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# DESIGN CONSIDERATIONS FOR RECHARGEABLE LITHIUM BATTERIES



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MARSHALL SPACE FLIGHT CENTER  
HUNSVILLE, ALABAMA  
NOVEMBER, 1992

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BATTERY SYSTEMS GROUP

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## OUTLINE

- \* OBJECTIVE
- \* CELL BASELINE DESIGN & TESTING
- \* CELL DESIGN PARAMETERS STUDIES
- \* CELL CYCLING PERFORMANCE
- \* SUMMARY AND CONCLUSIONS

## OBJECTIVE

DETERMINE THE INFLUENCE OF CELL DESIGN PARAMETERS ON THE PERFORMANCE  
OF Li-TiS<sub>2</sub> CELLS

**Li-TiS<sub>2</sub> CELL BASELINE DESIGN**

<b>RATED CAPACITY</b>	<b>1 Ah CELL</b>
<b>TiS<sub>2</sub> CAPACITY</b>	<b>1.2 Ah (Theoretical) 1.0 Ah (Practical)</b>
<b>LITHIUM CAPACITY</b>	<b>6 Ah</b>
<b>Li:TiS<sub>2</sub> CAP. RATIO</b>	<b>6</b>
<b>ELECTROLYTE</b>	<b>1.5M LiAsF<sub>6</sub>/ 10%EC + 90%2-MeTHF</b>
<b>SEPARATOR</b>	<b>CELGARD 2400</b>
<b>ELECTROLYTE QTY.</b>	<b>7.5 cc</b>
<b>CURRENT COLLECTOR</b>	<b>Ni EXMET</b>
<b>CAN &amp; COVER MAT'LS</b>	<b>SS</b>
<b>SEAL</b>	<b>GLASS TO METAL</b>

## CELL DESIGN PARAMETERS STUDIED

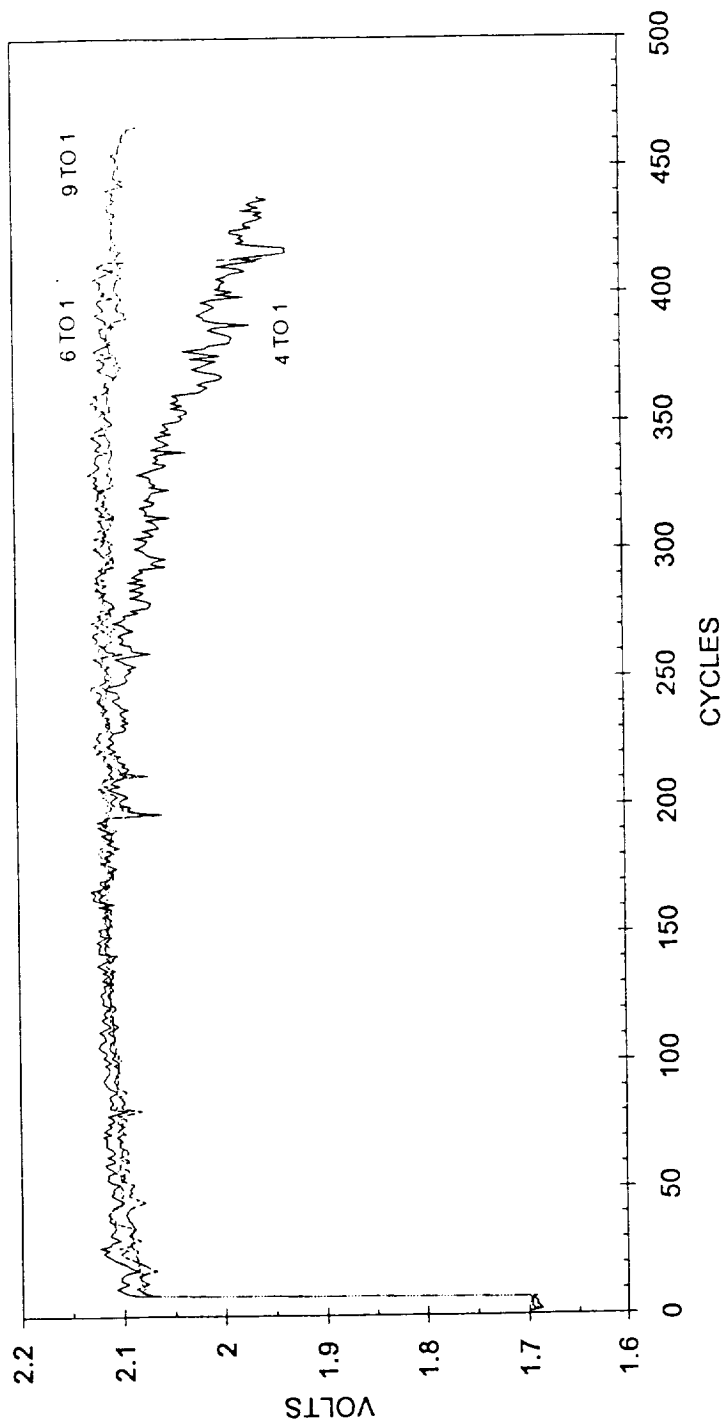
DESIGN PARAMETERS	VARIATIONS
ANODE TO CATHODE CAPACITY RATIO	4:1, 6:1, and 9:1
PACK TIGHTNESS	Tight, medium, and loose
TYPE OF ELECTROLYTE  Salt: 1.5 M LiAsF <sub>6</sub>	2-MeTHF, 10% EC + 90% 2-MeTHF, THF + 2% 2-MeF, THF + 2-MeTHF + 2% 2-MeF, Diox + 2-MeTHF + THF + 2% 2-MeF, and EC + PC.
QUANTITY OF ELECTROLYTE	4, 7.5, and 9 c.c.
SEPARATOR	Microporous Polypropylene Microporous Polyethylene Sub-microporous Polypropylene Thermal separator
BINDER CONCENTRATION	2 and 1 weight %
CASE POLARITY	Isolated, floating, and positive.

**CELL TESTING CONDITIONS**

* DISCHARGING	1 Ah CELLS
TYPE:	CONSTANT CURRENT
CURRENT DENSITY (mA/cm <sup>2</sup> ):	1
CUTOFF VOLTAGE (V)	1.7
DEPTH OF DISCHARGE	50%
* CHARGING	CONSTANT CURRENT
TYPE:	0.5
CURRENT DENSITY (mA/cm <sup>2</sup> ):	2.7 V
CUTOFF VOLTAGE:	
* TEMPERATURE	25° C

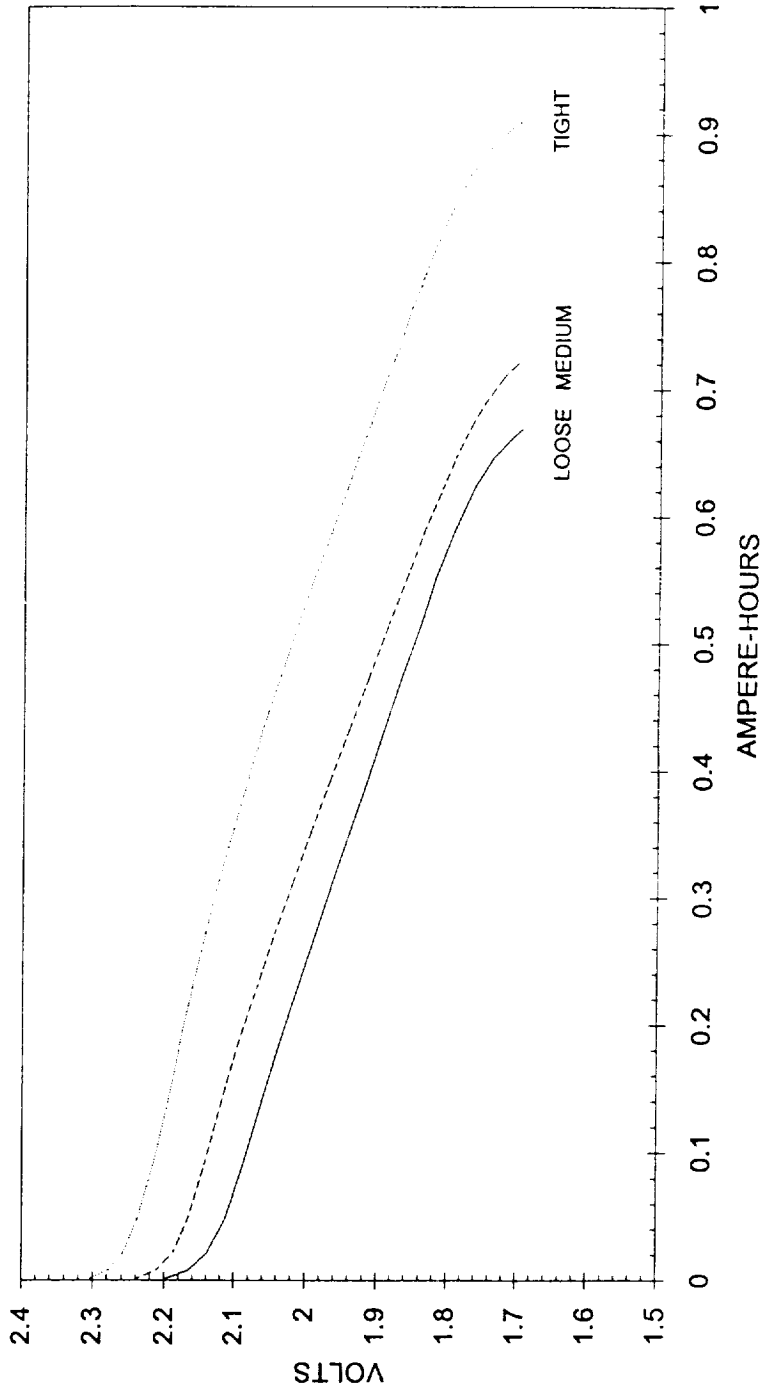
## DESIGN PARAMETER STUDIES

EFFECT OF ANODE TO CATHODE CAPACITY RATIO  
ON END-OF-DISCHARGE VOLTAGE



## DESIGN PARAMETER STUDIES

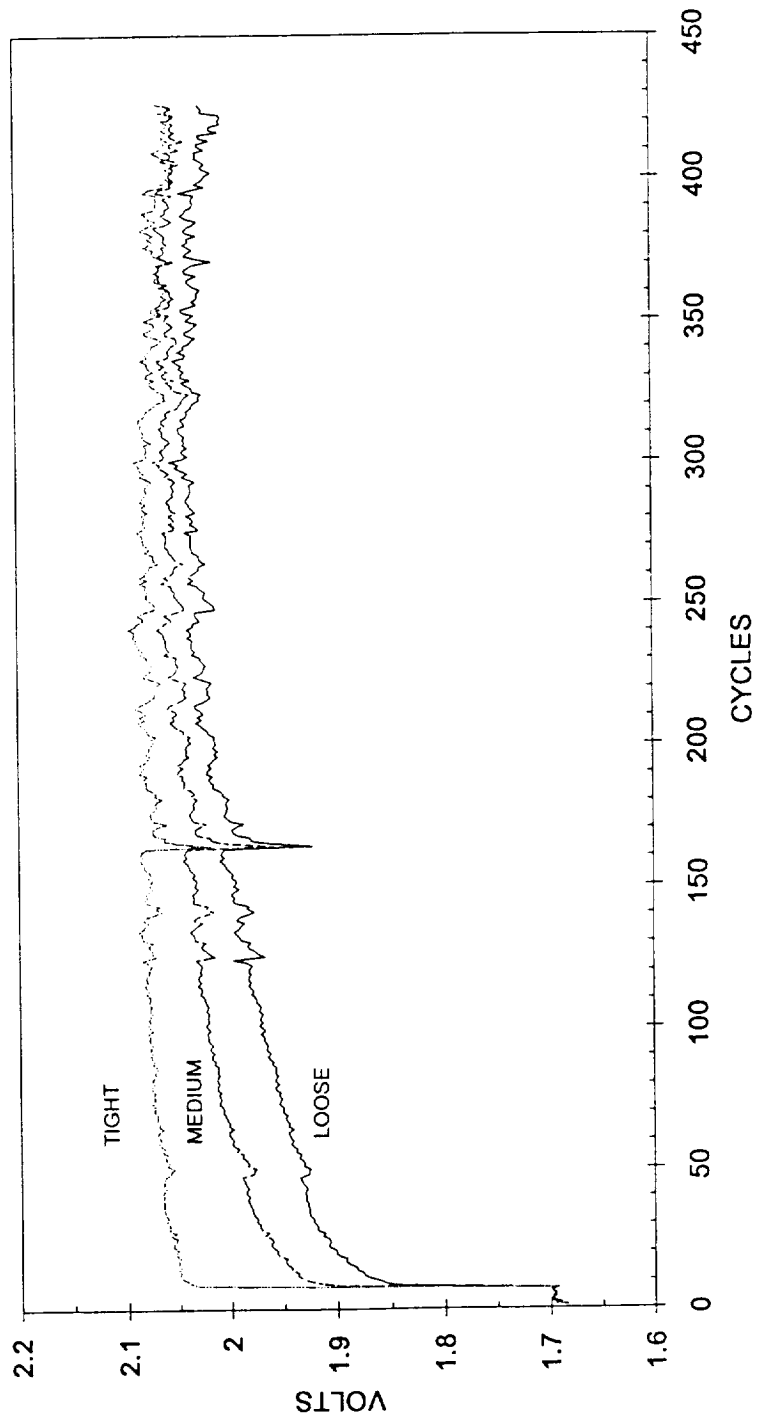
EFFECT OF PACK TIGHTNESS ON C/5 CAPACITY AT CYCLE 10





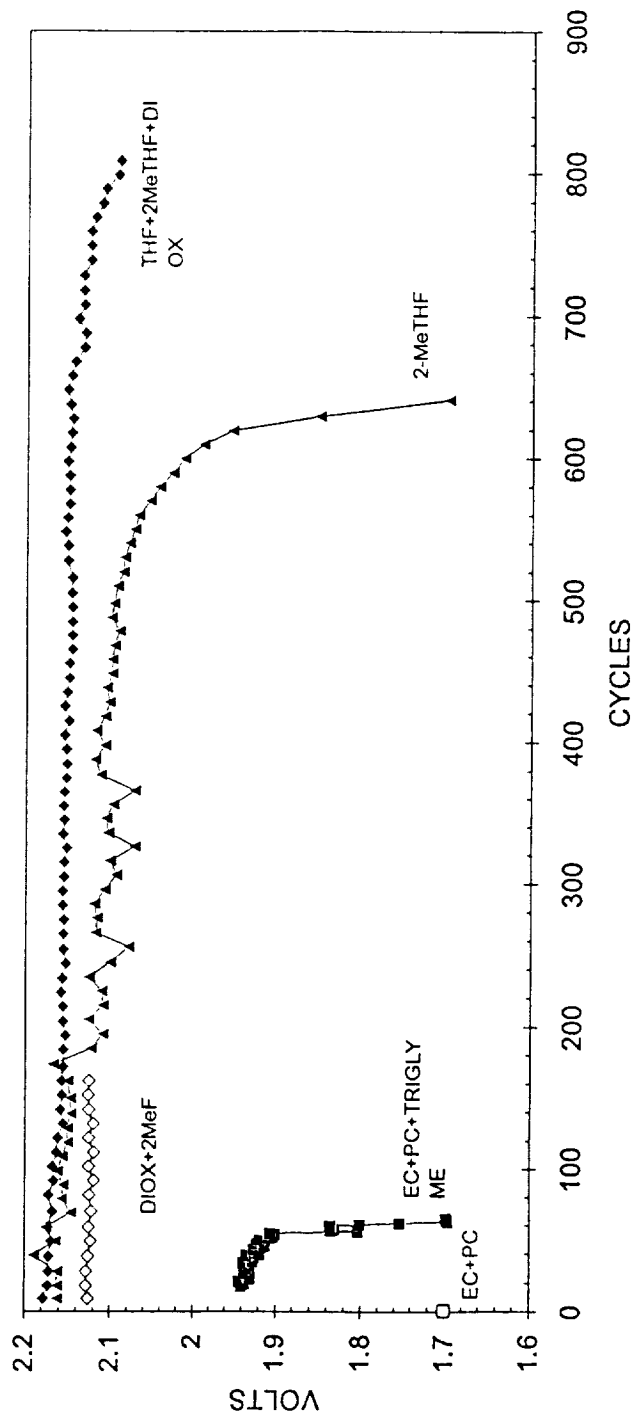
## DESIGN PARAMETER STUDIES

EFFECT OF PACK TIGHTNESS ON END-OF-DISCHARGE VOLTAGE



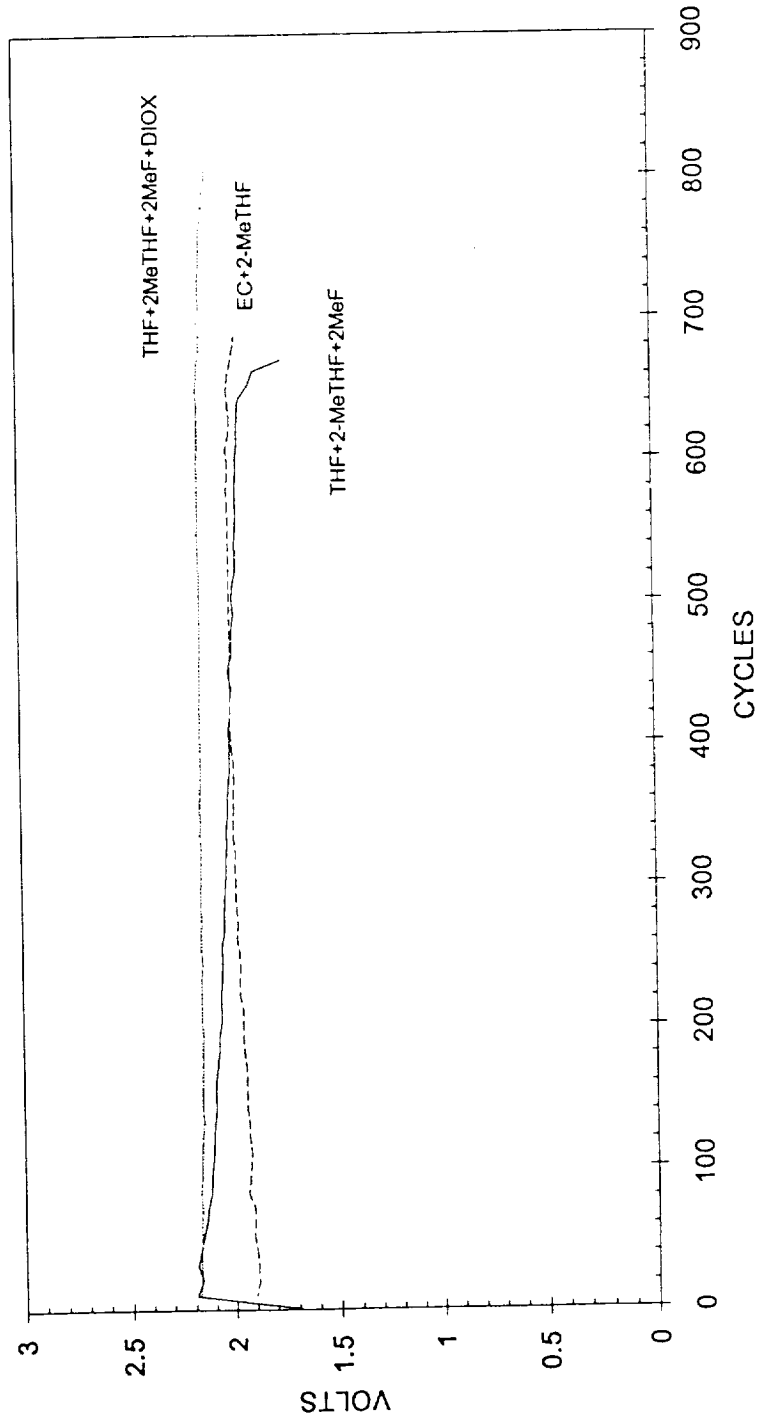
# DESIGN PARAMETER STUDIES

CYCLE LIFE PERFORMANCE OF 1 AHR LITHIUM-TITANIUM DISULFIDE CELLS WITH VARIOUS ELECTROLYTES



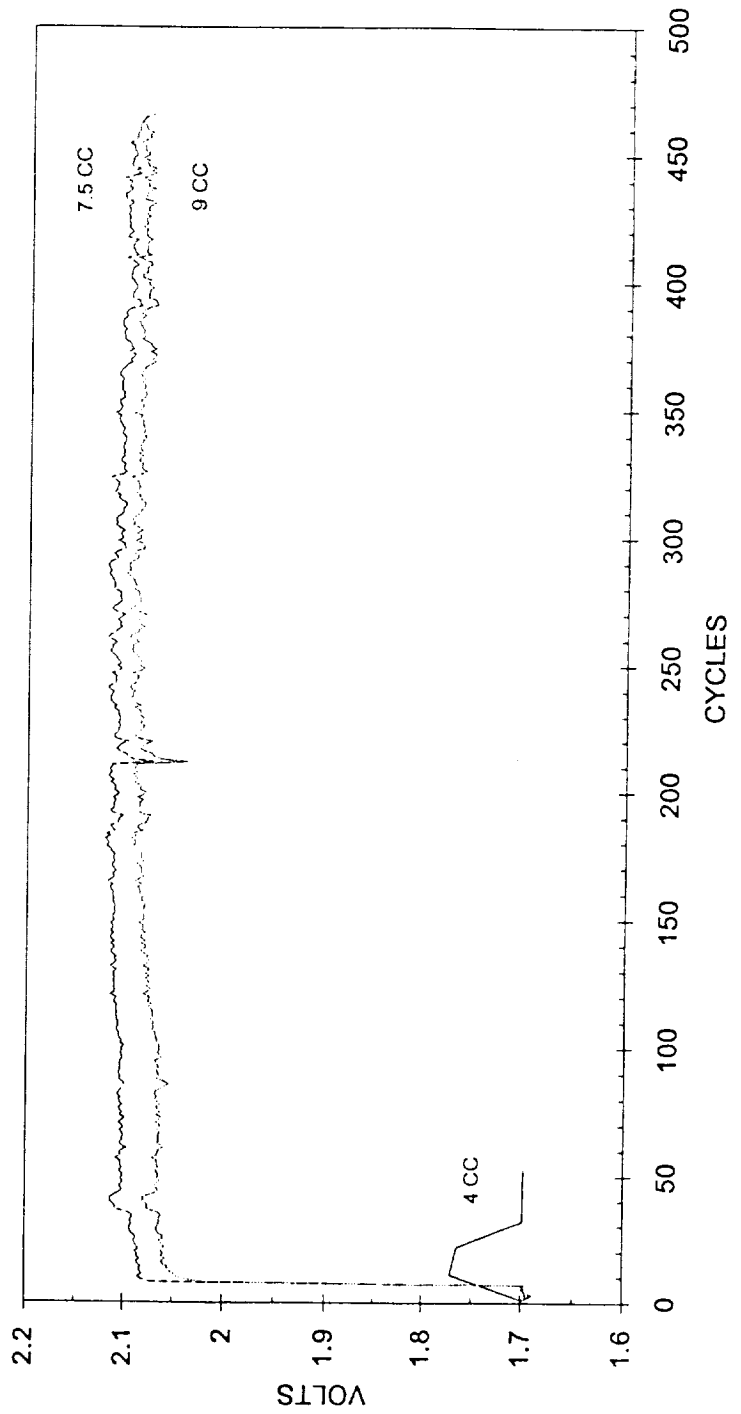
# DESIGN PARAMETER STUDIES

END-OF-DISCHARGE VOLTAGE OF CELLS WITH SELECTED ELECTROLYTES



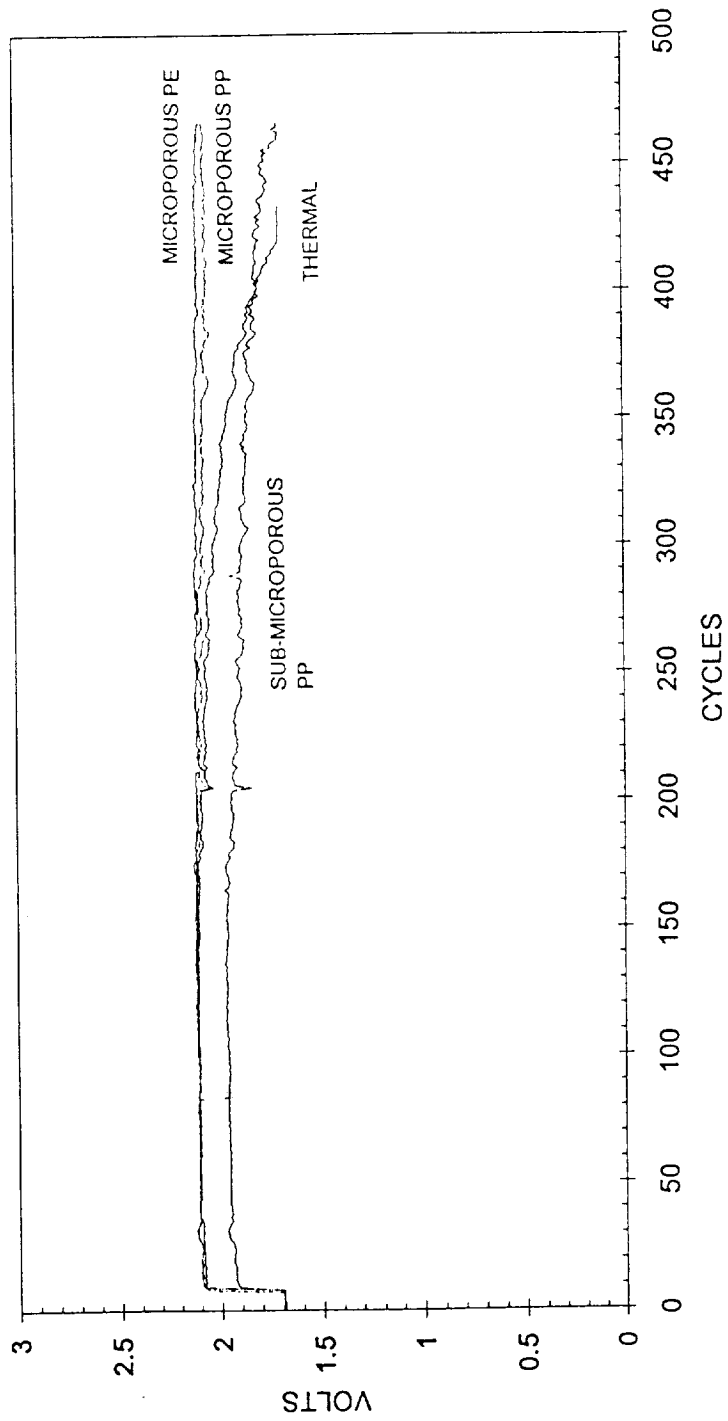
## DESIGN PARAMETER STUDIES

EFFECT OF ELECTROLYTE VOLUME  
ON END-OF-DISCHARGE VOLTAGE



## DESIGN PARAMETER STUDIES

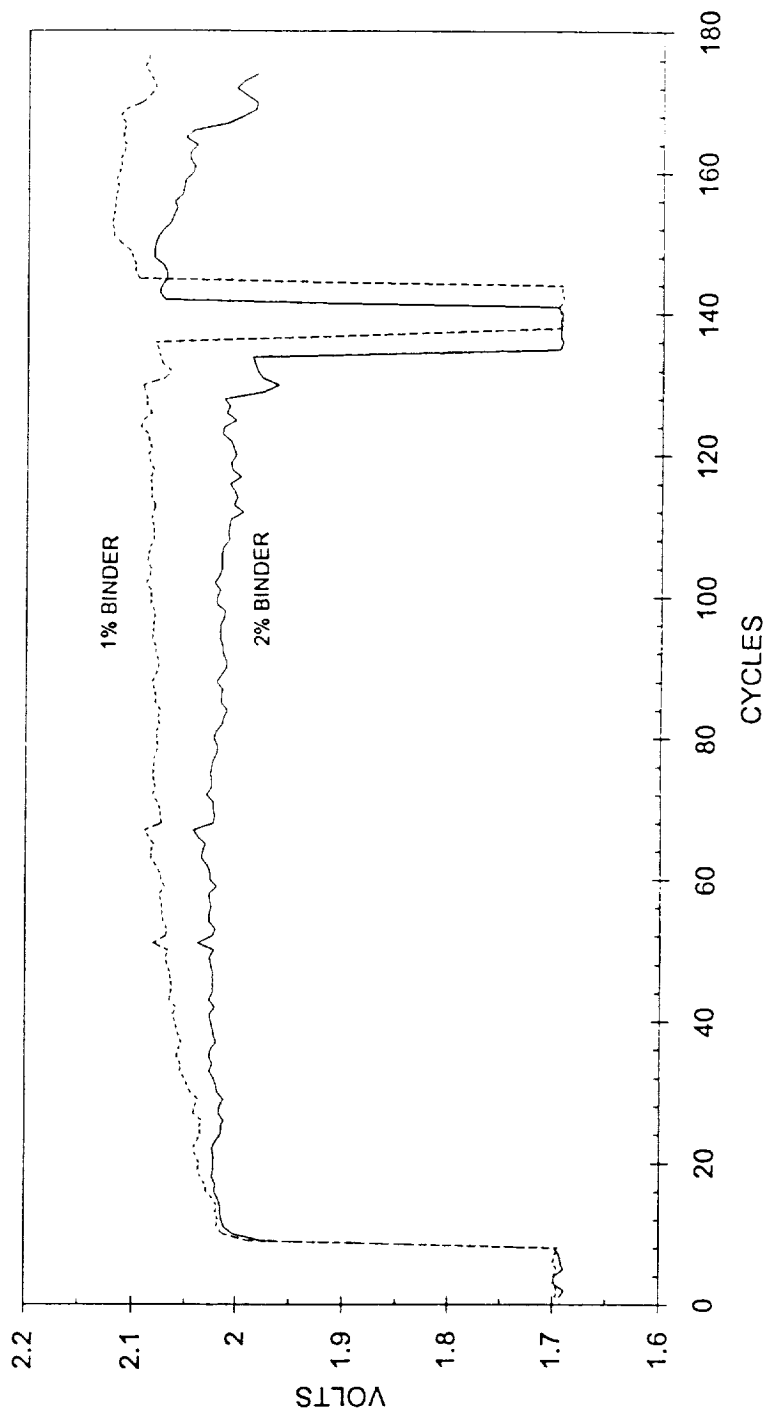
EFFECT OF SEPARATOR ON END-OF-DISCHARGE VOLTAGE



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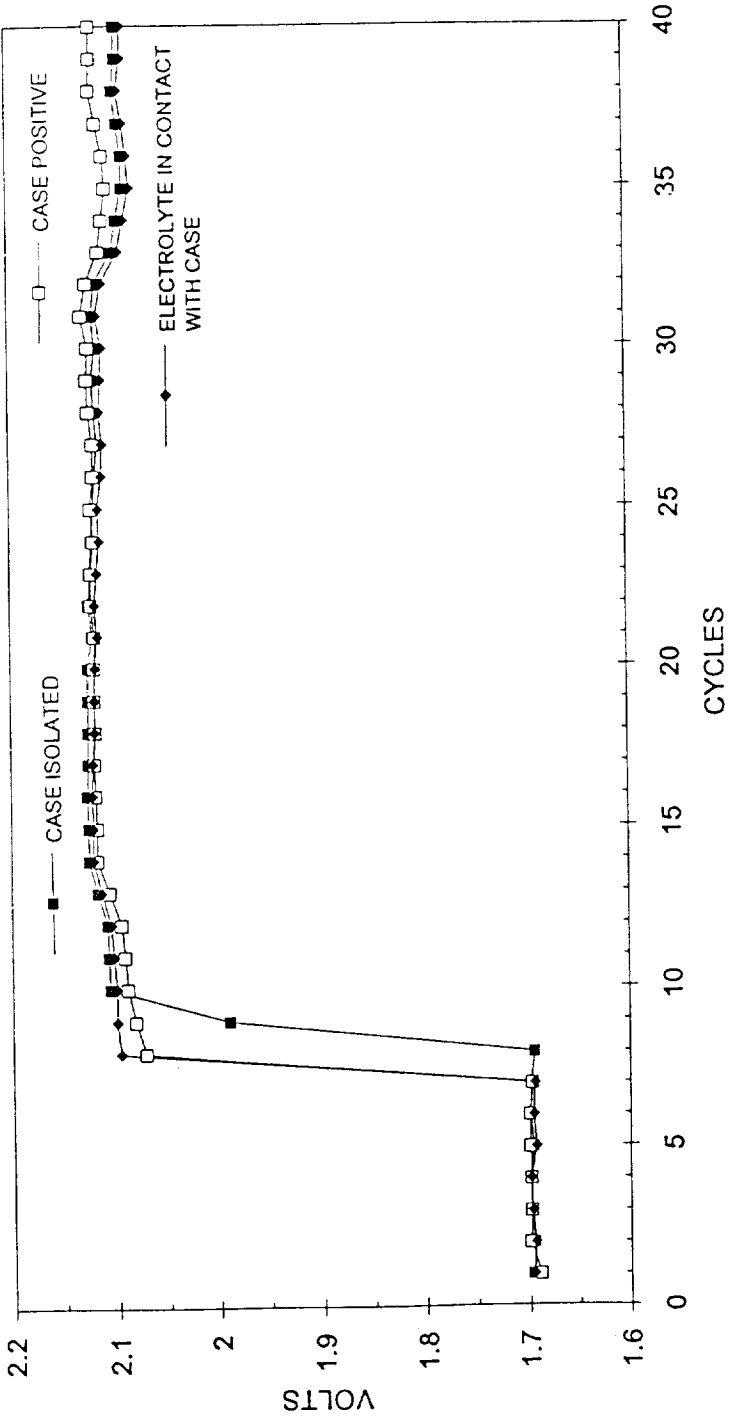
## DESIGN PARAMETER STUDIES

EFFECT OF CATHODE BINDER CONCENTRATION ON END-OF-DISCHARGE VOLTAGE



# DESIGN PARAMETER STUDIES

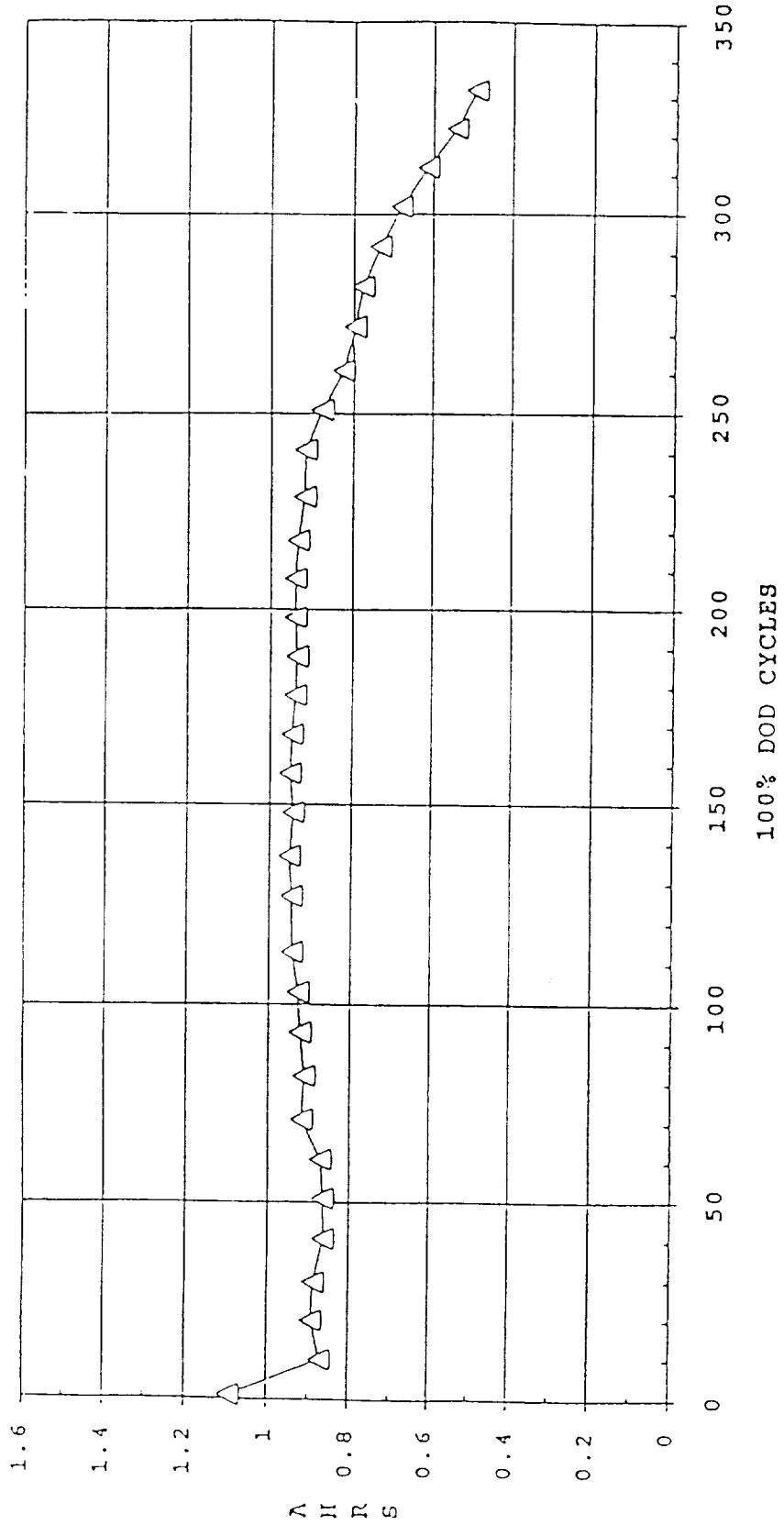
EFFECT OF CASE POLARITY ON END-OF-DISCHARGE VOLTAGE



## CYCLE LIFE CHARACTERISTICS OF 1 Ah Li-TiS<sub>2</sub> CELL

(C/5 DISCHARGE, C/10 CHARGE - AT 100% DOD)

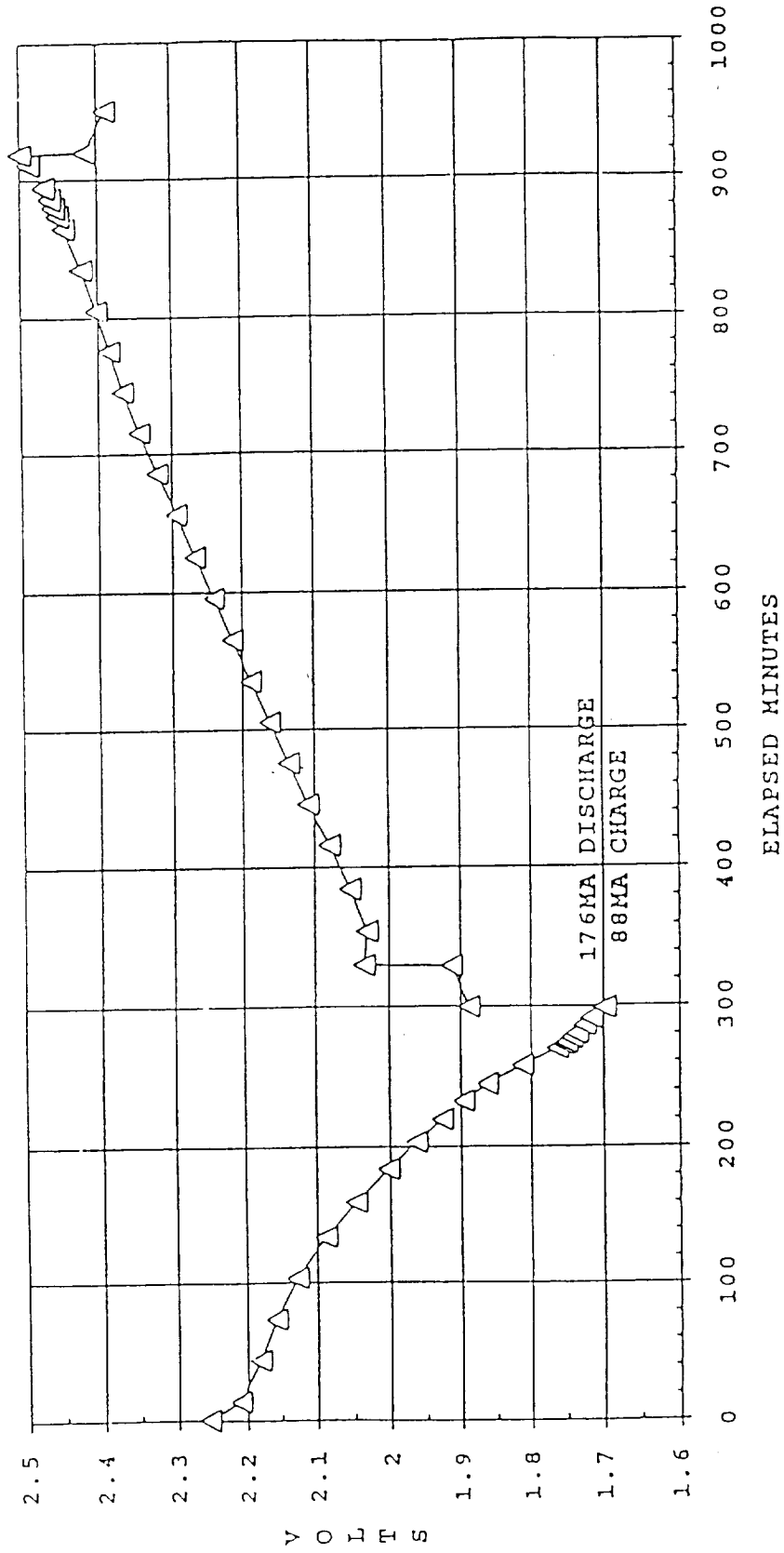
CELL #9005







TYPICAL CHARGE/DISCHARGE CURVE FOR 1 Ah Li-TiS<sub>2</sub> CELL



**SUMMARY**  
**SUGGESTED CELL DESIGN PARAMETERS**

DESIGN PARAMETERS	VARIATIONS
ANODE TO CATHODE CAPACITY RATIO	6:1
PACK TIGHTNESS	Tight
TYPE OF ELECTROLYTE Salt: 1.5 M LiAsF <sub>6</sub>	10% EC + 88% 2-MeTHF + 2% 2-MeF THF + 2-MeTHF + 2% 2-MeF, DIOX + 2-MeTHF + THF + 2% 2-MeF
QUANTITY OF ELECTROLYTE	7.5 c.c.
SEPARATOR	Microporous Polypropylene Microporous Polyethylene Sub-microporous Polypropylene
BINDER CONCENTRATION	1 % by weight
CASE POLARITY	floating or positive.

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
<small>Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.</small>				
1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE February 1993	3. REPORT TYPE AND DATES COVERED Conference Publication		
4. TITLE AND SUBTITLE The 1992 NASA Aerospace Battery Workshop			5. FUNDING NUMBERS	
6. AUTHOR(S) Jeffrey C. Brewer, Compiler				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) George C. Marshall Space Flight Center Marshall Space Flight Center, Alabama			8. PERFORMING ORGANIZATION REPORT NUMBER M-712	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Aeronautics and Space Administration Washington, DC 20546			10. SPONSORING/MONITORING AGENCY REPORT NUMBER NASA CP-3192	
11. SUPPLEMENTARY NOTES Proceedings of a workshop sponsored by the NASA Aerospace Flight Battery Systems Program, hosted by the Marshall Space Flight Center, and held at the U. S. Space and Rocket Center on November 15-19, 1992.				
12a. DISTRIBUTION AVAILABILITY STATEMENT Unclassified-Unlimited Subject Category: 44			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  This document contains the proceedings of the 23rd annual NASA Aerospace Battery Workshop, hosted by the Marshall Space Flight Center on November 15-19, 1992. The workshop was attended by scientists and engineers from various agencies of the U.S. Government, aerospace contractors, and battery manufacturers, as well as international participation in like kind from a number of countries around the world.  The subjects covered included nickel-cadmium, nickel-hydrogen, nickel-metal hydride, and lithium based technologies, as well as advanced technologies including sodium-sulfur and various bipolar designs.				
14. SUBJECT TERMS battery, nickel-cadmium, nickel-hydrogen, nickel-metal hydride, lithium, cadmium, battery test, electrode, pressure vessel, sodium, capacity fade			15. NUMBER OF PAGES 776	
			16. PRICE CODE A99	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	