NASA SBIR 2018 Phase I Solicitation

Z10.01 Cryogenic Fluid Management

Lead Center: GRC

Participating Center(s): JSC, MSFC

Technology Area: TA2 In-Space Propulsion Technologies

This subtopic solicits technologies related to cryogenic propellants (such as hydrogen, oxygen, and methane) storage, and transfer to support NASA's exploration goals.Â This includes a wide range of applications, scales, and environments consistent with future NASA missions. Â Such missions include but are not limited to a Methane Upper Stage, Nuclear Thermal Propulsion, Lander Propulsion, and In-Situ Resource Utilization in support of the Evolvable Mars Campaign.

Specifically, listed in order of importance:

- Develop reliable cryogenic screen channel acquisition devices (NASA is mainly interested in screens with pore sizes < 100 Âµm) using innovative manufacturing techniques to minimize stresses of cryogenic screen channels to improve screen-to-window manufacturing reliability. Reliability should be based on changes in bubble point pressure before and after thermal cycling the elements (> 10 times) at or below 77 K.
- New and improved technologies that provide for the densification (or sub-cooling) of cryogenic propellants. Propellant conditioning systems that allow for the production and maintenance of densified propellants that support operations including transfer and low-loss storage are of prime interest for future space vehicle and ground launch processing facilities.
- Advanced numerical design tools are sought for cryogenic propellant management systems accounting for large EUS-scale operations in relevant low-gravity (low-acceleration) environments. Ideally, such a tool should consider thermal gradients, acceleration gradients, perturbations due to docking, and orbital maneuvers in order to help system designers evaluate the impacts of these various environments to the propellant management system. Advanced numerical design tools are sought for fuels/cryogenic management systems accounting for large EUS-scale operations in relevant low-gravity (low-acceleration) environments considering the impacts of thermal gradients, gravity gradients, perturbations due to docking, orbital maneuvers, self-gravitation, and others.
- Develop an insulation to reduce the heat leak in the annulus space of approximately Â¾â€, which is located over a liquid hydrogen tank but under a broad area cooled (BAC) shield at 90 K for space applications.Â The insulation concept has the dual function of structurally supporting the 5 mil thick broad area cooled shield and roughly 35-40 outer layers of traditional multi-layer insulation (MLI) (or less with high performing MLI) and reducing the heat leak from the 90K surface to the LH_2 tank.Â Analysis shall focus on the thermal designâ€™s reduction of conductive and radiative heat transfer in the vacuum of space to minimize heat load (> 70% reduction in insulation heat load compared to equivalent MLI system without BAC shield) to the tank while being lightweight for flight.
- System/stage cryogenicÂ valves sized for 3 in. (7.62 cm) tube sizeÂ for low pressure (<50 psia; 3.4 bar),

scalable to 10 in. (25.4 cm)Â size, with Cv > 200, low internal (~ 1 sccm, goal of < 0.1 sccm) and external (~ 3 sccm, goal of < 0.1 sccm) leakage, > 500 cycles with a goal of 5,000 cycles, low heat leak (<3 W/valve), low actuation power. The valve should have a clear path to combine with an actuator and its requirements.

- Electric Pump technologies with low power (<40-50 kW) at flowrates suitable for feeding iRCS accumulator(s) supplying a bank of four (4) 1000-lb RCS engines operating at total oxygen or methaneÂ mass flowrates of ~8-10 lb/s (3.6-4.5 kg/s), or Low power (<4-6 kW) supplying a bank of four (4) 100-lb RCS engines, operating at a total flowrate of ~1 lb/s (0.45 kg/s).Â The pumps will operate between low pressure (<50 psia; <3.4 bar) propellant tanks, up to supercritical pressures >667 psia (>46 bar) under varying duty cycle demand regimes. Note actual duty cycle requirements will be mission specific â€“ proposers should describe scalability to handle changes in demand, and changes in the scale of thrusters per thruster bank (e.g., 3x100-lb & 1x1000-lb, etc.).

Phase I proposals should at a minimum deliver proof of the concept including some sort of testing or physical demonstration (not just a paper study).Â Phase II proposals will be expected to provide component validation in a laboratory environment preferably with a hardware deliverable to NASA.