

Prototype Lithium-Ion Battery Developed for Mars 2001 Lander



Prototype 25 A-hr, 28-V lithium-ion battery selected for Mars 2001 Lander.

In fiscal year 1997, NASA, the Jet Propulsion Laboratory, and the U.S. Air Force established a joint program to competitively develop high-power, rechargeable lithium-ion battery technology for aerospace applications. The goal was to address Department of Defense and NASA requirements not met by commercial battery developments.

This advanced lithium-ion battery chemistry is of interest for the following reasons:

1. It has a high cell voltage—3.6-V closed-circuit voltage compared with 1.3 V for conventional alkaline chemistries. Consequently, the battery can achieve a desired system voltage with fewer cells and, hence, reduced system complexity and lower manufacturing and assembly costs.
2. It has a high theoretical specific energy density—750 W-hr/kg, approximately twice that of conventional alkaline cells. The improvements in specific energy (watt-hours per kilogram) and energy density (watt-hours per liter) realized by this battery system can enhance any mission that uses rechargeable batteries for energy storage and can enable missions that have critical weight and/or volume margins.

3. It incorporates environmentally safe materials and has safe battery operation. Because of the way the battery operates, there is no danger of lithium fires or of environmental hazards associated with the disposal of the used batteries.
4. It operates over a wide range of temperatures centered on the ambient temperature. This flexibility simplifies thermal system design and expands the envelope of operational parameters under which the battery can be used.

Under this program, contracts have been awarded to Yardney Technical Products, Eagle-Picher Technologies, LLC, BlueStar Advanced Technology Corporation, and SAFT America, Inc., to develop cylindrical and prismatic cell and battery systems for a variety of NASA and U.S. Air Force applications. The battery systems being developed range from low-capacity (7 to 20 A-hr) and low-voltage (14 to 28 V) systems for planetary landers and rovers to systems for aircraft that require up to 270 V and for Unmanned Aerial Vehicles that require capacities up to 200 A-hr. Low-Earth-orbit and geosynchronous-orbit spacecraft pose additional challenges to system operation with long cycle life (>30,000 cycles) and long calendar life (>10 years), respectively.

Technical and program management advisory groups have been established to coordinate program and technical management activities and to verify and validate test results from the individual contractors. The NASA Glenn Research Center at Lewis Field has members on both committees and has supported the contracts with NASA's Office of Space Science, Cross-Enterprise Technology Development Program Funding. Additional funding support for the program has come from NASA's Office of Space Science, Mars 2001 Program Office; U.S. Air Force offices; and other Department of Defense agencies.

The initial work on lithium-ion battery development focused on the development of a battery to power the lander for the Mars 2001 mission. The challenge has been to develop a battery with high specific energy and energy density that could operate at the temperature extremes expected for the Mars mission (-20 to 40 °C). Under this program, Yardney and BlueStar successfully developed batteries that could meet the mission requirements for the Mars 2001 Lander. On the basis of a performance evaluation of the cells delivered to date, Yardney Technical Products was selected as the vendor for the Mars 2001 mission. The prototype 25 A-hr, 28-V battery developed by Yardney Technical Products has a specific energy of 123 W-hr/kg at 20 °C and of 85 W-hr/kg at the low end of the temperature range, -20 °C.

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