Long Term Cryogenic Propellant Storage, Management, and Acquisition

Lead Center: GRC

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

This subtopic includes technologies for long term cryogenic propellant storage, management and acquisition applications in-space as well as on the lunar surface. These technologies will impact cryogenic systems for space transportation orbit transfer vehicles, space power systems, spaceports, spacesuits, lunar habitation systems, robotics, and in situ propellant systems. Each of these applications has unique performance requirements that need to be met. The sizes of these systems range from the small (3 for supercritical air and payload cooling) to very large (> 3400 m$^3$ for LOX and LH$_2$ propellant storage). Advanced cryogenic technologies are being solicited for all these applications. 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.

Technology focus areas are divided as follows: fluid transfer/liquid acquisition devices, mass gauging/advanced instrumentation, passive systems, storage and distribution components, and refrigeration systems. Innovative concepts are requested for cryogenic insulation systems, fluid system components, and instrumentation. Cryogenic propellants such as hydrogen, methane, and oxygen are required for many current and future space missions. Operating efficiency and reliability of these cryogenic systems must be improved considering the launch environment, operations in a space environment, and system life, cost, and safety. This subtopic solicits unique and innovative concepts in the following technologies:

Fluid Transfer/Liquid Acquisition Devices

Liquid acquisition devices capable of preventing gas ingestion into engine feed lines in low gravity, analytical models of LAD’s to predict LAD performance in low gravity and to determine the effect of autogenous/non-autogenous pressurants on LAD wicking capability, techniques to minimize vaporization inside the LAD channel caused by incident heating through tank wall/lines and/or changes in tank pressure.

Mass Gauging/Advanced Instrumentation

Methods of determining liquid quantity gauging in propellant tanks in low gravity, high accuracy differential pressure transducers which can operate submerged in liquid cryogen and in-space fluid leak detectors.
Passive Systems

Advanced insulation technology including low loss cryogenic propellant tank penetrations and insulation materials capable of retaining structural integrity while accommodating large operating temperatures ranging from cryogenic to elevated temperature conditions, advanced tank support systems capable of supporting tanks during the launch environment, but decoupling on-orbit to minimize thermal loads and passive thermal control designs for cryogenic fluid storage on the lunar surface.

Storage and Distribution Components

Advanced low-gravity submersible pumps and helium compressors designed specifically for in-space cryogenic operation, low heat leak cryogenic quick disconnects capable of sealing against the vacuum of space, long-life, low power valves for LO$_2$ and LH$_2$ capable of sealing at cryogenic temperatures, being cycled many times without consuming pressurant gas and with minimal thermal loss and pressure drop.

Refrigeration Systems

Advanced LO$_2$ and LH$_2$ cryocooler concepts for in-space operation that are reliable, lightweight, low input power and capable of removing 5 to 10 watts of heat at 77 K and at 20 K, respectively, concepts to integrate Broad Area Cooling (removing heat over large areas and long distances) into in-space storage of LO$_2$ and/or LH$_2$ and heat exchanger designs for large-scale storage systems designed densification of LO$_2$ and LH$_2$. 