NASA SBIR 2009 Phase I Solicitation

X10 Cryogenic and Non-Toxic Storable Propulsion

The Exploration Systems architecture presents propulsion challenges that require new technologies to be developed. Non-toxic engine technologies are being explored for use in lieu of the currently operational nitrogen tetroxide (NTO) and monomethylhydrazine (MMH) systems. Safety concerns with toxic propellants drive mission planners to the use of more costly propulsion modules that are fueled and sealed on the ground and can limit operational flexibility on the launch pad. There are also concerns with exhaust residue from toxic systems, which may be carried into habitats for lunar and Mars systems. To address these challenges, the focus will be on the development of cryogenic and non-toxic propulsion technologies to support informed decisions on implementation in the Exploration architecture. The major components of this effort will focus on reaction control systems, main engine, and deep throttling descent engines. A summary of some of the current activities is located at:

http://spaceflightsystems.grc.nasa.gov/Advanced/Capabilities/PCAD/

The anticipated technologies to be proposed are expected to increase reliability, increase system performance, and to be capable of being made flight qualified and certified for the flight systems to meet Exploration Systems mission requirements.

Subtopics

X10.01 Cryogenic and Non-Toxic Storable Propellant Space Engines

Lead Center: GRC

Participating Center(s): JSC, MSFC

This subtopic intends to examine a range of key technology options associated with cryogenic and non-toxic storable propellant space engines. The primary mission for the engines will be to support lunar ascent/descent reaction control engines and lunar ascent engines. These engines can be compatible with the future use of in situ propellants such as oxygen, methane, methanol, monopropellants, or other non-toxic fuel blends. Key performance parameters:

- Reaction control thruster development is in the 25-500-lbf thrust class with a target vacuum specific impulse of 325-sec. These RCS engines would operate cryogenic liquid-liquid for applications requiring integration with main engine propellants; or would operate gas-gas or gas-storable liquid for small total impulse type applications.
- Ascent engine development is projected to be in the 3,500-8,000-lbf thrust class with a target vacuum specific impulse of 355-sec. The engine shall achieve 90% rated thrust within 0.5 second of the issuance of the Engine ON Command.

Specific technologies of interest to meet proposed engine requirements include:

- Non-toxic fuel blends or monopropellants that meet performance targets while improving safety and reducing handling operations as compared to current state-of-the-art storable propellants.
- Low-mass propellant injectors that provide stable, uniform combustion over a wide range of propellant inlet conditions.
- High temperature materials, coatings and/or ablatives for injectors, combustion chambers, nozzles and nozzle extensions.
- Combustion chamber thermal control technologies such as regenerative, transpiration, swirl or other cooling methods which offer improved performance and adequate chamber life.
- Highly-reliable, long-life, fast-acting propellant valves that tolerate space and lunar environments with reduced volume, size, and weight is also desirable.
- Cryogenic instrumentation such as pressure and temperature sensors that will operate for months/years instead of hours.

Research should be conducted to demonstrate technical feasibility during Phase 1 and show a path toward a Phase 2 hardware demonstration, and when possible, deliver a demonstration unit for functional and environmental testing at the completion of the Phase 2 contract.