NASA SBIR 2009 Phase I Solicitation

X8.02 Cryogenic Instrumentation for Ground and Flight Systems

Lead Center: GRC

Participating Center(s): JPL, KSC, MSFC, SSC

This subtopic includes technologies for reliable, accurate cryogenic propellant instrumentation needs in-space, on the lunar surface, and on the Earth. Innovative concepts are requested to enable accurate measurement of cryogenic liquid mass in low-gravity storage tanks, to enable the ability to detect in-space and on-pad leaks from the storage system, and to address other cryogenic instrumentation needs. Cryogenic propellants such as hydrogen, methane, and oxygen are required for many current and future space missions. Proposed technologies should offer enhanced safety, reliability, or economic efficiency over current state-of-the-art, or should feature enabling technologies to allow NASA to meet future space exploration goals.

Propellant mass gauging provides accurate measurement of cryogenic liquid mass (LH_2, LO_2, and LCH_4) in low gravity storage tanks, and is critical to allowance of smaller propellant tank residuals and assuring mission success. Both low-gravity gauging (measurement uncertainty

Leak detection technologies impact cryogenic systems for space transportation orbit transfer vehicles, lunar surface, and launch site ground operations. These systems will be operational both in atmospheric conditions and in vacuum with multiple sensor systems distributed across the vehicle or a region of interest to isolate leak location. Methane and hydrogen leak detection sensors with milli-second response times and 1 ppm detection sensitivity in air are desired for ground and launch operations.

Other cryogenic instrumentation needs include:

- Miniature cryogenic pressure sensors (0 - 1 atm) for use under MLI blankets.
- Zero dead-volume in-line pressure sensors for use in liquid hydrogen flow streams.
- Real-time in-situ measurements of ppm levels of N_2, O_2, and H_20 in gaseous helium purge streams. Sensors that can survive the temperature range 20 K - 300 K and the vibration loads on a launch platform are especially desired.

- Minimally intrusive in-situ measurements of liquid hydrogen and liquid oxygen purity levels in real time. The goal is to accurately measure cryogenic propellant liquid purity levels (99% - 100% purity) in ground test stands during test operations. Helium and nitrogen impurity levels are of specific interest, but the sensors must be able to measure overall purity level of the cryogenic liquid.

- Minimally invasive cryogenic liquid flow measurement sensors for rocket engine feed lines, and sensors to detect and quantify two-phase flow (bubbles) within the feed lines.

- Non-intrusive flowmeters for high-pressure (up to 6,000 psi) gaseous helium distribution lines are sought for flow rates ranging from a trickle flow up to 1500 SCFM. Ultrasonic clamp-on flowmeters are especially desired, but must be able to sense the flow through 2" Schedule-XX pipe (0.436" wall thickness).

- Position indicators and long life application of the instrumentation for deep space missions.