Nuclear Thermal Propulsion Development Risks

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Abstract. There are clear advantages of development of a Nuclear Thermal Propulsion (NTP) for a crewed mission to Mars. NTP for in-space propulsion enables more ambitious space missions by providing high thrust at high specific impulse (~900 sec) that is 2 times the best theoretical performance possible for chemical rockets. Missions can be optimized for maximum payload capability to take more payload with reduced total mass to orbit; saving cost on reduction of the number of launch vehicles needed. Or missions can be optimized to minimize trip time significantly to reduce the deep space radiation exposure to the crew. NTR propulsion technology is a game changer for space exploration to Mars and beyond.

However, "NUCLEAR" is a word that is feared and vilified by some groups and the hostility towards development of any nuclear systems can meet great opposition by the public as well as from national leaders and people in authority. The public often associates the "nuclear" word with weapons of mass destruction. The development NTP is at risk due to unwarranted public fears and clear honest communication of nuclear safety will be critical to the success of the development of the NTP technology.

Reducing cost to NTP development is critical to its acceptance and funding. In the past, highly inflated cost estimates of a full-scale development nuclear engine due to Category I nuclear security requirements and costly regulatory requirements have put the NTP technology as a low priority. Innovative approaches utilizing low enriched uranium (LEU).

Even though NTP can be a small source of radiation to the crew, NTP can facilitate significant reduction of crew exposure to solar and cosmic radiation by reducing trip times by 3-4 months. Current Human Mars Mission (HMM) trajectories with conventional propulsion systems and fuel-efficient transfer orbits exceed astronaut radiation exposure limits. Utilizing extra propellant from one additional SLS launch and available energy in the NTP fuel, HMM radiation exposure can be reduced significantly.

Keywords: Nuclear Thermal Propulsion, Project Management, Risk, Technology Development, Human Mars Mission