NASA SBIR 2006 Phase I Solicitation

X9.04 Nuclear Thermal Propulsion

Lead Center: GRC
Participating Center(s): MSFC

NASA is interested in the development of critical technologies for first in-space applications of solid core nuclear thermal propulsion (NTP) systems for use in future human exploration missions. For short round trip missions to Mars, NTP systems may be enabling by helping to reduce launch mass to reasonable values and by also increasing the payload delivered for Mars human exploration missions.

Preliminary solid core NTP system concepts could be based on a high thrust/high Isp (~850 - 950s) NTP system that would use a fission reactor with U-235 fuel as its source of thermal energy. During the short primary propulsion maneuvers of a typical conceptual mission, large quantities of thermal power (100's of MWt) would be produced within the NTP system and removed using LH$_2$ propellant that is pumped through the engine's reactor core. The superheated hydrogen gas is then exhausted out the engine's nozzle to generate thrust. Representative ranges of engine performance include: (1) hydrogen exhaust temperatures ~2500 - 2900 K, (2) propellant flow rates ~7 - 13 kg/s, (3) chamber pressures ~500 - 1500 psi, and (4) nozzle expansion area ratio ~200:1 - 500:1.

Proposals are sought to further improve factors contributing to safety, performance, reliability, and life as well as reduce projected weight and costs for the first in-space NTP systems, subsystems, and components beyond that in previously achieved ground test systems. Proposals are solicited in the following key technology/concept areas:

- High temperature, low burn-up carbide- and ceramic-metallic (cermet)-based nuclear fuels with improved coatings and/or claddings to reduce fission product gas release into the engine's H$_2$ exhaust stream;
- Reliable, high temperature materials, fabrication techniques, and concepts for non-reactor portions of NTP systems;
- Light-weight, multi-use shielding materials and designs;
- High temperature, radiation tolerant instrumentation and avionics for engine health monitoring. Non-invasive designs for measuring neutron flux (outside of reactor), chamber temperature, operating pressure, and H$_2$ propellant flow rates over wide range of temperatures are desired;
• Long life, lightweight, reliable hydrogen turbopump designs and technologies;

• Lightweight, long life, high heat flux thrust chambers, regenerative-cooled nozzles and radiation-cooled skirt extensions that are compatible with hot hydrogen;

• Radiation tolerant materials compatible with above engine subsystem applications and operating environments.