Construction of Temperature Compensated Constant Voltage (VT) Curves for Super NiCd™ Cells

HUGHES
ELECTRON DYNAMICS DIVISION
COMMERCIAL / INDUSTRIAL SECTOR

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pg 598

Abstract

Tests to establish current-voltage characteristics at selected temperatures for 9 ampere-hour Super Nickel-Cadmium™ cells were conducted at Hughes Industrial Electronics Company's Electron Dynamics Division (HIEC/EDD) under sponsorship of NASA Goddard Space Flight Center (NASA/GSFC) through their prime spacecraft contractors Fairchild Space (SMEX/SAMPEX) and TRW (TOMS-EP). Curves were constructed using techniques established by Webster, Ford, et al, at NASA/GSFC in the late 1960 - early 1970 tiime period for conventional nickel cadmium cells used on OAO and OSO spacecraft. The NASA/GSFC techniques were slightly modified by HIEC/EDD to fit the Super Ni-Cd situation.

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AGENDA

I. Introduction
- Purpose of VT Determinations
- Heritage - Use on OAO and OSO and current NASA spacecraft

II. Technique for Generation of VT Curves
- Results from early NASA/GSFC Studies (Webster, Ford)
- Use of Webster and Ford Techniques at HIEC/EDD

III. Results
- Charge/Discharge Ratios
- Characterization Tests
- Plots of Recharge Ratio vs. Charge Voltage Limit
- Voltage/Temperature Characteristics for Multiple Level Nickel-Cadmium Battery Charger

IV. Discussions of Results
- Reasons for Differences in Super NiCd and Conventional NiCd Plots
- Technique for Generation of Curves

V. Conclusions
- Principle the same although curves may be slightly different for Super NiCd.
- One set of curves can be used.

Procedure for Generation of Curves

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- Select % Recharge from Figure 1.
- Select % DOD's (e.g., 25%) characteristic recharge ratio and voltage limit from Figure 2.
- Put % return on curve at appropriate temperature - Drop perpendicular to abcissa for voltage reading.
- To verify plot on cell voltage vs. temperature scale, compare with past curves (Figure 3).
  (Set level 8 at 1.520 ± .015 at 0°C, 0.020 ± .002 per level)
- Level 8 limit may not be used.
- Level 7 for max. DOD expected.
  (Curves 1 & 2 allow operation with loss of cell)
- Operate 1 level lower than expected at BOL.
  (Level 3 at 10% DOD, Level 5 at higher DOD)

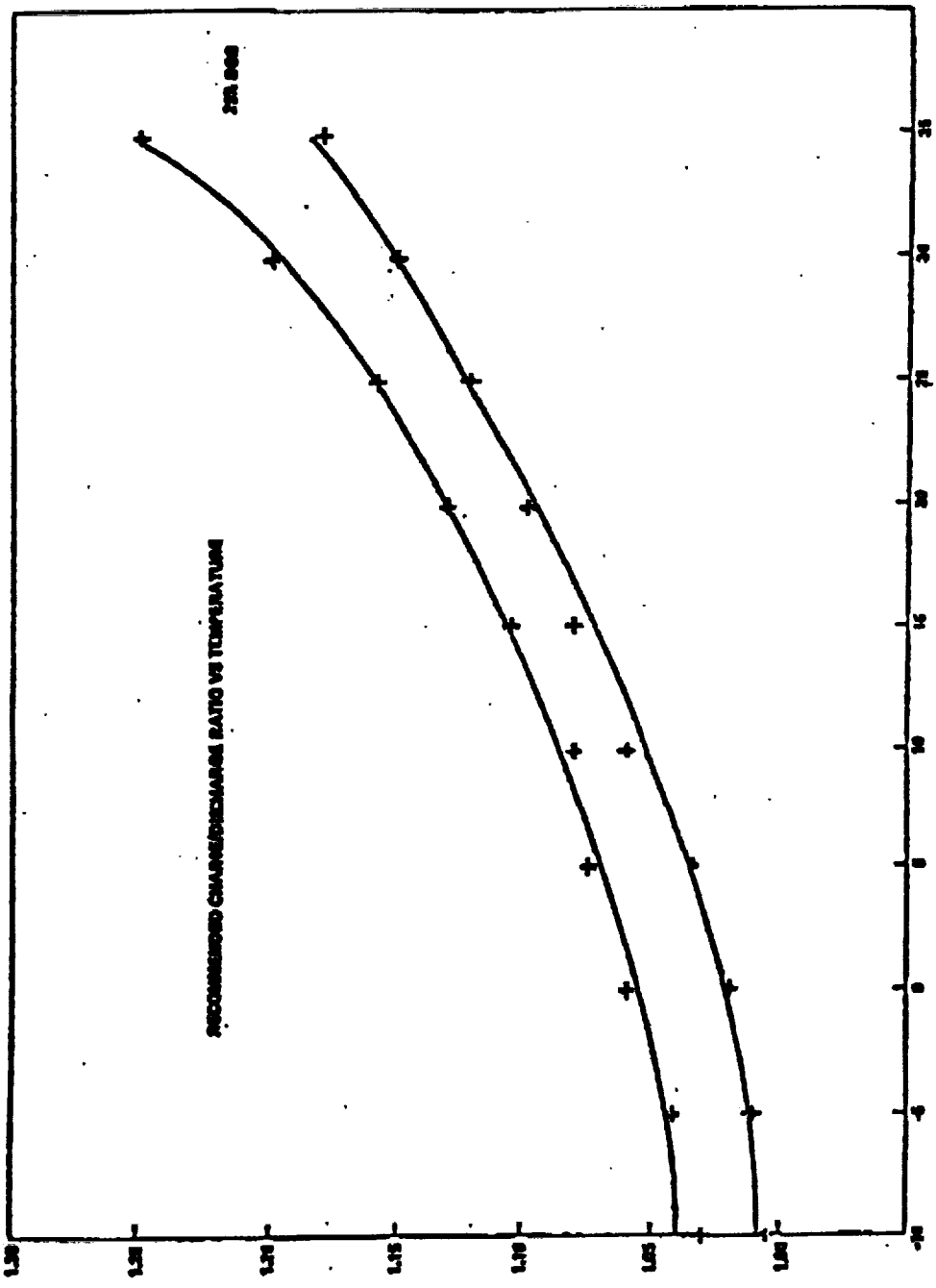

FIGURE 1

Recommended Charge/Discharge Ratio versus Temperature

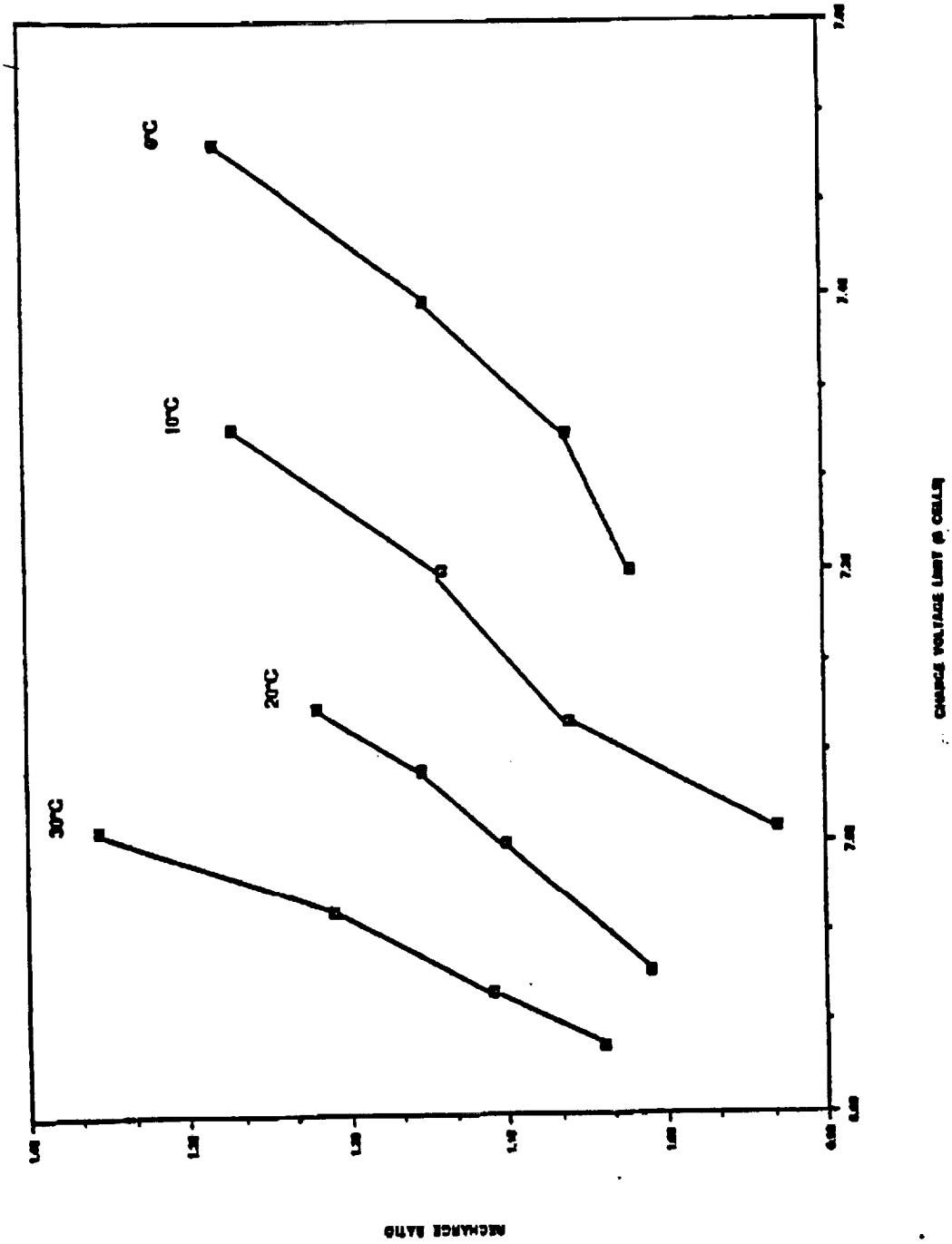

FIGURE 2
25% DOD

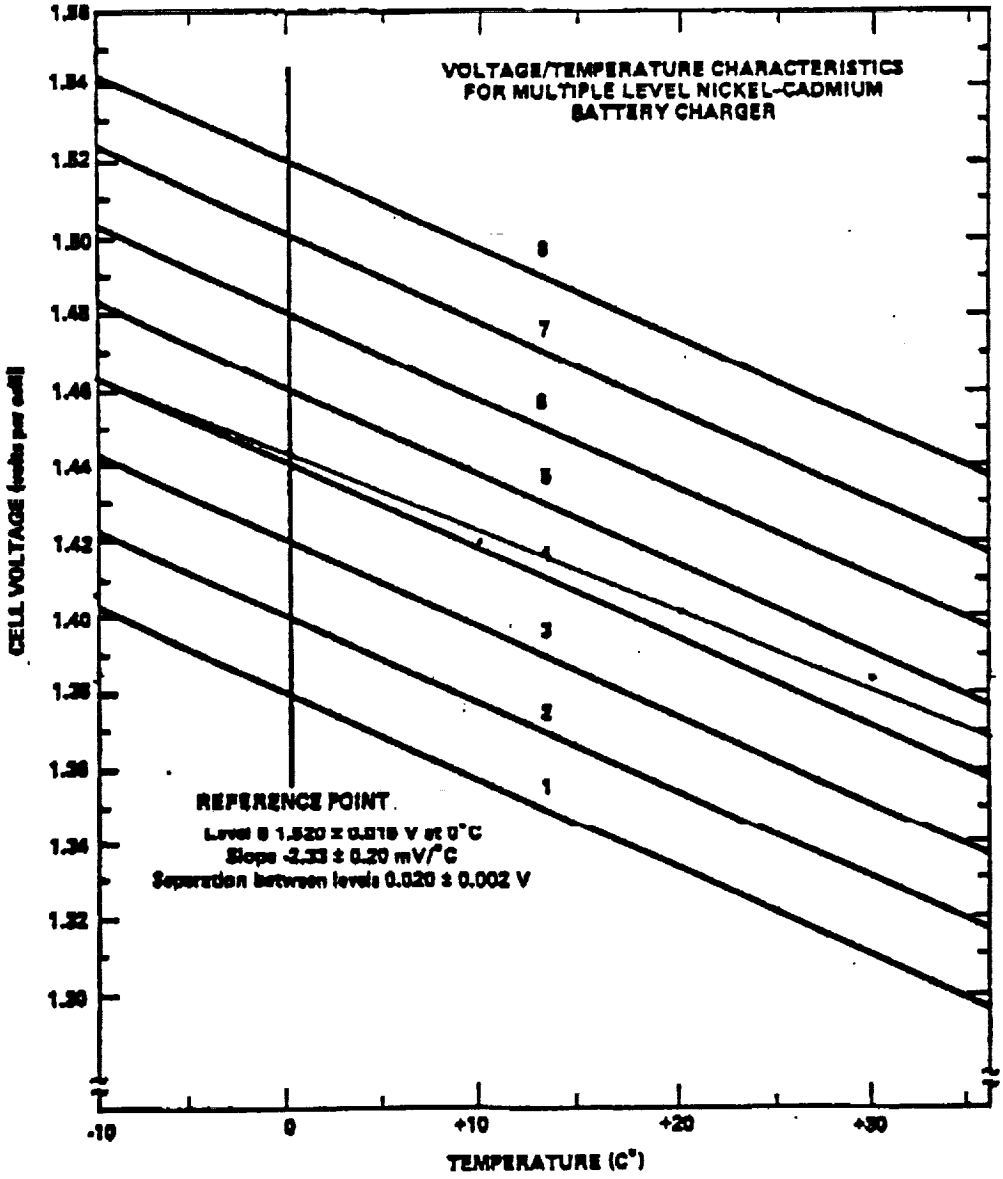

Figure 3 - Cell Voltage Limit versus Temperature

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TABLE 1
SMEX CHARACTERIZATION TEST

CHARGE/ DISCHARGE RATIOS

EOC VOLTS	0°C DOD			10°C DOD			20°C DOD			30°C DOD		
	10%	25%	40%	10%	25%	40%	10%	25%	40%	10%	25%	40%
6.7												
6.75										1.0806		
6.8							0.9944			1.1744		
6.85										1.3324	1.0391	0.9869
6.9				0.9993			1.1072	1.0101		1.5594	1.1075	
6.95							1.2377				1.2133	1.0637
7.0	0.9895			1.0478	0.9299		1.4024	1.0994	1.0244		1.3558	
7.05								1.1538				1.2169
7.1	1.0063			1.1890	1.0616	0.9397		1.2204	1.1088			
7.15												1.4691
7.2	1.055	1.0168	1.0091	1.4605	1.1403	1.0638			1.1899			
7.25									1.2418			
7.3	1.1764	1.0621	1.0426	1.8630	1.2709	1.1282						
7.35												
7.4		1.1495	1.0934			1.2033						
7.45												
7.5		1.2818	1.1634									

BATTERY CELL CHARACTERIZATION TEST
DATA SUMMARY

			DISCHARGE						CHARGE					
Test Cnd	Date 1993	Cycle No.	DoD %	EOD Temp. °C	EOD Curr. A	EOD Volts V	EOD Volts V/Cell	Output Ah	EOC Temp. °C	EOC Curr. A	EOC Volts V	EOC Volts V/Cell	Input Ah	C/D Ratio
1	2-25	6	10	1.(	1.797	23.0580	1.281	0.90	1.0	0.275	25.8980	1.439	1.13	1.256
2	2-25	5	25	2.(	4.490	22.301	1.239	2.25	1.8	0.818	26.4270	1.468	2.60	1.156
3	2-26	15	25	1.(	4.499	22.019	1.223	2.25	1.2	1.291	26.829	1.49	2.97	1.32
4	2-27	8	40	-1.(	7.193	21.687	1.205	3.61	-1.4	0.75	26.434	1.469	3.76	1.042
5	3-4	5	40	3.(	7.200	21.905	1.217	3.61	1.6	2.033	27.158	1.509	4.32	1.197
6	3-5	12	10	10.(	1.799	23.094	1.283	0.91	10.5	0.525	25.853	1.436	1.36	1.495
7	3-6	8	25	10.(	4.500	22.217	1.234	2.25	10.0	0.568	25.636	1.424	2.45	1.089
8	3-6	6	25	11.(	4.456	22.1810	1.232	2.24	11.0	1.24	26.0810	1.449	2.82	1.259
9	3-6	6	25	12.(	4.481	22.1190	1.229	2.25	12.0	1.837	26.2510	1.458	3.15	1.4
10	3-7	5	40	11.(	7.192	21.6880	1.205	3.60	10.9	0.887	25.8550	1.436	4.03	1.119
11	3-7	5	40	12.(	7.194	21.6660	1.204	3.61	12.0	2.292	26.4100	1.467	4.45	1.233
12	3-7	5	40	13.(	7.193	21.6490	1.203	3.60	13.0	3.119	26.5850	1.477	4.84	1.344
13	3-8	5	50	15.(	9.001	21.3930	1.189	4.50	13.3	3.587	26.7210	1.485	5.85	1.300
14	3-8	8	10	20.(	1.811	22.7036	1.261	0.90	19.7	0.199	24.7800	1.376	1.04	1.156
15	3-8	5	25	21.(	4.493	22.082	1.227	2.25	20.2	0.789	25.2015	1.400	2.56	1.138
16	3-9	5	40	22.(	7.194	21.603	1.200	3.61	21.0	1.320	25.4662	1.415	4.16	1.152
17	3-9	5	40	21.(	7.203	21.591	1.199	3.60	20.0	3.313	26.189	1.455	4.93	1.369