Design Concept for a Nuclear Reactor-Powered Mars Rover

John O. Elliott, JPL
Ron Lipinski, Sandia National Laboratory
Dave Poston, Los Alamos National Laboratory

The planning of Mars surface missions has progressed in recent years in the direction of increasing capability and science return with an attendant need for increased power and longevity. The Viking missions demonstrated longevity at low power levels (~ 70We per lander) and current planning includes plans for radioisotope-powered missions in the 100 to 200 We range. Beyond levels of about 1 kWe radioisotope sources begin to be prohibitively massive, especially for a landed system. At levels of about 3 kWe, the use of a fission power system for surface applications becomes attractive from a number of standpoints.

A study was recently carried out by a team from JPL and the DoE to investigate the utility of a DoE-developed 3 kWe surface fission power system for Mars missions. The team was originally tasked to perform a study to evaluate the usefulness and feasibility of incorporation of such a power system into a landed mission. In the course of the study it became clear that the application of such a power system was enabling to a wide variety of potential missions. Of these, two missions were developed, one for a stationary lander and one for a reactor-powered rover. This paper discusses the design of the rover mission, which was developed around the concept of incorporating the fission power system directly into a large rover chassis to provide high power, long range traverse capability. The rover design is based on a minimum extrapolation of technology, and adapts existing concepts developed at JPL for the 2009 Mars Science Laboratory (MSL) rover, lander and EDL systems. The small size of the reactor allowed its incorporation directly into an existing large MSL rover chassis design, allowing direct use of MSL aeroshell and pallet lander elements, beefed up to support the significantly greater mass involved in the nuclear power system and its associated shielding. This paper describes the unique design challenges encountered in the development of this mission architecture and incorporation of the fission power system in the rover, and presents a detailed description of the final design of this innovative concept for providing long range, long duration mobility on Mars.