

Technology Roadmaps for Space Exploration (09)  
Technology Development Concepts (2)

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SOLAR ELECTRIC PROPULSION MARS TRANSFER STAGES BASED FROM EARTH MOON  
LAGRANGE POINTS**Abstract**

Based from one of the Earth Moon Libration Points, a Mars exploration campaign is described that features reusable Solar Electric Propulsion (SEP) stages. SEP Earth-Mars transfer stages using advanced array and high specific impulse (Isp) (1500-5000) electric thruster technology would form a viable option for exploration missions, especially those with high delta-velocity requirements. The SEP transfer stages would provide for low propellant mass transfer to Mars and could be reused for multiple opportunities before being replaced. Once the L Point station is established, Mars vehicles can be reflown each opportunity (roughly every 2.2 years). This approach would allow a series of Mars missions requiring significantly less Initial Mass in Low Earth Orbit (IMLEO) than other systems over the life of a Mars campaign. The SEP Mars stage is compared to Nuclear Thermal Propulsion (NTP) and Chemical stages (with Aerobrake assist) Mars transfer stages carrying similar payloads.

This paper will include illustrations of SEP transfer stages in the 400kW-to-1MW power range, including Mars mission payloads (crew habitats, Mars landers); SLS manifests and SEP configuration options. This work will also include a discussion on how the SEP stage would evolve, over time, from lower power levels (30-100kW) to the increased power levels needed for LEO-to-L Point cyclers, and crewed Asteroid rendezvous missions, to the high power levels needed for crewed Mars missions. Cycler and Asteroid mission SEP precursors could form the basis for a series of SLS flights in the mid-to-late 2020s, with follow-on Phobos/Demos and Mars missions coming in the early 2030s. The elements and their masses necessary to this scenario will be linked to the launch capabilities of the SLS. Methodologies for highly reliable and robust transfer stage and crew habitation elements will be identified. The concept of the L point station is discussed as a staging base for other exploration missions in addition to the Mars mission; Mars missions are placed in the context of a exploration campaign that includes Lunar and asteroid missions, and which features teleoperation of assets from the transfer stage and L Point station.