Paper ID: 45233
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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Space Transportation Solutions for Deep Space Missions (8-A5.4)

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NUCLEAR THERMAL CRYOGENIC ROCKET WITH AN AFTERBURNER FOR A HUMAN MARS MISSION

Abstract

Many ideas and designs for a Mars Transfer Vehicle exist in literature. Unfortunately, nearly all of them are at a TRL 3 or below. Of these feasible designs, a Nuclear Thermal Rocket or NTR is the only option which has been tested in the past. This is the only option that simultaneously offers both high specific impulse and high thrust, making it the perfect candidate for crewed Mars exploration missions. With an added afterburner, it would be an ideal choice for missions that can leverage In-Situ Resource Utilization (ISRU) activities on the Moon (for extraction, processing and supply of liquid oxygen). Our proposal focuses on optimizing the design of a NERVA-based engine (Nuclear Engine for Rocket Vehicle Applications) with an added liquid oxygen(LOX) afterburner. This paper employs a trajectory design and Cislunar-based Mars transit strategy from an existing Mars mission architecture, MUSE(Moon Utilisation for Science and Exploration), outlined in Stefano Torresan et al., 2017. Based on this transfer strategy, a comparative analysis of a NTR with and without a LOX afterburner is performed to derive an optimal engine configuration and operation sequence (per maneuver). A lunar resource utilization plan is also proposed to enable full/partial supply of the Mars Transfer Vehicle.