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. This includes a wide range of applications, scales, and environments consistent with future NASA missions. 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 µm) 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 considering the impacts of thermal gradients, gravity gradients, perturbations due to docking, orbital maneuvers, self-gravitiation, and others.
- Develop an insulation to reduce the heat leak in the annulus space of approximately ¾", which is located over a liquid hydrogen tank but under a broad area cooled (BAC) shield at 90 K for space applications. 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 LH₂ tank. Analysis shall focus on the thermal design’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 cryogenic valves sized for 3 in. (7.62 cm) tube size for low pressure (<50 psia; 3.4 bar), scalable to 10 in. (25.4 cm) 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 methane 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). 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 – 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). Phase II proposals will be expected to provide component validation in a laboratory environment preferably with a hardware deliverable to NASA.