Mars Mission Concepts Incorporating a 3 kWe Surface Fission Power System

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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 missions incorporating radioisotope power systems 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 team from JPL and the DOE has recently completed a study to investigate the utility of a 3 kWe surface fission power system for Mars missions. 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 surface missions. Of these, two concepts were chosen for detailed investigation, one for a stationary lander and one for a reactor-powered rover. The stationary lander mission was developed around the concept of landing a cryobot on the Mars north polar ice cap. The cryobot is designed to bore through the entire 2-3 km thickness of the ice cap, providing a picture of the Martian climate spanning more than a million years of Martian history. The high sustained power available from the reactor system proved to be an ideal match for this mission design enabling a level of science return unavailable from an alternative power sources. The lander design was based on a minimum extrapolation of technology, drawing heavily on the existing concepts in development at JPL for the 2009 Mars Science Laboratory (MSL) lander mission.

The rover mission investigated the concept of incorporating the fission power system directly into a large rover chassis to provide high power for science, telecommunications and long range traverse capability. The small size of the reactor power system allowed its incorporation directly into an existing large MSL rover chassis design, providing an opportunity to evaluate the feasibility of collocating a reactor and shielded electronics in such a small package. This paper describes the unique design challenges encountered in the development of these mission architectures and the incorporation of the fission power system in the landed elements, and presents detailed descriptions of the final designs of these innovative concepts for Mars exploration.