NICAD BATTERY PACKAGES

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"This technical report has been reviewed and is approved for publication."

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Division Director

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Presented is the development of a packaging concept for nickel-cadmium (nicad) cells used in sounding rocket payload under Contract F19628-81-C-0029. Included are design specifications, assembly procedures and test sequences four (4) types of nicad batteries.
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1. INTRODUCTION
Problems encountered with purchased battery packages and increasing requirements for larger capacity cells in sounding rocket payloads led to the development of the battery packages in this report. Gel cells, lead acid batteries, silver cells and lithium batteries were considered along with nickel-cadmium (nicad) cells; however, nicads proved to be the most versatile. Several packaging concepts considering ease of assembly and servicing; minimization of weight and volume; and payload environmental requirements were evaluated.

2. CELL TESTING
Test fixtures were fabricated to cycle individual cells in groups of 24 (24 cells at 1.2 volts per cell for a nominal 28.8 volt battery). Two cycles of 14-hour charge at a C/10 rate, followed by a discharge at the 1C rate were used to evaluate the cells. Cells reading 1.0 volt under load after 60 minutes discharge are defined as acceptable and are assigned to battery packs. "C" is numerically equal to the rated ampere hour capacity of the cell. For the standard 1.2AH cell, C = 1.2. "C-rate" is a charge or discharge current (amperes), numerically equal to "C". For example, if C = 1.2, then 2C rate = 2.4 and a 2C discharge would be performed using a 2.4 ampere discharge current. Similarly, a C/10 charge on the same cell implies a 120 milliampere charge current.
Characteristics of the cells included in this report are as follows:

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>AH Rating</th>
<th>Diameter</th>
<th>Length</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>C/2</td>
<td>1.2</td>
<td>1.012 in.</td>
<td>0.925 in.</td>
<td>1.10 oz.</td>
</tr>
<tr>
<td>D/2</td>
<td>2.2</td>
<td>1.275 in.</td>
<td>1.448 in.</td>
<td>2.80 oz.</td>
</tr>
<tr>
<td>D</td>
<td>4.0</td>
<td>1.275 in.</td>
<td>2.318 in.</td>
<td>4.6 oz.</td>
</tr>
<tr>
<td>F</td>
<td>7.0</td>
<td>1.275 in.</td>
<td>3.508 in.</td>
<td>7.4 oz.</td>
</tr>
</tbody>
</table>

3. **SEALED BATTERY BOXES**

Figure 1 depicts a typical (28.8 volt at 1.2AH) sealed battery box in which the cells are encapsulated in a foam or silastic potting compound. This packaging concept proved suitable for normal operation of 1.2AH and 2.2AH systems; however, thermal problems became a concern if high rate charging or discharging is required. Furthermore, the recent trend to larger payloads with multiple experiments and longer flight times necessitates larger capacity batteries.

4. **OPEN FRAME BATTERIES**

In contrast to the sealed battery boxes the equivalent open frame unit in Figure 2 requires no potting material and has non-conducting top and bottom trays to hold the cells securely in place. Assembly is simplified since the cells are installed in the trays (observing proper polarity relationships) and can be wired in place. Temporary screws
are used in conjunction with the spacers to clamp the cells in place between the fiberglass trays which are counterbored to hold the cells securely and have 0.25 inch grooves machined to house the interconnecting links below the outside surface of the trays. Figure 3 depicts the top tray for a 1.2AH battery pack which is typical for all assemblies. Details of the counterbore, interconnecting link slots and the through slots for the exit wires are indicated.

Wiring of the sub-assembly, illustrated in Figure 4, is accomplished by soldering all of the interconnecting links on the bottom side, then inverting the sub-assembly to interconnect the top of the cells. Insulators are installed on all interconnecting links. The final wiring step is to attach wires to the cells through the top tray to the interface connector. A typical wiring schematic in Figure 4 shows a 28.8 volt battery with a center tap at 14.4 volts, a charging diode, and a monitor resistor. The diode and resistor are typically housed in the connector backshell which is then potted. Other wiring options or connectors can, of course, be specified. At this point the battery is mated to the battery charge/discharge console for evaluation.

The next step in the assembly procedure is to install the jam-nut receptacle (Bendix PT07A-10-6S for standard wiring) on the base mount, remove the temporary screws on the wiring sub-assembly and install the base mount using the seven (7) flathead socket screws indicated in Figure 5. Finally the
cover is installed using seven (7) binder head screws into the stand-offs and four (4) binder head screws into the tapped holes on the base mount. Two cycles of 14-hour charge at the C/10 rate followed by discharge at the 1C rate are then recorded as acceptance tests for each battery pack. When batteries are assigned to a project they are tested to the specific power profile and required environmental specifications.

5. BATTERY TYPES

Three of the nicad cells used (2.2AH, 4.0AH and 7.0AH) have the same diameter and vary only in length, enabling the use of a common top tray, bottom tray and cover. Selecting the proper stand-off and base mount allows fabrication of any of the three batteries. Assembly Drawing #D-5061 (Figure 5) is tabulated to enable selection of the required hardware. A second assembly drawing (Figure 6) is dedicated to the 1.2AH batteries since the cell diameter is smaller.

Physical characteristics of the four battery packages are as follows:

<table>
<thead>
<tr>
<th>AH Rating</th>
<th>W</th>
<th>L</th>
<th>H</th>
<th>WT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>4.75 in.</td>
<td>7.10 in.</td>
<td>2.24 in.</td>
<td>4.16 lb.</td>
</tr>
<tr>
<td>2.2</td>
<td>6.0 in.</td>
<td>9.25 in.</td>
<td>2.19 in.</td>
<td>6.75 lb.</td>
</tr>
<tr>
<td>4.0</td>
<td>6.0 in.</td>
<td>9.25 in.</td>
<td>3.05 in.</td>
<td>9.38 lb.</td>
</tr>
<tr>
<td>7.0</td>
<td>6.0 in.</td>
<td>9.25 in.</td>
<td>4.26 in.</td>
<td>13.75 lb.</td>
</tr>
</tbody>
</table>
6. DOCUMENTATION

Tech Data Report #NU-183-3 "Battery Testing and Assembly Procedures" provides detailed fabrication information. The following drawings are also applicable.

D-5061 Assembly, Open Frame Battery Pack
A-5056 Stand-Off, Open Frame Battery Pack
C-5057 Cover, Open Frame Battery Pack
C-5058 Bottom Tray, Open Frame Battery Pack
C-5059 Top Tray, Open Frame Battery Pack
D-5060 Base Mount, Open Frame Battery Pack
D-5061B Assembly, Open Frame Battery Pack
D-5063 Wiring Sub-Assembly, Open Frame Battery Pack
D-5563 Base Mount, Open Frame Battery Pack (1.2AH)
C-5564 Cover, Open Frame Battery Pack (1.2AH)
C-5565 Bottom Tray, Open Frame Battery Pack (1.2AH)
C-5560 Top Tray, Open Frame Battery Pack (1.2AH)
D-5568 Assembly, Open Frame Battery Pack (1.2AH)
APPENDIX A

Related Contracts and Report


APPENDIX B

Personnel

The following members of the Electronics Research Laboratory staff contributed to the work reported.

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