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Technology Roadmaps for Space Exploration (09)
Advancing Propulsion Technologies (4)

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AFFORDABLE DEVELOPMENT OF NUCLEAR THERMAL PROPULSION FLIGHT DEMONSTRATOR BASED ON A SMALL PROPULSION CONCEPT THAT IS SCALABLE TO HUMAN MISSIONS

Abstract

Recent exploration architectures are considering capability based approaches that use various propulsion technologies that need flight qualification. When human exploration missions come to fruition, rapidity of mission flight time and minimization of the number of flight elements will be important to reduce risk and cost. Nuclear thermal propulsion (NTP) is a technology that enables rapidity of transit and minimizes the number of spacecraft systems and launch vehicles to enable robust exploration. NTP has been proven scientifically and many engineering challenges have been addressed in past ground testing. The final validation and verification that still remains is to prove NTP in a flight demonstrator. Current efforts are focused on reducing demonstrator cost via application of proven liquid rocket components and fuel element design technology evolution. Pratt Whitney Rocketdyne has been working with NASA Glenn Research Center in 2011 to conceptualize the reactor design requirements and propulsion system design relative to a small NTP with scalability to human exploration spacecraft systems. Studies performed in 2011 show this new affordable NTP approach can provide a small NTP that provides improved capability when used on current Delta IV and Atlas V expendable launch vehicles for robotic missions that have been defined in the NASA 2011 Decadal Study. The use on these missions provides two major payoffs: the first is performing robotic exploration with increased payload and shorter mission times direct to the planet; the second is system validation via flight operation to reduce the risk for human missions. Figure 1 illustrates the size perspective of the small NTP relative to current LOX/Hydrogen upper stage engines. This paper will provide an overview of the small NTP design, robotic exploration mission trades, and the scalability characteristics for human missions.