

<p>SAFT</p> <p>DIVISION SPACE ESPACE DEPARTMENT ROMAINVILLE FRANCE</p>	<p>1992 - NASA AEROSPACE BATTERY WORKSHOP</p>
<p>NICKEL HYDROGEN CAPACITY LOSS</p> <p>J. GOUALARD - D. PAUGAM - Y. BORTHOMIEU</p> <p>US SPACE AND ROCKET CENTER HUNTSVILLE - AL</p> <p>17 - 19 NOVEMBER 1992</p>	

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CONTENT

- . CELL DESIGN
- . DEFINITIONS
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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/cm³ 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 $21 \pm 3^\circ \text{C}$

- 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 <u>3 BARS</u> (40 PSI) REFERENCE CAPACITY (AH) 2ND PLATEAU AH (%)	7.7 2.3 (23%)	8 2.2 (23%)
B) PRECHARGE <u>30 BARS</u> (400 PSI) INITIAL : REFERENCE CAPACITY 2ND PLATEAU	7.6 2.8 (26.9%)	8.1 2.4 (22.8%)
STORAGE 3 WEEKS REFERENCE CAPACITY 2ND PLATEAU	6.4 3.4	7.2 2.9 (28.7%)
C) PRECHARGE <u>3 BARS</u> REFERENCE CAPACITY 2ND PLATEAU	6.2 3.7 (37.4%) 9.2 AH	7 3.3 11.2

---> STORAGE UNDER H₂ PRESSURE INCREASES CAPACITY LOSS
 ---> EFFECT OF H₂ PRESSURE SEEMS REDUCED IN HIGH COBALT CONTENT CELL



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EXPERIENCE : 2 - VHS 50 BL - L1

A) ACCEPTANCE REFERENCE CAPACITY 2ND P.	49.6 AH 16	(24,4%)
B) STORAGE 3 MONTHS REFERENCE CAPACITY 2ND P.	52.5 AH 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

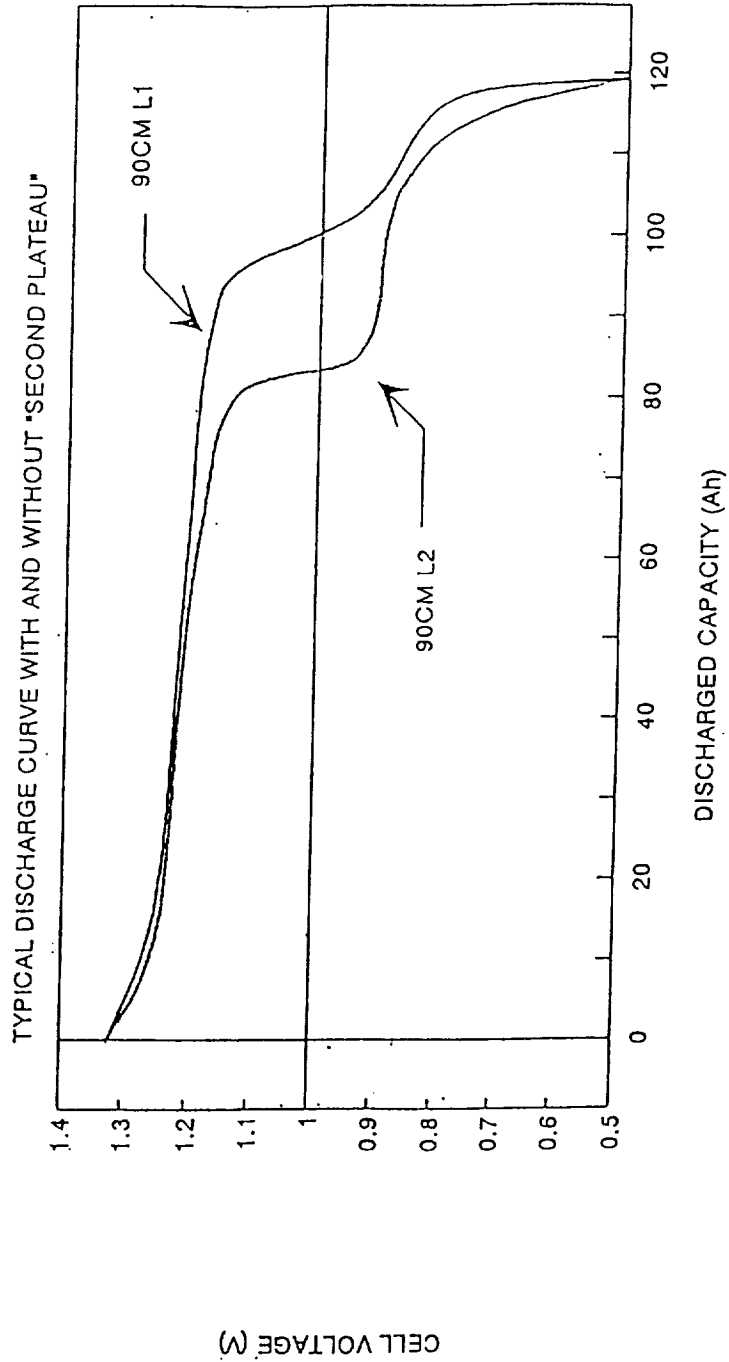
	QUALIFICATION TESTS	QUALIFICATION TESTS + REVERSAL
A) ACCEPTANCE REFERENCE CAPACITY (AH) 2ND P.	100 AH 19.5 (16%)	100 AH 19.5 (16%)
B) QUALI. TESTS STORAGE 3 DAYS - CHARGED CELL REFERENCE CAPACITY 2ND P.	1 VOLT 72.3 AH 2 ND P. 5.7 (7%) 98.8 26 (21 %)	91.5 36 (28%)
C) STORAGE 2 MONTHS	98	90
D) CYCLING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

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



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EXPERIENCE : 4 - VHS, 90 CM - L2

A) ACCEPTANCE REFERENCE CAPACITY (AH) 2ND PLATEAU	97.8 AH 21.6 AH (18%)
B) BURN -IN CYCLES (50 CYCLES) REFERENCE CAPACITY 2ND PLATEAU	88 AH 34.5 AH (28%)
C) TENTATIVE RECOVERY PROCEDURE LOW RATE CHARGE C/10 + C/20 STORAGE 15 DAYS OPEN CIRCUIT 23°C REFERENCE CAPACITY 2ND P	86 34 (28.3%)
D) STORAGE 2 MONTHS DISCHARGED OPEN CIRCUIT 23°C REFERENCE CAPACITY 2ND P	91 27 23%
----> 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) 2ND P.	108 AH 21	(16%, 3)
B) STORAGE 5 DAYS CHARGED CELL OPEN CIRCUIT DISCHARGE 1 VOLT 2ND P	58 AH 2.2 AH	(3.7%)
C) 2 MONTHS TESTING VIBRATIONS - OVERCHARGE 3 GEO CYCLES REFERENCE CAPACITY 2ND P	100 29	(22.5%)
D) 10 MONTHS STORAGE 0°C - 23° C REFERENCE CAPACITY 2ND P	99 25	(20%)
----> 2ND PLATEAU DOES NOT EXISTS AFTER CHARGE RETENTION ----> NO CAPACITY LOSS DURING LONG STORAGE		



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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.

