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DIVISION ESPACE SPACE DEPARTMENT

ROMAINVILLE FRANCE

1992 - NASA AEROSPACE BATTERY WORKSHOP

NICKEL HYDROGEN CAPACITY LOSS

J. GOUALARD - D. PAUGAM - Y. BORTHOMIEU

US SPACE AND ROCKET CENTER

HUNSTSVILLE - AL

17 - 19 NOVEMBER 1992

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CONTENT

. CELL DESIGN

. DEFINITIONS

. EXPERIENCE

. PRELIMINARY CONCLUSIONS

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CELL DESIGN

. GENERAL : "COMSAT" DESIGN

. POSITIVE ELECTRODE

- . SINTERED NICKEL - SLURRY PROCESS - PERFORATED STEEL GRID
- . AQUEOUS ELECTROCHEMICAL IMPREGNATION
- . LOADING 1.7 G/CM^3 OF VOIDS - COBALT 5%

. NEGATIVE ELECTRODE

- . ACTIVE CHARCOAL 5% PLATINUM CATALYST ON NICKEL GRID
- . TEFLON HYDROPHOBIC LAYER

. ELECTRODES STACK

- . BACK TO BACK STACKING
- . SEPARATOR : NON WOVEN POLYAMID FELT
- . GAS SCREEN : WOVEN POLYAMID
- . CENTRAL TIE ROD

. CELL

- . HYDROGEN (NEGATIVE) PRECHARGE 3 BARS (40 PSI)
- . KOH 31% (STANDARD)
- . MAXIMUM OPERATING PRESSURE 75 BARS (1040 PSI)

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DEFINITIONS

REFERENCE CAPACITY AT 21 ± 3° C

A) . 5 Ω RESISTORS FOR 16 HOURS
B) CHARGE 7.7 H AT C/5
---> C) DISCHARGE C/2 TO 1 VOLT
D) C/5 TO .5V

TOTAL CAPACITY : CAPACITY TO 1V + CAPACITY 1V - .05V

AVERAGE VALUES : CAPACITY 1V TO.5V (D) 15% - 20% OF TOTAL

2ND PLATEAU OR CAPACITY LOSS

IF CAPACITY 1V TO .5V (D) > 20 - 25% OF TOTAL

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EXPERIENCE : 1 - BOILER PLATES 8 AH

	MM V 1 COBALT 5%	MM V 2 COBALT 10%
FLOODED ELECTROLYTE CAPACITY	10.8 AH	13.2 AH
A) PRECHARGE H_2 3 BARS (40 PSI)		
REFERENCE CAPACITY (AH)	7.7	8
2^{ND} PLATEAU AH (%)	2.3 (23%)	2.2 (23%)
B) PRECHARGE 30 BARS (400 PSI)		
INITIAL : REFERENCE CAPACITY	7.6	8.1
2^{ND} PLATEAU	2.8 (26.9%)	2.4 (22.8%)
STORAGE 3 WEEKS		
REFERENCE CAPACITY	6.4	7.2
2^{ND} PLATEAU	3.4	2.9 (28.7%)
C) PRECHARGE 3 BARS		
REFERENCE CAPACITY	6.2	7
2^{ND} PLATEAU	3.7 (37.4%)	3.3 (32%)
FLOODED ELECTROLYTE CAPACITY	9.2 AH	11.2

---> STORAGE UNDER H_2 PRESSURE INCREASES CAPACITY LOSS
---> EFFECT OF H_2 PRESSURE SEEMS REDUCED IN HIGH COBALT CONTENT CELL

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EXPERIENCE : 2 - VHS 50 BL - L1

A) ACCEPTANCE		
	REFERENCE CAPACITY	49.6 AH
	2ND P.	16 (24,4%)
B) STORAGE 3 MONTHS		
	REFERENCE CAPACITY	52.5 AH
	2ND P.	7.3 AH (12%)
C) GEO CYCLING		
70% DOD - 10°C		
CAPACITY MEASUREMENT		
AFTER EACH SHADOW PERIOD		
	SHADOW 4	54.5
		7.5 (12.1%)
	SHADOW 13	50.8
		12.2 (19%)

---> INITIAL CAPACITY LOSS RECOVERED AFTER STORAGE 3 MONTHS.
---> NORMAL BEHAVIOR IN CYCLING.

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EXPERIENCE : 3 - VHS 90 CM - L1

	QUALIFICATION TESTS	QUALIFICATION TESTS + REVERSAL
A) ACCEPTANCE REFERENCE CAPACITY (AH) 2ND P.	100 AH 19.5 (16%)	100 AH 19.5 (16%)
B) QUALI. TESTS STORAGE 3 DAYS - CHARGED CELL	1 VOLT 72.3 AH 2 ND P. 5.7 (7%)	
REFERENCE CAPACITY 2ND P.	98.8 26 (21 %)	91.5 36 (28%)
C) STORAGE 2 MONTHS	98	90
D) CYCLING GEO 80 % DOD 10°C		ON PROGRESS NORMAL BEHAVIOR

---> EFFECT OF REVERSAL TO BE CONFIRMED
---> NO CAPACITY LOSS DURING STORAGE

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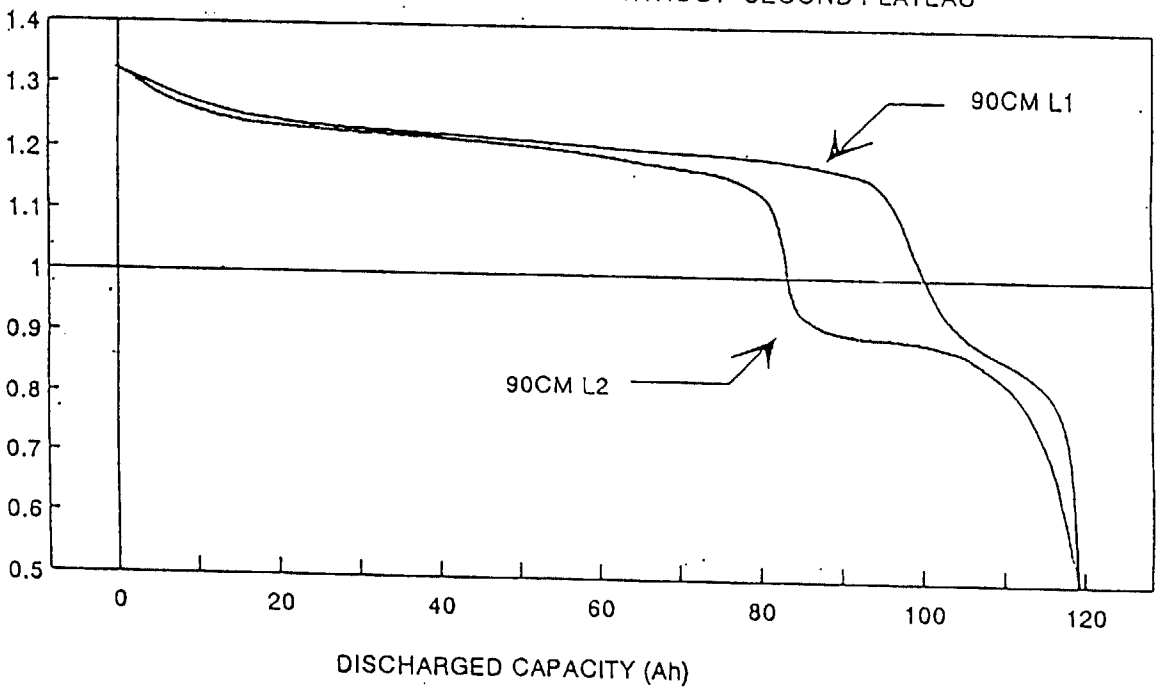
TYPICAL DISCHARGE CURVE WITH AND WITHOUT "SECOND PLATEAU"



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EXPERIENCE : 4 - VHS, 90 CM - L2

A) ACCEPTANCE			
REFERENCE CAPACITY (AH)		97.8 AH	
2ND PLATEAU		21.6 AH	(18%)
B) BURN -IN CYCLES (50 CYCLES)			
REFERENCE CAPACITY		88 AH	
2ND PLATEAU		34.5 AH	(28%)
C) TENTATIVE RECOVERY PROCEDURE			
LOW RATE CHARGE C/10 + C/20			
STORAGE 15 DAYS OPEN CIRCUIT	23°C	86	
REFERENCE CAPACITY		34	(28.3%)
2ND P			
D) STORAGE 2 MONTHS			
DISCHARGED OPEN CIRCUIT	23°C	91	
REFERENCE CAPACITY		27	23%
2ND P			

---> EFFECT OF RECOVERY PROCEDURE NOT PROVEN

---> NO CAPACITY LOSS DURING LONG STORAGE

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EXPERIENCE : 5 - VHS 100 CM - PR

A) ACCEPTANCE		
REFERENCE CAPACITY (AH)	108 AH	
2ND P.	21	(16%,3)
B) STORAGE 5 DAYS		
CHARGED CELL OPEN CIRCUIT		
DISCHARGE 1 VOLT	58 AH	
2ND P	2.2 AH	(3.7%)
C) 2 MONTHS TESTING		
VIBRATIONS - OVERCHARGE		
3 GEO CYCLES		
REFERENCE CAPACITY	100	
2ND P	29	(22.5%)
D) 10 MONTHS STORAGE		
0°C - 23° C		
REFERENCE CAPACITY	99	
2ND P	25	(20%)

---> 2ND PLATEAU DOES NOT EXISTS AFTER CHARGE RETENTION
---> NO CAPACITY LOSS DURING LONG STORAGE

PRELIMINARY CONCLUSIONS

CAPACITY LOSS - 2ND PLATEAU PHENOMENA

- NOT OBSERVED DURING LONG STORAGE (> 1 MONTH)
- OBSERVED DURING ELECTRICAL FORMATION
- FAVOURED BY HIGH HYDROGEN PRESSURE AND LOW VOLTAGE
- CAPACITY LOSS SEEMS REDUCED IN CELLS WITH HIGH COBALT CONTENT
- WHEN OBSERVED, ALL SHORT TIME TENTATIVE RECOVERY ACTIONS HAD MORE DETRIMENTAL THAN BENEFICIAL EFFECT.
- DOES NOT AFFECT THE CELL BEHAVIOR IN CYCLING GEO 80% DOD AND LEO 40% DOD.