Return to Menu

Nuclear Thermal Propulsion

Project Manager(s)/Lead(s)

Sonny Mitchell, Program Manager/ZP30
(256) 544–7306

Michael G. Houts, Principal Investigator/ZP30
(256) 544–8136

Tony Kim, Deputy Project Manager/ZP30
(256) 544–6217

Sponsoring Program(s)

Human Exploration and Operations Mission Directorate
Space Technology Mission Directorate
Advanced Exploration Systems

Project Description

Development efforts in the United States for nuclear thermal propulsion (NTP) systems began with Project Rover (1955–1973) which completed 22 high-power rocket reactor tests. Results indicated that an NTP system with a high thrust-to-weight ratio and a specific impulse >900 s would be feasible. John F. Kennedy, in his historic special address to Congress on the importance of Space on May 25, 1961, said, "First, I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth…" This was accomplished. He also said, *"Secondly ... accelerate development of the Rover nuclear rocket. This gives promise of someday providing a means for even more exciting and ambitious exploration of space… to the very end of the solar system itself."* The current NTP project focuses on demonstrating the affordability and viability of a fully integrated NTP system with emphasis on fuel fabrication and testing and an affordable development and qualification strategy. The goal is to enable NTP to be considered a mainstream option for supporting human Mars and other missions beyond Earth orbit.

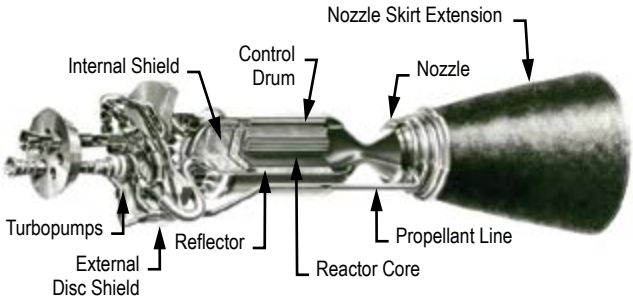

Figure 1: NTP engine schematic.

Figure 2: NTP fuel element fabrication.

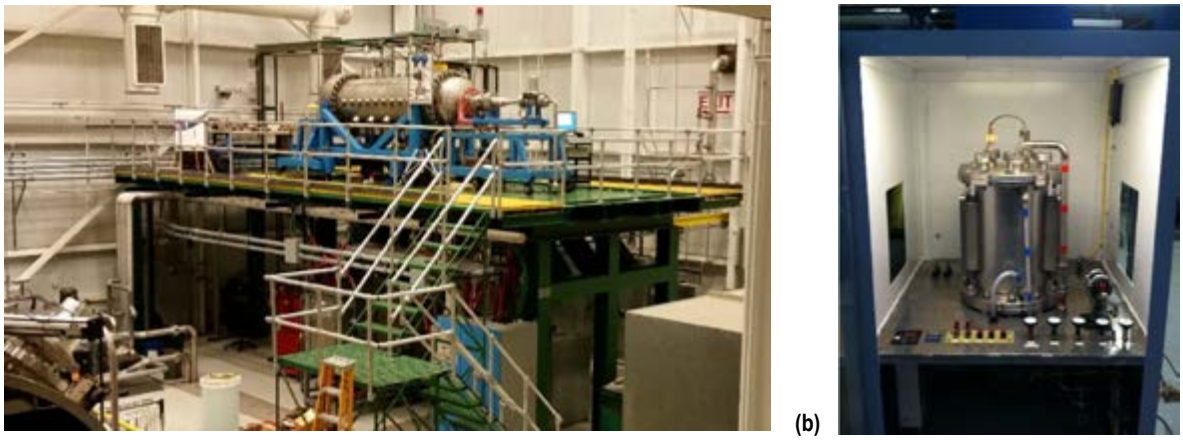

Figure 3: MSFC test facilities: (a) Nuclear Thermal Rocket Element Environmental Test System (NTREES) and (b) Compact Fuel Element Environmental Test (CFEET) System.

Anticipated Benefits

The fundamental capability of NTP is game changing for space exploration. A first generation NTP stage could provide high thrust at a specific impulse above 900 s, roughly double that of state-of-the-art chemical engines. The energy comes from fission, not chemical reactions, resulting in unlimited energy density. NTP enables the shortest trip times to Mars and beyond which exposes astronauts to less galactic radiation and zero-g time. An NTP system would require approximately four less Space Launch System (SLS) launches for a human Mars mission that saves billions of dollars. The system would result in reduced propellant mass and an increase in payload capacity.

Potential Applications

Near-term NTP systems would provide a foundation for the development of significantly more advanced, higher performance systems. The role of NTP in the development of advanced nuclear propulsion systems could be analogous to the role of the DC-3 in the development of advanced aviation. Progress made under the NTP project could help enable both advanced NTP systems and advanced Nuclear Electric Propulsion. Combined with current technologies, the vision to go beyond the Moon and to the very end of the solar system can be realized with NTP.

Notable Accomplishments

Dedicated fuel materials and processing laboratories have been brought on line at Oak Ridge National Laboratory and NASA Marshall Space Flight Center (MSFC) and are fabricating fuel elements of various materials (including the use of depleted uranium) for testing. The CFEET and NTREES test facilities have been designed and brought to operational status to perform testing on fuel element materials. This testing helps to resolve a majority of thermal hydraulic issues (including fuel endurance) while lowering cost and time needed to develop nuclear systems. Laboratories and test facilities have been licensed to handle depleted uranium for fabrication and testing. Various options are being examined for viable ground testing of an engine system. The possible use of low enriched uranium is being examined to reduce, cost, ops, testing, and diagnostics.

References

Houts, M.; Kim, T.; Emrich, J.; et al.: "Affordable Development of a Nuclear Cryogenic Propulsion Stage," AIAA Space 2012 Conference, Pasadena, CA, September 11–13, 2012.