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IMPACT OF SCALING A SMALL NTP FROM 31-KN TO 111-KN THRUST FOR HUMAN MARS AND OTHER MISSIONS

Abstract

Exploration architectures that require substantial payload capability (e.g., Mars Lander/Sample Return; Jupiter, Saturn, Neptune, or Uranus Orbiters) or rapid trip times (e.g., human Mars missions) have been shown to benefit from nuclear thermal propulsion (NTP) because of the 2X Specific Impulse (ISP) increase over cryogenic chemical propulsion. A small (33-kN) NTP approach could provide an affordable path for getting nuclear propulsion into the Global Exploration Roadmap. The benefit of a NTP smaller than previously developed nuclear systems under NERVA/Rover is in the reactor size. The small 150-MWt NTP provides a development cost benefit with a smaller physical reactor core with less uranium content and is more easily tested with a smaller facility foot-print. The smaller facility and lower exhaust flow rate provides for less effluent to clean and manage, which, in turn, reduces the development cost due to environmental safety and nuclear material security concerns that dominate the 1000-3000 MWt tested in the past in the USA. Fundamentally a small NTP can reduce the development, procurement, and operational costs making it a more affordable NTP system for a nuclear cryogenic propulsion stage. Although the smaller NTP has the potential for a lower cost flight demonstrator, higher thrust NTP systems may be more desirable for stages used to "inject" larger payloads (e.g., 40 to 80 Mt) to Mars and beyond. These larger thrust NTP systems could range from 66-kN to 156-kN and operate in clusters as multiple NTP engine systems. Aerojet Rocketdyne has been working with NASA and performing internal studies to characterize the impact for scaling the 33-kN to a larger 111-kN thrust engine system. This paper will provide an overview of the impact of scaling from a 33-kN to 111-kN NTP system and the impact on a human exploration mission.