RAY-O-VAC BR2325 LITHIUM CARBON MONOFLUORIDE CELL PERFORMANCE

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ABSTRACT

RAY-O-VAC currently markets a 160 mAH lithium cell recommended for usage in watch and calculator products. The lithium carbon monofluoride cell offers an extended shelf life with no reduction in performance effectiveness. The BR2325 cell has aerospace applications for memory devices and telemetry systems. Over one-hundred thirty (130) cells were purchased and tested for evaluation purposes. This paper reviews the test statistics and overall cell performance of the RAY-O-VAC BR2325 lithium carbon monofluoride cell.

INTRODUCTION

The RAY-O-VAC BR2325 lithium monofluoride cell is a commercially available product recommended for usage in watch and calculator products. The cell has a nameplate capacity of 160 mAH (13,000 Ohms at 21^{o}C to 2.0 V), a volume of 1.04 cc and a weight of 3.1 grams. The button cell dimensions, depicted in Figure 1, comply with the proposed industry standard sizes for lithium cell utilized for watch and calculator products (ref 1). Figures 2 and 3 depict advertised discharge characteristics for varying loads and temperatures.

The RAY-O-VAC BR2325 cell has possible applications for memory backup and telemetry systems. The most important features of any battery power system are first, reliability, and second, the ability to deliver energy with a good volumetric efficiency. Most lithium cells, including the BR2325, fulfill the second requirement but have not clearly demonstrated the first. Therefore, a goal of the test program was to establish a reliability data base for consideration of the monofluoride cell for future aerospace usage. Another important feature of a lithium power system, due to the historical backgound of lithium couples, is the safety considerations associated with the lithium battery. The fact that not all lithium cells/batteries are hazardous is demonstrated by the existence of certain lithium batteries, such as the BR2325, in the commercial market (ref 2).

The procurement of 130 BR2325 cells specified the cells be manufactured from the same lot and on the same day. The cells were manufactured 08 April 1983 at the RAY-O-VAC Corporation in Madison, Wisconsin. The testing facilities, test plan and test statistics are reviewed in the following paragraphs.

TEST FACILITIES

The evaluation testing of the RAY-O-VAC BR2325 cells was conducted at the Experimental Battery Test Facility (EBTF), a dedicated facility for performing testing and evaluation on experimental battery types such as high energy density lithium batteries. The facility is equipped with seven temperature test chambers and a dedicated data acquisition system. Each of the test chambers is capable of maintaining temperatures of minus 40°F to plus 350°F. The chambers have been modified to accommodate six modular test fixtures designed for cells such as the BR2325. The chamber test patch panel, mounted externally, is the interface point for the Data Acquisition System and the mounting location for the test load resistors.

The EBTF Data Acquisition System consists of a 420 channel Fluke Model 2240C Data Logger, a Commodore PET computer and a Texas Instrument Silent 700 Electronic Data Terminal. This system, depicted in Figure 4, is controlled by the test monitoring software resident in the 32K PET computer. All test data, including cell voltages and chamber temperatures, is monitored approximately every two minutes. When a data recording is required, as determined by cell voltage rate of change or prescribed data record interval, the data record is transmitted to the electronic data terminal where it is recorded on cassette magnetic tape and printed on hardcopy.

TEST PLAN

The test plan for the RAY-O-VAC BR2325 cells is summarized in Table 1. The cells were tested at six discharge rates and five temperatures. Twelve cells were placed in ambient storage for 6 months and six cells for 12 months to measure the effect of long term storage on the BR2325 cell.

TEST SUMMARY

The average capacities for the BR2325 cell as a function of temperature and discharge rate are summarized in Tables 2 and 3. Typical discharge curves for the five test temperatures at the 30 day discharge rates are provided in Figures 5 through 9. Figure 5 illustrates the voltage sensitivity of the BR2325 cell to test temperature changes for the low temperature (-10°F) test. The voltage sensitivity versus test temperature changes was not as pronounced for the other test plan temperatures. As expected, the RAY-O-VAC BR2325 cell generally provided the greatest capacity at the +75°F test temperature. The capacities obtained at the various discharge rates and temperatures generally agreed with the RAY-O-VAC literature on the lithium carbon monofluoride cell.

The effect of long term storage on the cell performance of the BR2325 cell is negligible. Figure 10 depicts the discharge profile for the median cell from the 12 month storage test group. The cell performance was nearly identical to the performance of a cell not subjected to long term storage.

CONCLUSIONS

The overall cell performance of the RAY-O-VAC BR2325 lithium carbon monofluoride cell was acceptable from a statistical viewpoint. The coefficient of variation was generally below 5% and the standard deviation was generally less than 10 milliampere-hour for the five cell test groups. The statistical uniformity is attributed partly to the fact the cells came from the same manufacturing lot.

The low capacities at -10°F can be attributed to the rate reductions of the energy producing chemical reactions within the lithium carbon monofluoride cell. The voltage stability at the low temperature was excellent provided the test temperature of -10°F was stable. The voltage sensitivity to test temperature changes for the high temperature tests was minimal. The reduced capacities at the high temperature are attributed to the speed up in battery deterioration.

The BR2325 cell appears to be a viable candidate for aerospace applications for memory devices and telemetry systems. The cells tested were "off the shelf" hardware which uniformally supported the resistive loads. A special build of the RAY-O-VAC BR2325 cell for a particular aerospace application should provide a reliable energy storage system.

REFERENCES

1. Crompton, T. R., Small Batteries Primary Cells Volume 2, John Willey and Sons, Inc., New York, 1983.

2. Smith, J. J., "Research Issues in Future Navy Lithium Inorganic Electrolyte Batteries for Navy Application", Naval Undersea Center TP 564, February 1977.

Table 1. RAY-O-VAC BR2325 LITHIUM CARBON MONOFLUORIDE TEST PLAN

Discharge Rate	Resistive Load (Ohms)	Discharge Current (mA)	Test Temperature
53 Hrs	905	3.0	+ 32°F
53 Hrs	905	3.0	+ 75°F
53 Hrs	905	3.0	+ 120°F
80 Hrs	1330	2.0	+ 32°F
80 Hrs	1330	2.0	+ 75°F
80 Hrs	1330	2.0	+ 120°F
160 Hrs	2745	1.0	+ 32°F
160 Hrs	2745	1.0	+ 75°F
160 Hrs	2745	1.0	+ 120°F
30 Days	12 K	0.22	- 10°F
30 Days	12 K	0.22	+ 32°F
30 Days	12 K	0.22	+ 75°F
30 Days	12 K	0.22	+ 120°F
30 Days	12 K	0.22	+ 160°F
90 Days	36.4 K	0.074	- 10°F
90 Days	36.4 K	0.074	+ 32°F
90 Days	36.4 K	0.074	+ 75°F
90 Days	36.4 K	0.074	+ 120°F
90 Days	36.4 K	0.074	+ 160°F
180 Days	75 K	0.037	- 10°F
180 Days	75 K	0.037	+ 32°F
180 Days	75 K	0.037	+ 75°F
180 Days	75 K	0.037	+ 120°F
180 Days	75 K	0.037	+ 160°F
Storage 8 months	36.4 K	0.074	+ 75°F
Storage 10 months	36.4 K	0.074	+ 75°F
Storage 12 months	36.4 K	0.074	+ 75°F

Table 2. AVERAGE CAPACITY TO A 2.0 VOLTAGE CUTOFF

Discharge Rate	Test Temperature °F				
	-10	32	75	120	160
53 Hrs (3.0 mA)		081	110	170	
80 Hrs (2.0 mA)		087	122	165	
160 Hrs (1.0 mA)		098	142	155	
30 Days (0.22 mA)	043	146	173	168	141
90 Days (0.074 mA)	086	155	137	146	102
180 Days (0.037 mA)	093	169	171	130	104

Table 3. AVERAGE CAPACITY TO A 0.2 VOLTAGE CUTOFF

Discharge Rate	Test Temperature °F				
	-10	32	75	120	160
53 Hrs (3.0 mA)		149	149	172	
80 Hrs (2.0 mA)		152	158	172	
160 Hrs (1.0 mA)		152	167	169	
30 Days (0.22 mA)	073	171	174	170	148
90 Days (0.074 mA)	103	172	174	149	127
180 Days (0.037 mA)	130	171	172	142	136

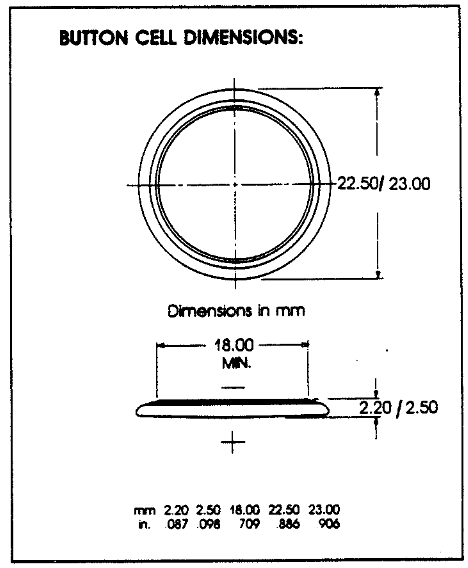

Figure 1. Ray-O-Vac BR2325 Cell Dimensions

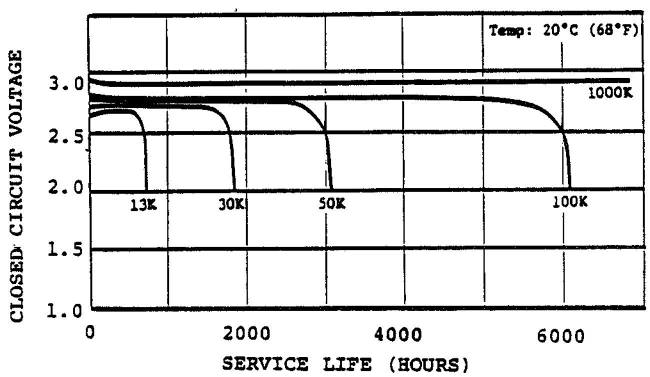

Figure 2. Ray-O-Vac BR2325 Service Life Versus Load

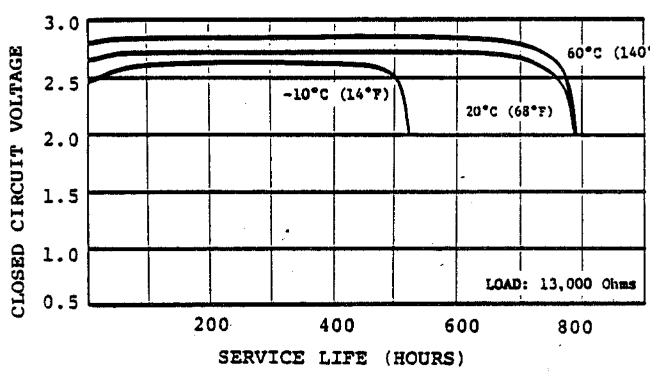

Figure 3. Ray-O-Vac BR2325 Service Life Versus Temperature

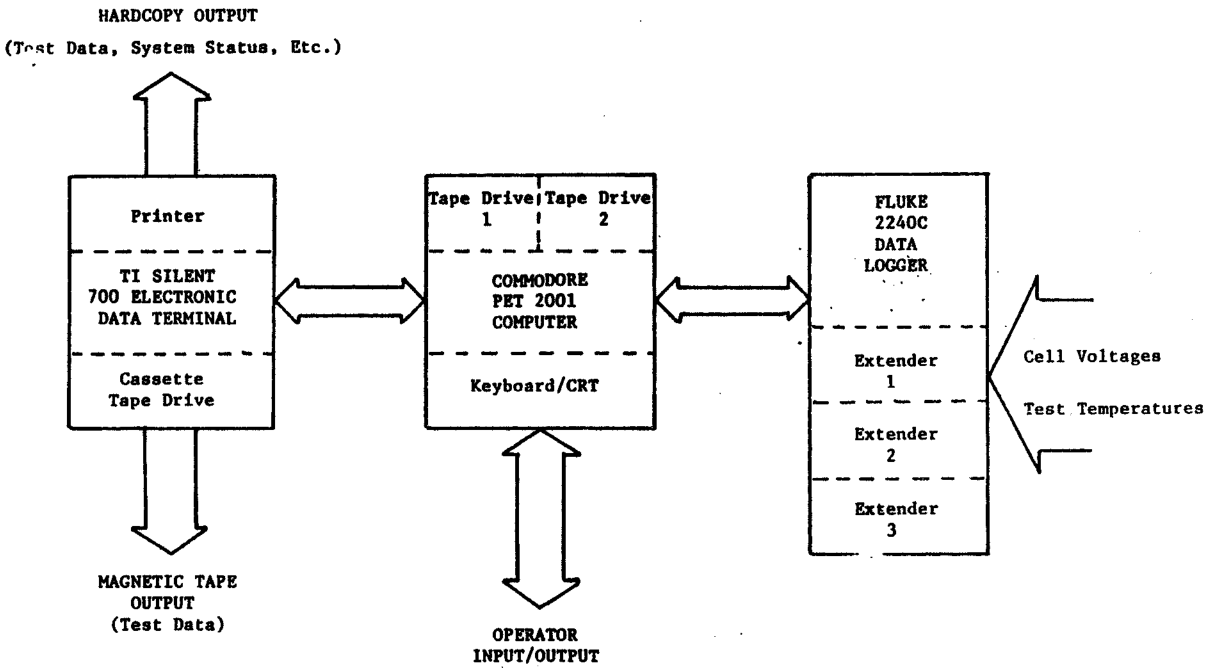

Figure 4. EBTF Data Acquisition System

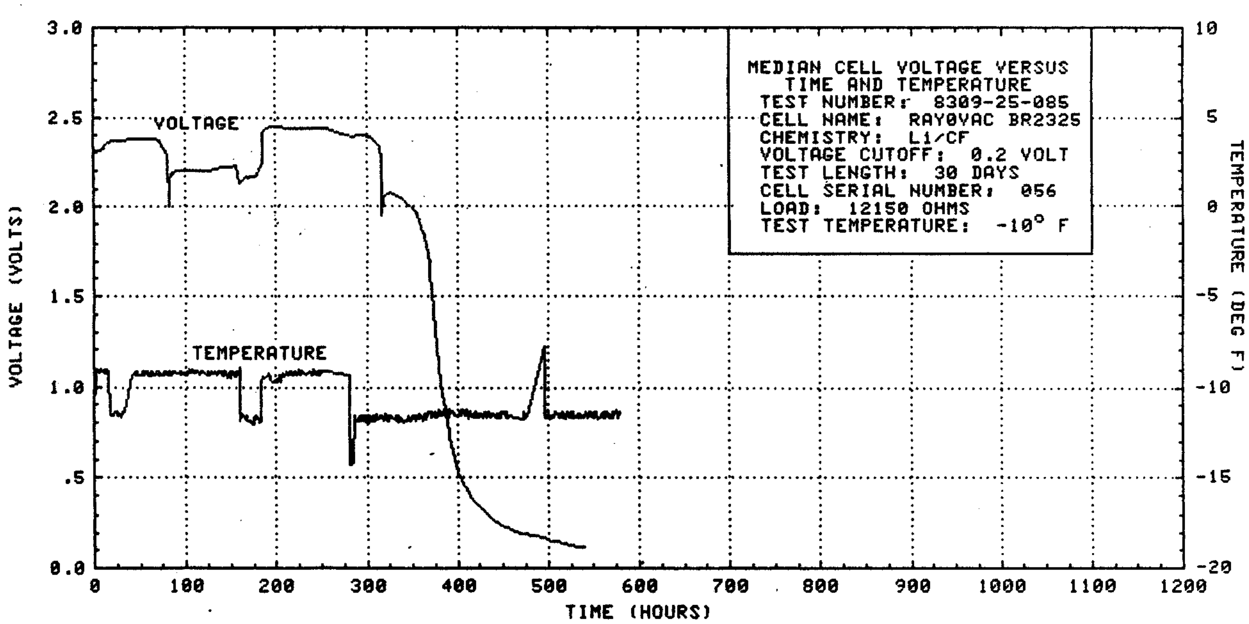

Figure 5. Median Cell Voltage Versus Time and Temperature, -10°F

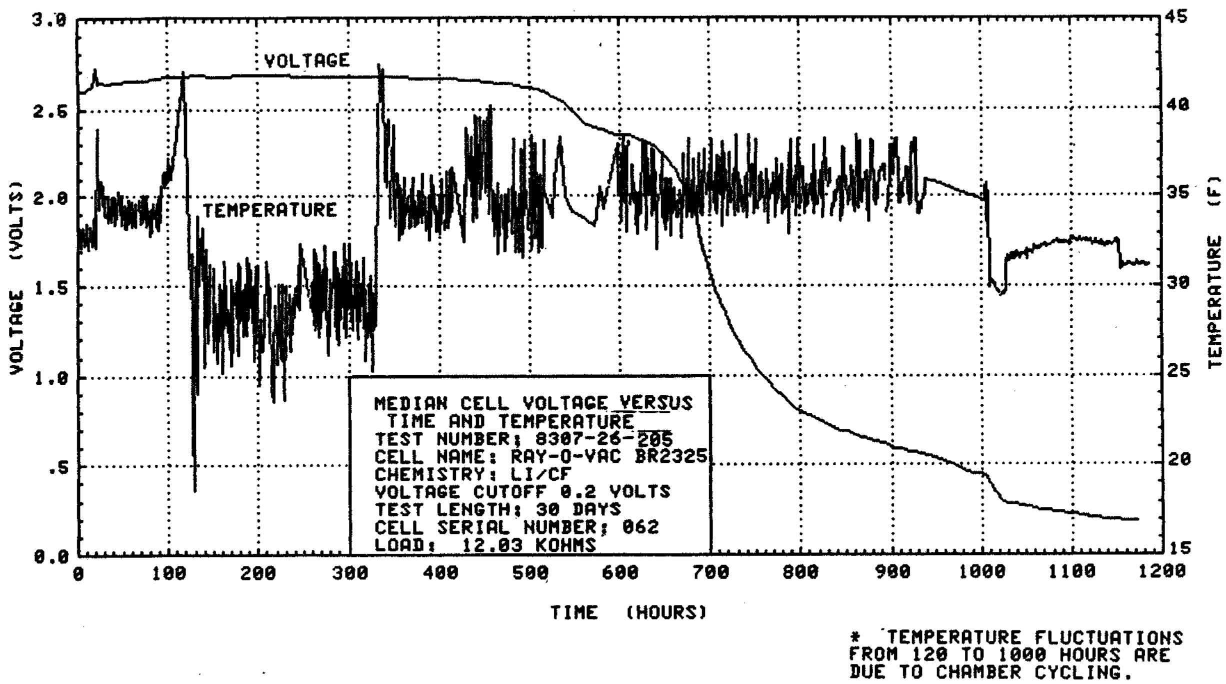

Figure 6. Median Cell Voltage Versus Time and Temperature, 32°F

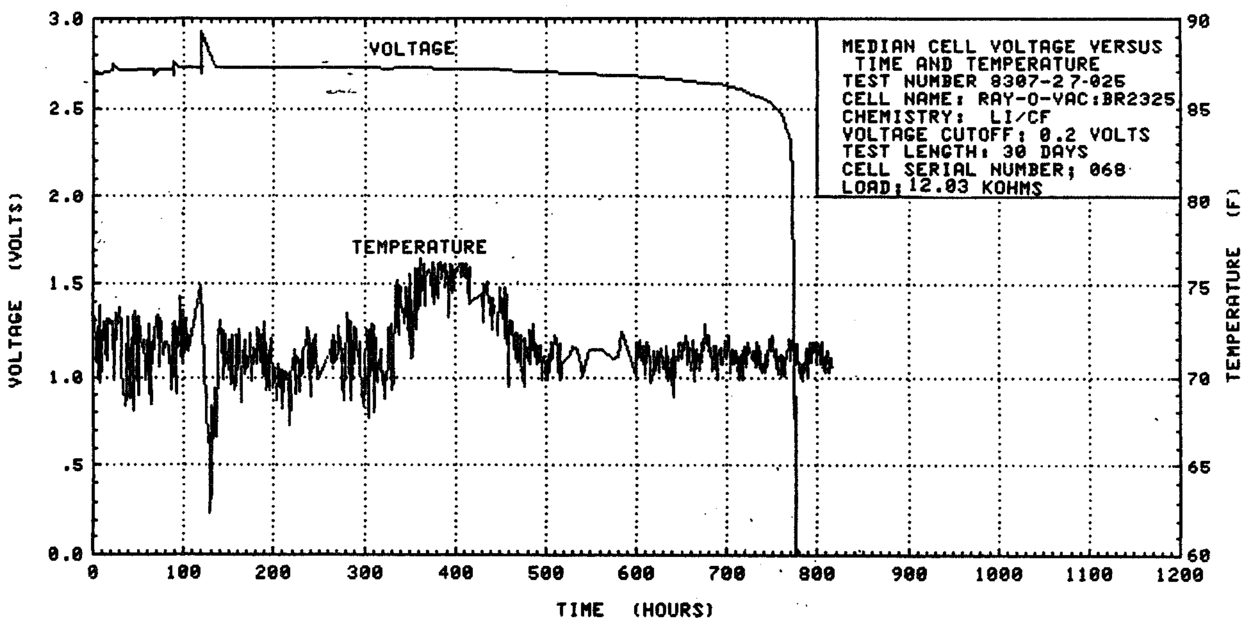

Figure 7. Median Cell Voltage Versus Time and Temperature, 75°F

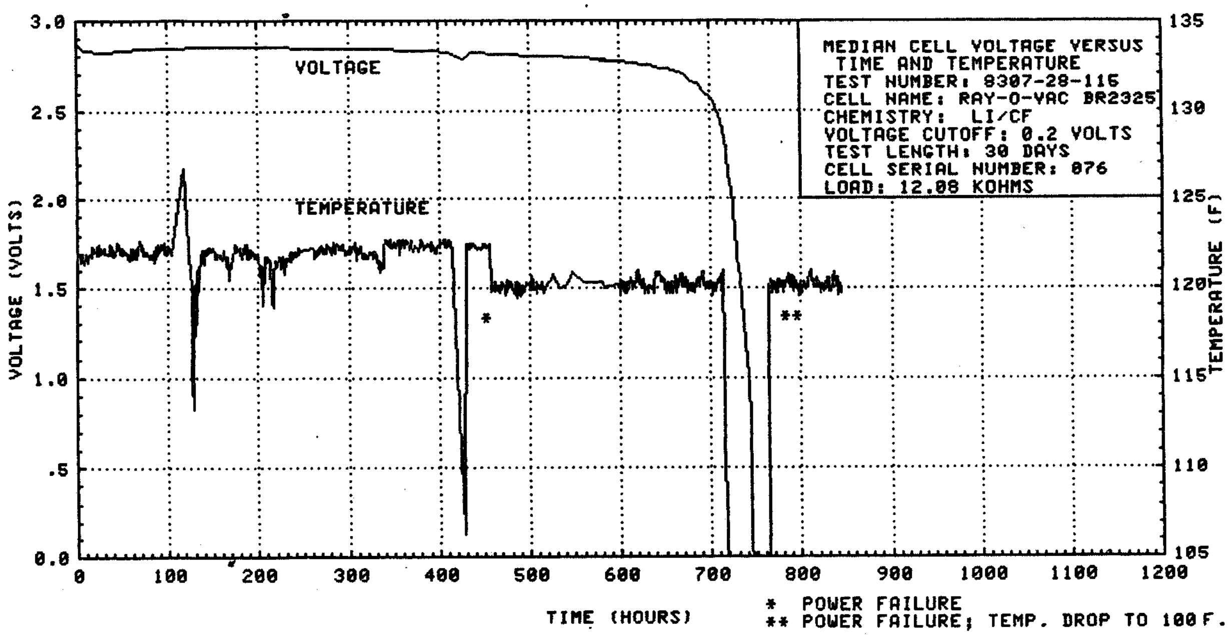

Figure 8. Median Cell Voltage Versus Time and Temperature, 120°F

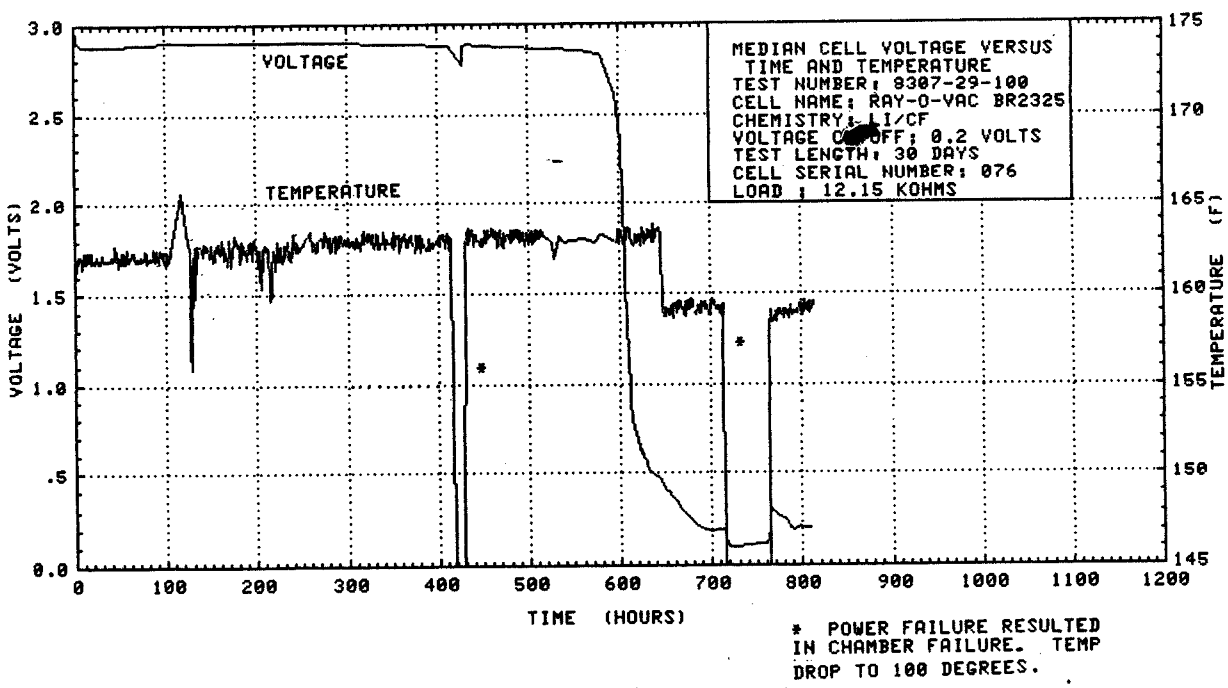

Figure 9. Median Cell Voltage Versus Time and Temperature, 160°F

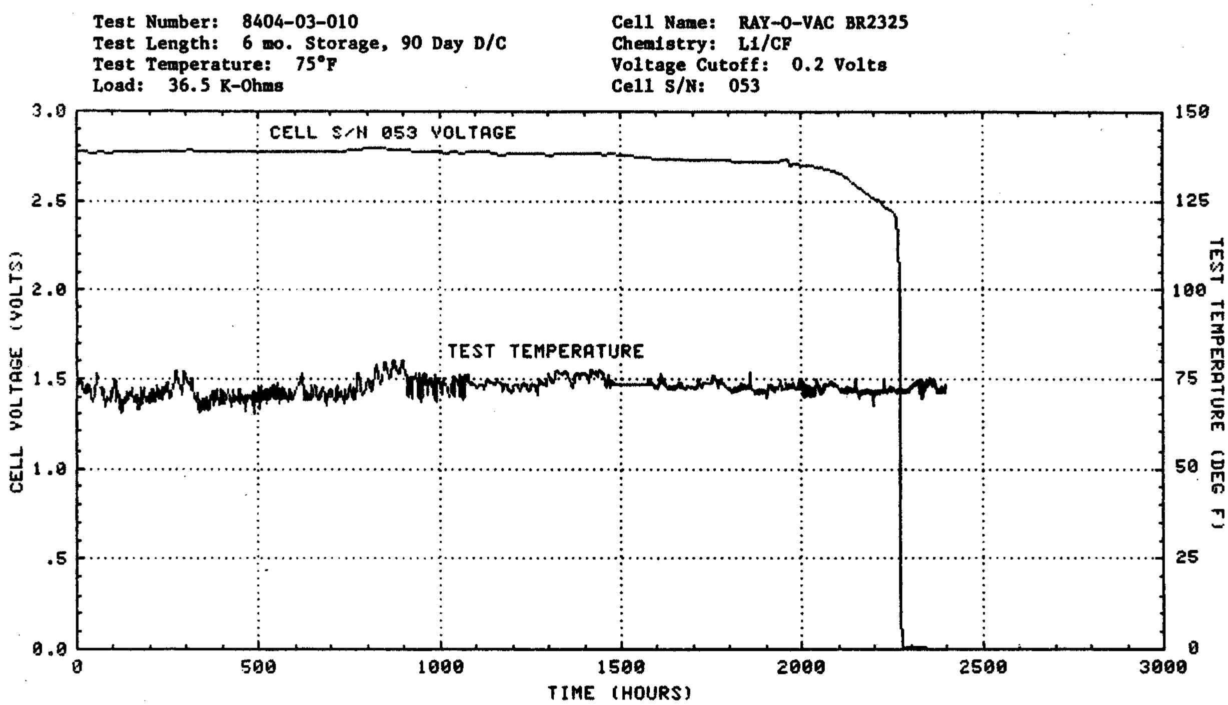

Figure 10. Median Cell Voltage Versus Time and Temperature, 6 Month Storage