HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Human Mars Exploration (2)

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A COMBINED SOLAR ELECTRIC AND STORABLE CHEMICAL PROPULSION VEHICLE FOR PILOTED MARS MISSIONS

Abstract

The recently published NASA Mars Design Reference Architecture (DRA) 5.0 explored a piloted mars mission in the 2030 timeframe, focusing on architecture and technology choices. The original DRA 5.0 study considered nuclear thermal and cryogenic chemical propulsion system options for the mission. Subsequent work by NASA's COMPASS design team explored both nuclear electric propulsion and solar electric propulsion (SEP) options. One intriguing architecture that arose from these design studies utilized a 1-MW class SEP system combined with storable chemical propulsion systems derived from vehicles planned under NASA's Constellation Program. It was found that by using either SEP or chemical propulsion at different phases of the mission, one could deploy the entire Mars mission spacecraft (i.e., integrated SEP stage and habitat) into Low Earth Orbit (LEO) with just two 120-tonne class Space Launch System (SLS) heavy lift vehicles. Generally, the higher thrust chemical system is used for maneuvers with crew within planetary gravity wells, while SEP is used during planetary transit and for maneuvers without crew. Thus in this scenario, the unmanned Mars spacecraft would first spiral out from LEO to the 2nd Earth-Moon Lagrange Point (L2) using its SEP system. The crew would then be launched aboard a Multipurpose Crew Vehicle (MPCV) which would subsequently rendezvous with the Mars spacecraft at L2. After the crew transfers to the Mars spacecraft, the SEP system is used to place the spacecraft on a trajectory to Mars. SEP also slows the vehicle enough to minimize the capture and departure V from the Mars gravity well by a factor 5 compared to an all-impulsive mission. This trajectory also allows the Mars vehicle to arrive in the highly elliptic 1-SOL (Mars day) parking orbit assumed in the previous DRA 5.0 nuclear thermal and all-chemical propulsion concepts. This paper evaluates the mission option splits between the SEP and chemical propulsion systems, design of the SEP system including the solar array and propulsion system choices, and packaging in the SLS shroud. Trades of stay time, power level, specific impulse and propellant type are also included.