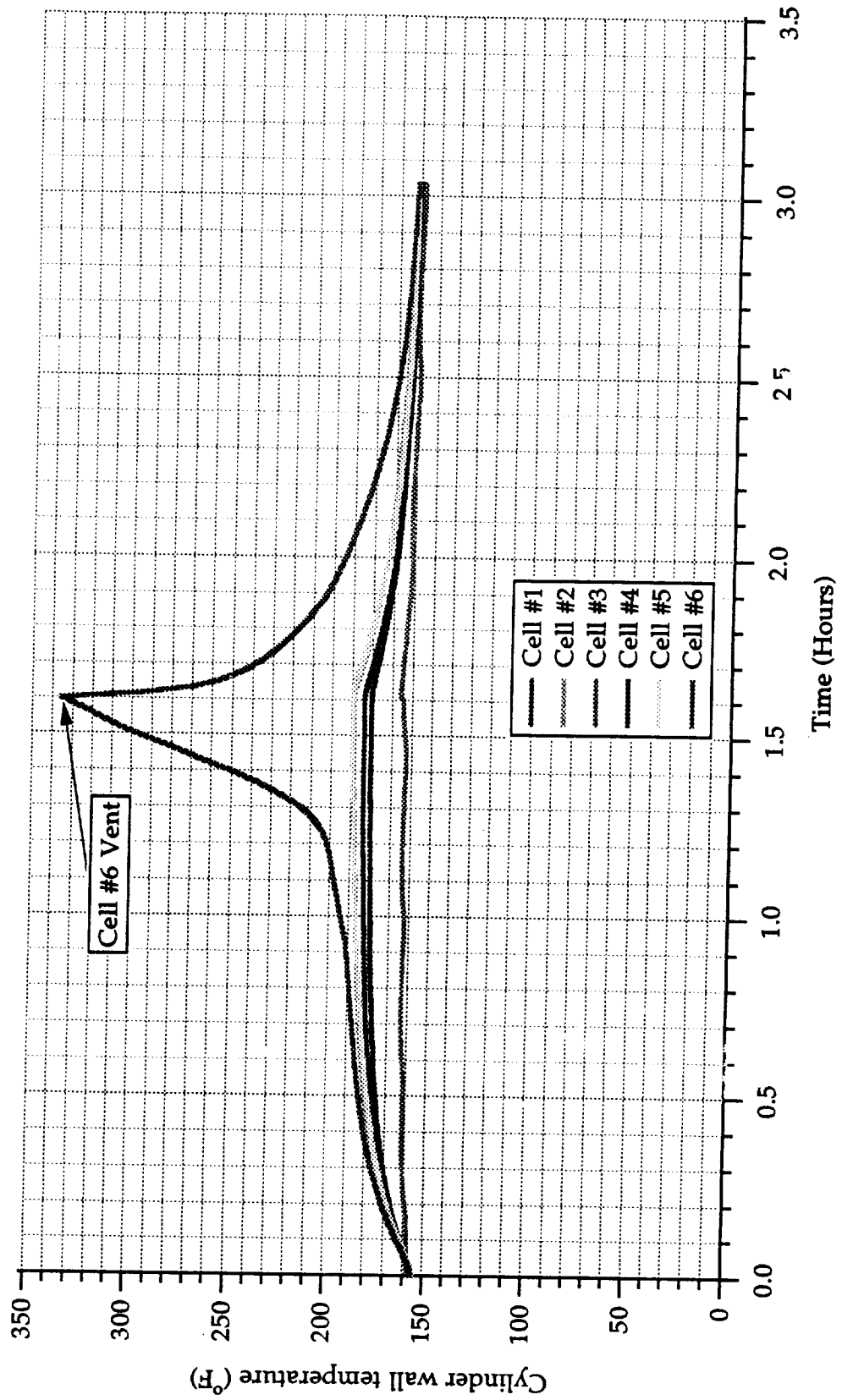
Li-SOCl₂ High Rate "D" Cell
 Two week post-discharge overdischarge without shunt diodes
 1.5 A at 160°F



Li-SOCl₂ High Rate "D" Cell
Four week post-discharge without shunt diodes
1.5 A at 160°F



Li-SOCl₂ High Rate "D" Cell
 Four week post-discharge overdischarge without shunt diodes
 1.5 A at 160°F





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CONCLUSIONS

- Take note of presented capacity to 1.5 volt end voltage.
- RT data, in particular, shows gradual decline from 3 v to 1.5 v.
- Final report will compare fresh capacities at higher end voltages.
- Overdischarge Tolerance
- Data taken after a 2-week interval of OCV was very tolerant.
- Data taken after a 4-week interval vented very quickly.
- Susceptibility to venting on overdischarge increases with length of OCV interval after discharge.
- By-pass diodes protect the cell from this effect.

Nickel-Cadmium Technologies Session

*Organizers: Dean Maurer
AT&T*

*Larry Thaller
The Aerospace Corporation*

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