NASA SBIR 2015 Phase I Solicitation

H2.04 Cryogenic Fluid Management for In-Space Transportation

Lead Center: GRC

Participating Center(s): JSC, MSFC

This subtopic solicits technologies related to cryogenic propellant (such as hydrogen, oxygen, and methane) storage, transfer, and instrumentation to support NASA's exploration goals. This includes a wide range of applications, scales, and environments consistent with future NASA missions. Specifically, listed in order of NASAâ€™s current priority:Â

- Simple mass efficient techniques for vapor cooling of structural skirts (aluminum, stainless, or composites) on large upper stages containing liquid hydrogen and liquid methane (can include para-to-ortho hydrogen catalyst for hydrogen applications).
- Lightweight, multifunctional cryogenic insulation systems (including attachment methods) that can survive exposure to the free stream during the launch/ascent environment in addition to high performance (less than 0.5 W/m^2 with a warm boundary of 220 K) on orbit or <5 W/m^2 on Mars surface.Â
- Advanced cryogenic spacecraft components including:
    - Valves (minimum Â½â€ tube size) for low (< 50 psi, Cv > 5, goal of 100+) pressure liquid hydrogen with 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).
    - Isolation valve/regulation (minimum Â½â€) for high pressure (>4500 psi) gaseous helium systems (< 70 K fluid, Cv > 2.1) with low internal (~ 1 sccm) and external (~ 3 sccm) leakage (> 500 cycles with a goal of 5,000 cycles).
    - Spherical all-composite 1-2 m diameter propellant tank for Mars application using LO_2/LCH_4; Pressure from 350-1000 psig; Temperature range from ambient to 77 K (LN_2); and Ghe permeability less than 1x10-4 $sccs/m^2$ (at 500 psi, 77 K).
- Micro-gravity cryogenic pressure control components for thermodynamic vent systems including:
    - Improved alternatives to state of the art spray bars for using fluid dynamics to collapse the ullage and thoroughly mix a propellant tank in micro-gravity.
    - Low voltage (28 VDC) two-phase flow tolerant mixing pumps of flow rates between 10 and 40 gpm.
    - Novel methods of packaging and manufacture to minimize feedthroughs to the tank and ease of installation into a tank.
- Innovative concepts for cryogenic fluid instrumentation including:
    - Fiberoptic and wireless concepts to enable accurate measurement (with minimal sensitivity to electromagnetic interference) of propellant pressures and temperatures in low-gravity storage tanks
    - Cryogenic pressure transducers (0 â€“ 50 psia typical range, 1% full scale accuracy, 0.5 Hz response) at 20 K.
    - Low power (< 15 W goal) video camera systems for viewing fluid dynamics within a propellant tank (3 â€“ 5 m diameter).
- Wicking materials or other novel methods/materials of liquid acquisition for use with liquid oxygen, liquid

methane, and liquid hydrogen for low temperature heat pipes or tank expulsion.

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.Â