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MARS MISSION CAPABILITIES ENABLED BY NUCLEAR THERMAL PROPULSION

Abstract

As part of the Artemis era of space exploration, space agencies will be working together with their industry partners to establish systems and infrastructure that enable sustained lunar missions and develop capabilities for Mars. Lockheed Martin has a longstanding history of designing, building, and operating systems for deep space applications, from Viking to Orion. To enable future missions, Lockheed Martin develops concepts, trades, and early system designs for Moon and Mars exploration. In 2016, Lockheed Martin presented a vision for achieving crewed exploration of Mars. Known as Mars Base Camp (MBC), this design reference mission envisioned a crewed vehicle in Martian orbit from which astronauts could perform excursions to Phobos and Deimos and perform telerobotic exploration of the Martian surface, including sample return. This concept served as an "existence proof" for a novel, practical, and affordable path to enable human exploration of the Martian system. In 2017, an update was published that included the production of propellant from water and a single-stage fully reusable Mars lander concept. Then in 2021, Lockheed Martin introduced a nuclear thermal propulsion (NTP) configuration of Mars Base Camp, a technology that will be greatly enabling for crewed missions to Mars.

This paper matures the design of the NTP configuration of Mars Base Camp and explores the Mars mission capabilities that the NTP technology will enable. These investigations include optimized trajectories for faster transit to Mars and an analysis of abort scenarios that are made possible by the high thrust and performance of NTP. The results provide insight into the performance and capabilities that are realized when NTP technology is matured and integrated into a Mars transit vehicle. The paper will also describe initial surface infrastructure capabilities that significantly enhance sortie science operations, including mobility and power. The resulting updated Mars Base Camp serves as an example of what is possible with current technologies and technologies under development. The MBC reference mission builds on the capabilities that will be developed and demonstrated through Artemis missions, enabling a viable, sustainable long-term Mars exploration program, with the first crewed Mars mission possible in the 2030s.