SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

Author: Mr. Mark Schaffer
SpaceWorks Enterprises, Inc., United States

Dr. Brad St. Germain
SpaceWorks Enterprises, Inc. (SEI), United States
Ms. Tara Polsgrove
NASA Marshall Space Flight Center, United States

REACHMARS 2024: A CANDIDATE LARGE-SCALE TECHNOLOGY DEMONSTRATION MISSION AS A PRECURSOR TO HUMAN MARS EXPLORATION

Abstract

ReachMars 2024 is a large-scale, robotic precursor Mars mission concept designed to demonstrate and mature key technologies required for future human Mars missions. As envisioned, this mission would serve to focus NASA's technology maturation efforts and leverage ongoing spaceflight hardware developments to achieve a flagship-class exploration mission as early as 2024. This paper outlines the results of a three month study to develop the ReachMars concept sponsored by NASA Marshall Space Flight Center and executed by SpaceWorks Engineering.

ReachMars is designed to demonstrate four key technologies: 1. Mars atmospheric entry with a Hypersonic Inflatable Aerodynamic Decelerator (HIAD) of appropriate scale for human-class missions 2. Descent and surface landing using Supersonic Retro Propulsion (SRP) 3. Representative scale In-Situ Resource Utilization (ISRU) of O2 production and storage from CO2 in Martian atmosphere 4. Ascent segment of a future sample return capability with a Mars Ascent Vehicle (MAV)

In order to achieve the required technology demonstration goals ahead of human missions proposed in the early-2030s, ReachMars is required to launch in the mid-2020s, during either the 2024 or 2026 Mars conjunction-class mission opportunities. The lander vehicle is designed for launch on a NASA Space Launch System (SLS) Block 1, using an interim Cryogenic Propulsion Stage (iCPS) to provide trans-Mars injection from Earth.

The resulting vehicle has a launch mass of 18.0 t and delivers a useful payload mass of 7.4 t to the Martian surface. The vehicle is designed with a rigid diameter of 5.0 m and total inflated diameter (with HIAD) of 12.5 m. The primary launch opportunity is in September to October of 2024, with a secondary launch opportunity available in October to November 2026. The sample return Mars Ascent Vehicle is capable of returning a 10 kg Mars surface sample to Earth, and is supported by Curiosity-class rover for sample collection and scientific exploration.

Details of the engineering analysis are provided in the paper, including: interplanetary trajectory analysis to determine launch C3 requirements and available launch windows; entry, descent, and landing trajectory profiles; engineering diagrams and mass breakdown statements of the ReachMars vehicle; and descriptions of the ISRU demonstration and MAV sample return payloads. Programmatic factors such as de-scope options and mission dependencies are also discussed.