1993 NASA AEROSPACE BATTERY WORKSHOP

BATTERY STUDY FOR THE MARS ENVIRONMENTAL SURVEY (MESUR) PATHFINDER

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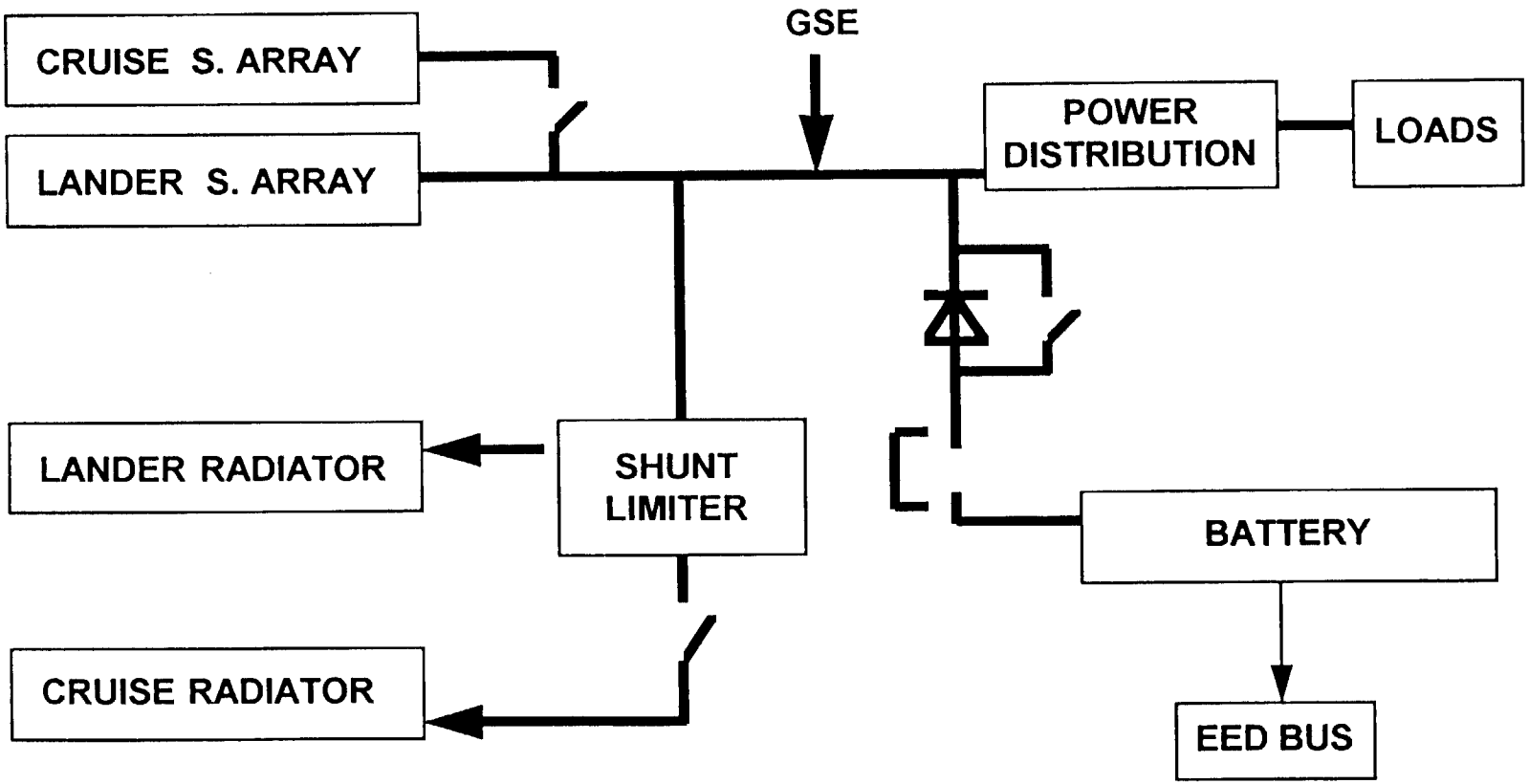
MESUR PATHFINDER - BATTERY WORKSHOP
BATTERY STUDY OVERVIEW

- MESUR PATHFINDER INTRODUCTION
- POWER SUBSYSTEM CONCEPT
- BATTERY TECHNOLOGY SELECTION
- MISSION BATTERY PERFORMANCE
- CELL/BATTERY BASELINE DESIGN
- CHARGE METHODOLOGY
- PROPOSED TESTING

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
MESUR POWER SYSTEM BLOCK DIAGRAM



MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
Ag/Zn INTRODUCTION

- BATTERY MISSION PROFILE

  PROVIDE AND STORE ELECTRICAL POWER FOR THE MESUR LANDER DURING LAUNCH, CRUISE, ENTRY - DESCENT - LANDING, AND MARS SURFACE OPERATION.

- TECHNOLOGY SELECTION

  PERFORMANCE

SPECIFIC ENERGY DENSITY (0^0 C)	~75 Wh/Kg
VOLUMETRIC ENERGY DENSITY	~158 Wh/L
RATE CAPABILITY	~C RATE
CYCLE LIFE	~50 CYCLES

  FLIGHT HERITAGE (GENERIC)

  SURVEYOR, MARINER, PIONEER, TITAN, VIKING

  CELL AND BATTERY DESIGN GENERIC

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
Ag/Zn HERITAGE

BATTERY	MAR 4557-X	CELL	SAR -4265	MAR - 4333	LARGE PROBE	UNKNOWN
PROGRAM	MESUR	US ARMY	APOLLO	LOCKHEED / SAT.	PIONEER/VENUS	CLASSIFIED
FLIGHT EXPERIENCE	YES	N/A	YES	YES	YES	YES
NUMBER OF CELLS	18	one	20	16	19	one
WEIGHT (Kg)	13.3		12.9	52.7	13.4	
SIZE (cm)	22.5x21x18.1		29.9x17.4x14.6	50.8x34.3x20.3	33.3x19.3x14.4	
CAPACITY (A-H)	40	43	40	300	40	30
VOLTAGE (NOMINAL)	27	1.5	30	24	28.5	1.5
RATE (AMPERES)	1	10 TO 60	25-35	9 TO 12	10 to 50	5 TO 20
CYCLE LIFE (actual)	30	100 (200)	6 (20)	3200 (6700)	1 (25)	50 (100)
DEPTH-OF-DISCH. (%)	80 (max)	62.5	80 (max)	1 to 4	90	100
WET LIFE (MONTHS)	15	12	12	9	12	12
GROUND (MONTHS)	2	12	11	2	7	7
FLIGHT (MONTHS)	8	N/A	1	7	5	5
CELL PART No.	SZLR 40-3	BB-465/U	1560-7	2599-3	SZLR40	SZHR30
CELL WEIGHT (Kg)	0.577	0.581	0.51	2.951	0.51	0.49
CELL Vol. (cm^3)	278	373	271	1066	271	260
ELECTRO. CONC. (%)	40	42	40	40	45	45
NEG. to POS. RATIO	1.53	1.67	1.9	1.04	1.46	1.6
SEPARATION SYSTEM						
POS. ABSORBER *	1 WEBRIL	1 DYNEL	1 PELLON	1 PELLON	1 PELLON	1 WEBRIL
MEMBRANE	5 CELLOPHANE	5 CELLOPHANE	4 CELLOPHANE	5 CELLOPHANE	6 CELLOPHANE	6 CELLOPHANE
MEMBRANE			1 PVA	1 PVA		
NEG. ABSORBER *	1 VISKON	1 DYNEL	1 VISKON	1 VISKON	1 VISKON	1 VISKON

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
BATTERY OVERVIEW

- PERFORMANCE DRIVEN DESIGN
  - OPERATIONAL PARAMETERS WILL BE DETERMINED BY CELL AND BATTERY PERFORMANCE
- DERIVED PERFORMANCE TARGETS
  - BATTERY VOLTAGE 22-36 VOLTS
  - LOAD 1 - 4 AMPERES
  - TWO MONTHS ACTIVE STORAGE 20°C (SHIP AND LAUNCH)
  - SEVEN MONTH CRUISE
  - 30 CYCLES MARS SURFACE 20 Ah AT 10 TO -20°C
  - CAPACITY
    - 40 AH AT RT AND BOL
    - 20 Ah AT 0°C
  - VOLUME: 8.3 X 7.37 X 7.12 INCHES (ESTIMATE)
  - MASS: LESS THAN 14 KG

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
CELL DESIGN

- CELL BASELINE DESIGN

ELECTRODE	POSITIVE	NEGATIVE
MATERIAL	SINTERED Ag	Zn OXIDE BLEND
NUMBER	4	5
SURFACE AREA	124.5	
CAPACITY		
THEORETICAL	66.5 AH	101.4 AH
INITIAL EXPECTED	54.5 Ah	
SEPARATOR SYSTEM	5/6 LAYERS - CELLOPHANE	
ELECTROLYTE	40 % KOH, 85 ml	
DIMENSION	6.61 X 3.54 X 0.725 INCHES	
WEIGHT	445 grams DRY (APPX)	

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
BATTERY DESIGN

- **BATTERY BASELINE DESIGN**

  BASED ON CURRENT 20 CELL, 3 CONNECTORS, Ti HOSING

  18 CELL CELL BATTERY

  THREE CONNECTOR. MAIN POWER, INSTRUMENTATION, HEATER POWER

  DIMENSIONS 8.30 X (8.87) X 7.12 INCHES

  FOOTPRINT TBD (HOLE PATTERN) FLANGE 0.75 INCH

  HEATER SET POINT APPX 80 F, POWER TBD, THERMOSTATS TBD

  WEIGHT (ACTIVE BATTERY) ESTIMATES

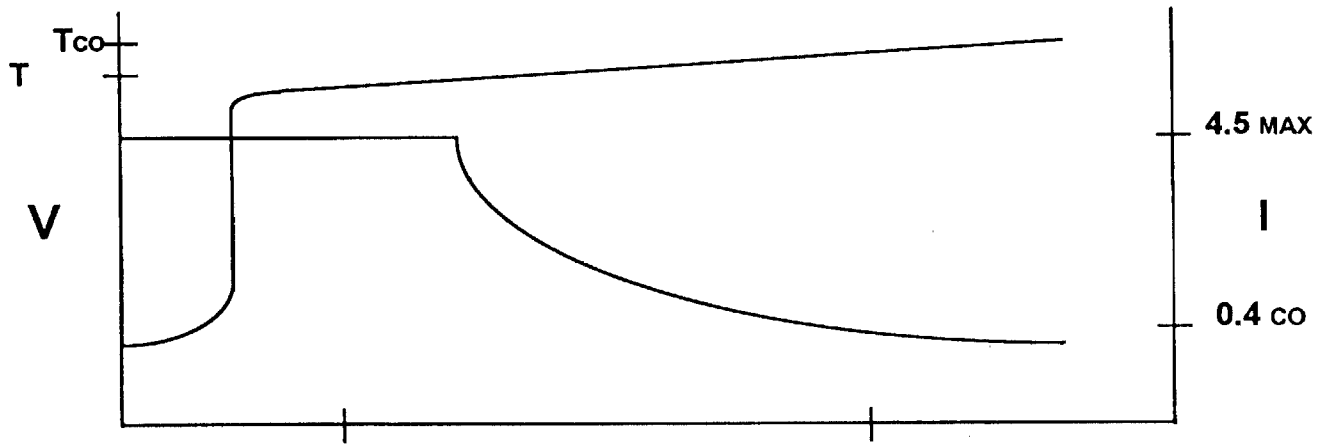
18 CELLS	22.86	TOTAL = 29.25 lbs
HOUSING	3.22	13.28 KG
COMPOSITE	1.07	EXPECT WEIGHT GROWTH
CONNECTORS	0.28	
WIRING	0.40	
HEATER	0.03	
MISC	1.39	

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
DESIGN/PERFORMANCE ISSUES

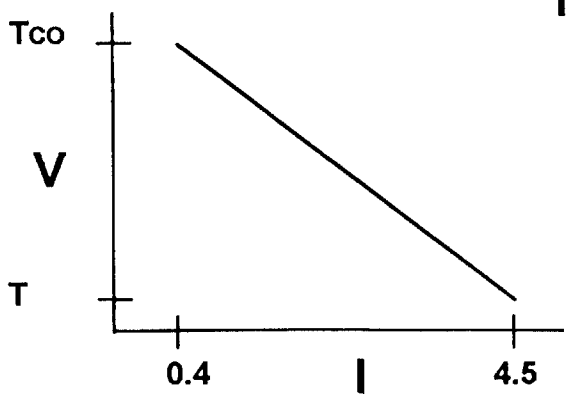
- **DESIGN**
  - DESIGN BASED ON EXISTING TECHNOLOGY
  - CELL 5 OR 6 LAYERS OF SEPARATOR
  - 18 CELL BATTERY (CONCEPT BASED ON 20 CELL BATTERY)
- **OPERATIONAL**
  - CHARGE
    - ENERGY BALANCE IS CRITICAL
    - 20 Ah CHARGE IN 6 HOURS
    - CHARGE/DISCHARGE TEMPERATURE LIMITS (PREFER 20°C)
    - CHARGE METHODOLOGY (CP OR TAPER)
  - DISCHARGE
    - TEMPERATURE LIMIT FOR CAPACITY (NOMINAL 20Ah)
  - CRUISE
    - TEMPERATURE 0C PREFERRED WILL TEST AT 20°C
    - OCV OR 1.86 VOLT FLOAT

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
PROPOSED CHARGE METHODOLOGY

BATTERY CHARGE VOLTAGE/CURRENT



TAPER



MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
CELL CHARACTERIZATION TESTING

- **CHARGE DEFINITION**
  - CONSTANT POTENTIAL
    - V = 1.91 TO 1.94, I = 4.5 MAX TO 0.4, TEMP., 23 TO 10C
  - VIRTUAL RESISTANCE
    - V_{VO} = 1.91 TO 1.94, VT_{OS} = 1.91, TEMP. = -10 TO 10C
- **CHARGE/STAND CYCLE LIFE**
  - 8 MONTH STAND, 0 AND 25C, OCV AND 1.86V FLOAT
- **DISCHARGE CHARACTERISTIC**
  - TEMP. -40, -20, -10, 0, 10C, RATES 1.5, 4.35, 12.5, 1.5 AMPS
- **SYSTEM PERFORMANCE**
  - FLIGHT - PRELAUNCH, CRUISE/TCM, EDL, MARS SURFACE OPERATION
- **CYCLE LIFE INITIAL**
  - CHARGE/DISCHARGE CYCLE AT 0C TO 1.22V, TAPER TBD

MESUR PATHFINDER - BATTERY WORKSHOP
LANDER Ag/Zn BATTERY
DESIGN OPTIONS DETERMINED BY TESTING

- **HARDWARE**
  - 18 OR 17 CELL BATTERY
  - 5 OR 6 LAYERS OF SEPARATOR
- **OPERATION**
  - CHARGE
    - LIMITED CHARGE MAY LEAD TO NEGATIVE ENERGY BALANCE
    - DURATION OF CHARGE PERIOD AND CHARGE ACCEPTANCE
    - CHARGE TEMPERATURE COMPENSATION REQUIRED
    - CHARGE METHODOLOGY
  - CRUISE
    - TEMPERATURE, OCV OR 1.86 VOLT FLOAT

MESUR PATHFINDER - BATTERY WORKSHOP

SUMMARY

- SELECTION OF Ag/Zn BATTERY BASED ON DERIVED MISSION REQUIREMENTS.

- CELL AND BATTERY DESIGNS ARE CONSISTENT WITH FLIGHT REQUIREMENTS.

- CELL TESTING WILL PROVIDE DATA ON
  - CHARGE/DISCHARGE TEMPERATURE COMPENSATION
  - CYCLE LIFE
  - CHARGE METHODOLOGY
  - CRUISE REQUIREMENTS