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JPL

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DS2 MARS MICROPROBE BATTERY
• Transmit water & other science data

• Heat vaporize & analyze for H\textsuperscript{2}O

• Drill scoops soil sample into chamber

• Forboddy penetrates \sim 1 meter

• Affibody with batteries & telecom stays on surface

• Impact Mars Dec. 1999

• Launch Jan. 1999

DS 2 MISSION
battery delivery are carried out safely.

- Ensure that all operations from cell fabrication to documentation packages to project.

- Deliver Right Hardware Cells, Spares, and environmental, and the requirements.

- Develop battery that will meet DS-2 power requirements under specified operational objectives.

DS-2 BATTERY
TECHNOLOGY NEEDS

DS 2 BATTERY
LI-SOCl₂ SYSTEM
DS 2 BATTERY
Discharge curves of D-size Li-SOCl₂ cell at 80°C at 120 ohm.

Cell Voltage, V

Discharge Time, h

0.5M
1.5M

5 ohms

Ll-SOCl₂ CHEMISTRY DEVELOPMENT

DS 2 BATTERY
Cell Design Features
Final 2 Ahr Cell Design
Industrial Partner

High Impact Shock Capability

Ultra Low Temperature Operation

Technology Challenges

Shock Impact: 80,000 G

Shelf Life: 2.5 Years

2 A/h at 25°C

Battery Capacity: 550 mAh at -80°C

Battery Voltage: 6.4 V

Two 4 cell batteries

Primary Battery

Lithium-Thionyl Chloride Chemistry

Battery Description

DS-2 Mars Microprobe Battery
<table>
<thead>
<tr>
<th>Functioned</th>
<th>+2</th>
<th>11</th>
<th>7</th>
<th>NEW</th>
<th>10/24/97</th>
<th>53</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cracks, no leaks, 7</td>
<td>-15</td>
<td>11</td>
<td>8</td>
<td>NEW</td>
<td>8/28/97</td>
<td>60</td>
</tr>
<tr>
<td>1 bubble, 7 functioned</td>
<td>+2</td>
<td>11</td>
<td>8</td>
<td>OLD</td>
<td>5/29/97</td>
<td>42</td>
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<tr>
<td>No cracks, no leaks, 1 tested, 1 open, 7 functioned</td>
<td></td>
<td>11</td>
<td>NA</td>
<td>OLD</td>
<td>4/4/97</td>
<td>38</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>10 degrees</td>
<td>48</td>
<td>3/13/97</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>All G1M cracks and leaks, both functioned</td>
<td>10 degrees</td>
<td>21</td>
<td>4</td>
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<td></td>
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<tr>
<td>AOA</td>
<td>PROBE TYPE</td>
<td>NO CELLS</td>
<td>DATE</td>
<td></td>
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</tr>
</tbody>
</table>

**OVERVIEW**

**IMPACT TESTING**
PROFILE TEST
- Max uses rate $= 100 \text{ mw}$, $= 20.9 \mu A = 0.2 \text{ Ah/yr}$

- Series 1

- Power (Series 1)

- $T = 25^\circ C$
CIRCUMFERTENTIAL TOOL MARKS OBSERVED IN SOME SEALS

FOURTEEN CELLS SHWOWED NO CRACKS ON INSPECTION

SEALS IN 34 OF 48 CELLS
RADIAL CRACKS (1-3) WERE OBSERVED IN THE GLASS TO METAL

CELLS WEIGHTS AND DIMENSIONS MET SPECIFICATIONS

GOOD CELLS
CELL IMPEDANCES WERE FOUND TO BE IN THE RANGE OF PRIOR

CELLS SHOWED NORMAL OPEN CIRCUIT VOLTAGES (3.66+/-.01V)

SEAL PROBLEM
INSPECTION FINDINGS &
FLIGHT/QUALIFCATION CELL LOT
IMPROVED HEAT SINK FOR WELDING
PRE-HEAT TUBE
CHANGE SEAL DIMENSIONS

CORRECTIVE ACTIONS

SEAL CROAK

PPR # ZA6474 BATTER Y CLASS TO METAL

MARS MICROPROBE PROJECT
• REDUCE WATER CONTAMINATION OF ELECTRODES
  • PROVIDE SECOND DEPASSIVATION PULSE
    AFTER LANDING BUT BEFORE HIGH LOAD OPERATION

PROBLEM: VOLTAGE DELAYS IN EXCESS OF 50 SECONDS

SOLUTION:
Delivered hardware and documentation.

Mission life.

Demonstrated acceptable low self discharge for 2 year.

Temp after shock.

Demonstrated functionality for mission profile at low.

Demonstrated capability to withstand shock.

Demonstrated low temp (-80°C) capability.

ACCOMPLISHMENTS

DS-2 BATTERY
DS-2 BATTERY
CONCLUSIONS

- Can withstand shock (to 80,000 g).
- Can meet discharge profile post shock at Mars temps.
- Self discharge rate moderate but not excessive (0.2 Ah/year max).
- Can meet environmental requirements and tolerate electrical abuse.
- Shorting across 0.020 Ohms.
- Discharge and Reversal at 114 mA, and at 25 and -80°C.
- Random vibration
- Thermal cycling, -30 to +75°C.
- Quasi-static acceleration, 100g for 60 sec.
Vardeny Technical Products, Inc.

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DS-2 BATTERY