



NASA SBIR 2011 Phase I Solicitation

X10 Cryogenic Propellant Storage and Transfer

The Exploration Systems architecture presents cryogenic storage, distribution, and fluid handling challenges that require new technologies to be developed. Reliable knowledge of low-gravity cryogenic fluid management behavior is lacking and yet is critical for future manned and robotic exploration in the areas of storage, distribution, and low-gravity propellant management. Additionally, Earth-based and planetary surface missions will require success in storing and transferring liquid and gas commodities in applications. Some of the technology challenges are for long-term space use cryogenic propellant storage and distribution; cryogenic fluid processing and fluid conditioning; liquid hydrogen and liquid oxygen liquefaction processes. Furthermore, specific technologies are required in valves, regulators, instrumentation, modeling, mass gauging, cryocoolers, and passive and active thermal control techniques. The technical focus for component technologies are for accuracy, reduced mass, minimal heat leak, minimal leakage, and minimal power consumption. The anticipated technologies proposed are expected to increase safety, reliability, economic efficiency over current state-of-the-art cryogenic system performance, and are capable of being made flight qualified and/or certified for the flight systems and dates to meet Exploration Systems mission requirements.

Subtopics

X10.01 Cryogenic Fluid Management Technologies

Lead Center: GRC

Participating Center(s): ARC, GSFC, JSC, KSC

This topic solicits technologies related to cryogenic propellant storage, transfer, and instrumentation to support NASA's exploration goals. Proposed technologies should feature enhanced safety, reliability, long-term space use, economic efficiency over current state-of-the-art, or enabling technologies to allow NASA to meet future space exploration goals. This includes a wide range of applications, scales, and environments consistent with future NASA missions. Specifically:

- Innovative concepts for cryogenic fluid instrumentation are solicited to enable accurate measurement of propellant mass in low-gravity storage tanks, sensors to detect in-space and on-pad leaks from the storage system, minimally invasive cryogenic liquid mass flow measurement sensors, including cryogenic two-phase flow.

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- Passive thermal control for Zero Boil-Off (ZBO) storage of cryogenics for both long term (>200 days) and short term (~14 days) in all mission environments. Insulation systems that can also serve as Micrometeoroid/orbital debris (MMOD) protection and are self-healing are also desired.
 - Active thermal control for long term ZBO storage for space applications. Technologies include 20K cryocoolers and integration techniques, heat exchangers, distributed cooling, and circulators.
 - Zero gravity cryogenic control devices including thermodynamic vent systems, spray bars, mixers, and liquid acquisition devices.
 - Advanced spacecraft valve actuators using piezoelectric ceramics. Actuators that can reduce the size and power while minimizing heat leak and increasing reliability.
 - Large scale propellant conditioning and densification technologies for zero loss propellant storage and transfer. Specific component technologies include compact, efficient and economical cryogenic compressors, cryocoolers and integration techniques, Joule-Thompson orifices, vapor shielded transfer lines, and heat exchangers.
 - Liquefaction of oxygen for in space resource utilization applications. This includes passive cooling with low temperature radiators, cryocooler liquefaction, or open cycle systems that work with HP electrolysis.
 - Processes or components/instrumentation that can reduce or eliminate helium usage. This includes real time purge gas concentration visibility, helium capture and purification technology, and alternatives to helium use such as hydrogen gas purges or advanced insulation systems.