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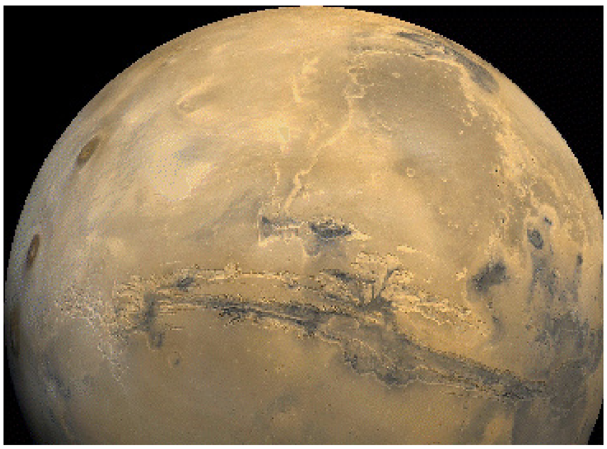
Mars Exploration

Radioisotope Power and Heating for Mars Surface Exploration



Electrical power is critical for exploring Mars — it keeps radios, computers, and scientific instruments working on Mars lander and rover missions. Electrical power systems must survive Mars' harsh environment, where temperature extremes, dust storms and high radiation levels from space present challenges to spacecraft systems that must operate long enough for missions to accomplish their scientific goals. Currently, two kinds of electrical power systems are considered — a combination of solar arrays and batteries, and radioisotope power systems.

Extreme Cold and Dust

For some missions, Mars is close enough to the Sun that solar energy is sufficient to power a lander or a rover. But surface-based missions that rely exclusively on solar power systems can be short-lived due to the harsh Martian environment, especially the day-to-night temperature extremes, which can vary by more than 150 degrees Fahrenheit. In addition, fine dust covers the surface of Mars and is carried by winds throughout its atmosphere. This dust can settle and build up on solar panels. Ultimately, the dust can block sunlight from the solar cells, reducing or cutting off power and ending the mission. Batteries on landers and rovers can be recharged while spacecraft solar panels are working, but even the batteries and the central electronics must be warmed over the course of subzero Martian nights when temperatures can dip to –150 degrees Celsius (–238 degrees Fahrenheit). Small radioisotope heaters are sometimes used to keep the electronics and other equipment within range of their operating temperatures.

Science Requirements

Radioisotope electrical power and heating systems enable science missions that require greater longevity, more diverse landing locations or more power than missions limited to solar power systems.

With radioisotope power systems, years of operation are possible. The Viking landers, each with a radioisotope thermoelectric generator, operated on Mars for four and six years, respectively. By comparison, the 1997 Mars Pathfinder mission, which used radioisotope heaters but only solar and battery power on the rover, lasted only three months. The Mars Exploration Rovers, also equipped with radioisotope heaters and solar and battery power, have well exceeded their original three-month mission lifetimes, but are limited in their operations in winter's cold and dim sunlight.

More Places to Explore, Greater Science Return

Radioisotope power systems do not require any sunlight to operate, permitting spacecraft to land at more diverse locations regardless of season, time of day or latitude. Because of the number of moving parts, rovers and other mobile explorers require more power than landers. If rovers are solar powered, they must land and operate within a fairly narrow latitude band near the equator where enough sunlight shines to provide adequate electricity. For rovers, radioisotope electrical power systems could provide the capability to land and operate at a greater variety of scientifically important locations.

Accessing the Most Promising Sites

As NASA's rovers have shown, Martian terrain varies dramatically, and features challenges such as craters, gullies and fields of rocks and boulders. Navigating and driving through complex and rugged terrains also requires more energy than driving in barren flatlands. Frequently, the energy required to move through very complex, and scientifically interesting, areas may exceed the capacity of solar-powered systems. Shadows in rugged terrain such as canyons or ridges further limit the effectiveness of solar-powered landed spacecraft. Vehicles that draw energy from radioisotope power systems would not be limited by such conditions.

Understanding the "real" Mars requires global accessibility and the ability to reliably traverse rugged terrain in all seasons regardless of dust, temperature or lack of sunlight. Radioisotope power and heating systems for Mars surface missions provide expanded surface access, opening up far more terrain for intensive surface-based exploration and discoveries.

For More Information

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4-06