BATTERIES AND FUEL CELLS IN SPACE
A CHRONOLOGY

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The year 2002 marks the 46th anniversary of the space program that started with the launch of the first Sputnik on October 4, 1956. Significant progress has been made in the exploration of space since the late '50's.. Thanks to the flexibility and capability of batteries and fuel cells, NASA and the U.S. Air Force have been able to accomplish a wide range of challenging space missions. Batteries and fuel cells are used in a wide variety of space applications such as launch vehicles, earth-orbiting spacecraft, space shuttle, crew return vehicles, astronaut equipment, planetary spacecraft, landers, rovers, and penetrators.

In these missions, batteries and fuel cells are used as a primary source of electrical power or as an electrical energy storage device. Space missions impose several critical performance requirements on batteries and fuel cells. Batteries required for space applications must be capable of operating in hard vacuum and withstand severe launch environments (vibration, shock, and acceleration). Space applications also require batteries that can provide maximum electrical energy in minimum weight and volume. Long cycle life (>30,000 cycles) is the critical driver for orbiting spacecraft, and long active shelf life is the driver for planetary probes (>7-10 years). Radiation resistance and operation at temperatures as low as -80C is essential for some of planetary missions. No single battery system can meet all these complex requirements. A number of different battery systems such as silver-zinc, nickel-cadmium, nickel-hydrogen and lithium-Ion have been used to meet the complex requirements of various missions. Generally, batteries for space applications are custom designed and fabricated to meet the mission requirements.

The Ag-Zn battery was the choice in the early days of space missions. The Ni-Cd battery became the major energy storage device over the next 20 years because of its long cycle life. The Ni-H_2 battery started to play a role in the 80s. Recently, there has been considerable interest in the use of Lithium-Ion batteries because of their high specific energy and energy density. Key historic events and a chronology of batteries in space will be described, as will the plans for energy storage in future missions.

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