NASA's Nuclear Thermal Propulsion Project

Michael Houts[1], Sonny Mitchell[1], Tony Kim[1], Stanley Borowski[2], Kevin Power[3], John Scott[4], Anthony Belvin[5], Steven Clement[6]

[1]NASA MSFC, MSFC, AL
[2]NASA GRC, Cleveland, OH
[3]NASA SSC, SSC, MS
[4]NASA JSC, Houston, TX
[5]DOE-NE75, Germantown, MD
[6]DOE-NNSA, NNSS, NV
(256)544-8136: michael.houts@nasa.gov

Abstract. Space fission power systems can provide a power rich environment anywhere in the solar system, independent of available sunlight. Space fission propulsion offers the potential for enabling rapid, affordable access to any point in the solar system. One type of space fission propulsion is Nuclear Thermal Propulsion (NTP).

NTP systems operate by using a fission reactor to heat hydrogen to very high temperature (>2500 K) and expanding the hot hydrogen through a supersonic nozzle. First generation NTP systems are designed to have an Isp of ~900 s. The high Isp of NTP enables rapid crew transfer to destinations such as Mars, and can also help reduce mission cost, improve logistics (fewer launches), and provide other benefits. However, for NTP systems to be utilized they must be affordable and viable to develop.

NASA's Advanced Exploration Systems (AES) NTP project is a technology development project that will help assess the affordability and viability of NTP. Early work has included fabrication of representative graphite composite fuel element segments, coating of representative graphite composite fuel element segments, fabrication of representative cermet fuel element segments, and testing of fuel element segments in the Compact Fuel Element Environmental Tester (CFEET). Near-term activities will include testing ~16" fuel element segments in the Nuclear Thermal Rocket Element Environmental Simulator (NTREES), and ongoing research into improving fuel microstructure and coatings.

In addition to recapturing fuels technology, affordable development, qualification, and utilization strategies must be devised. Options such as using low-enriched uranium (LEU) instead of highly-enriched uranium (HEU) are being assessed, although that option requires development of a key technology before it can be applied to NTP in the thrust range of interest. Ground test facilities will be required, especially if NTP is to be used in conjunction with high value or crewed missions. There are potential options for either modifying existing facilities or constructing new ground test facilities. At least three potential options exist for reducing (or eliminating) the release of radioactivity into the environment during ground testing. These include fully containing the NTP exhaust during the ground test, scrubbing the exhaust, or utilizing an existing borehole at the Nevada National Security Site (NNSS) to filter the exhaust.

Finally, the project is considering the potential for an early flight demonstration of an engine very similar to one that could be used to support human Mars or other ambitious missions. The flight demonstration could be an important step towards the eventual utilization of NTP.

Keywords: Nuclear, Propulsion, Mars, NASA, Affordable