Paper ID: 23294
oral
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SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (6)

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OPTIMIZATION OF A NUCLEAR THERMAL ROCKET FERRY FOR GEOSYNCHRONOUS TRANSFER MISSIONS WITH CONSIDERATION OF COMMERCIAL RETURN ON INVESTMENT

Abstract

The United States first designed and tested Nuclear Thermal Rockets (NTR) from 1955-72 during Project Rover and NERVA. 42 years since the end of NERVA, NASA is proposing the possible use of NTRs for human Mars missions during the 2030-40 time period under the Design Reference Architecture 5 (DRA5). NTRs are known to have favorable characteristics for thrust and Isp in comparison to current chemical or electric propulsion engines and would be ideal for high v missions that require quick transit. Historically, the development cost of NTRs has been tied to DRA5 like missions, which if canceled results in the cancellation of funding for NTR development. The authors have suggested finding alternative applications for the use of NTRs whereby the commercial sector will be enticed to develop NTRs independently from government funding.

Recent investigations by the authors have looked at the feasibility of a 15,000 lbf low enriched uranium NTR for Earth based ferrying, specifically as a ferry for geosynchronous missions [1]. It was shown that the use of an NTR ferry could allow customers to choose alternative launch vehicles or make use of added mass margin for geosynchronous transfer (GTO) missions [2].

This paper will present new results for the NTR ferry applied to GTO missions. An optimization of key NTR subsystem parameters with a linked business model are used to arrive at a family of solutions for the NTR ferry applied to the GTO market. The family of solutions may then be represented as Pareto fronts for system designers to find a solution with favorable characteristics. The final parameter results set objectives for subsystems engineers such that a conceivable vehicle may be created. In this manner, engineers designing an engine core will know what parameter limitations they are constrained by for a feasible and profitable vehicle. Similar analogs will be given for other critical subsystems. Discussion will also be given to how the GTO NTR ferry can be made evolvable toward DRA5 missions.

[1] Beeson R. et al., Business Case for a Commercially Developed Nuclear Thermal Rocket, Nuclear and Emerging Technologies for Space 2014.

[2] Beeson R. et al., Design of an Evolvable Nuclear Thermal Rocket Ferry for Geosynchronous Transfer, Nuclear and Emerging Technologies for Space 2014.