Active Project (2015 - 2017)

Cellular Load Responsive MLI: Structural In-Air and In-Space LH2 Insulation, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Advanced space propulsion systems are a critical need for future NASA deep space missions. High thrust engines could revolutionize space exploration. Nuclear Thermal Propulsion ("NTP") is a high thrust/high Isp propulsion technology. Reduced or Zero Boil Off of LH2 propellant for long duration missions is among the critical technology advancements needed for cryogenic propellant storage for both NTP and chemical propulsion. Quest proposes to continue development of Cellular Load Responsive MLI (CLRMLI), an innovative, high performance thermal insulation system. CLRMLI is a novel technology with a cryopumping cellular core containing Load Responsive MLI layers. This new form of insulation uses cryosorption cryopumping to self-evacuate when in contact with cryogenic propellant tanks, allowing high thermal performance in-air and in-space. The Phase I program successfully demonstrated CLRMLI is a feasible and attractive insulation for new launch vehicle platforms and LH2 or LNG powered aircraft. CLRMLI has a measured heat flux of 11.4W/m2, 25X lower than SOFI (vacuum). NASA's Technology Roadmaps call "Zero Boil Off storage of cryogenic propellants for long duration missions" and "Nuclear Thermal Propulsion components and systems" the

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: CLRMLI is a novel high performance thermal insulation offering dramatically better thermal performance than SOFI both in-air and in-space. CLRMLI could be a good SOFI replacement for launch vehicle platforms, such as SLS, where it could help solve cryogenic propellant boiloff concerns. SLS is baselining using SOFI at 1.2", nearly double the usual thickness, to reduce boiloff. CLRMLI, with a measured heat flux of 46 W/m2 in-air and 11 W/m2, offers much lower heat leak than SOFI (289 W/m2). Boeing has indicated strong interest in CLRMLI (and the companion VCMLI

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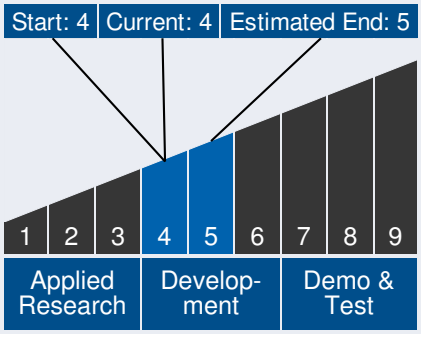
Technology Maturity



concept), and will support this Phase II work with engineering support. CLRMLI could benefit NASA for LH2 storage for long duration nuclear thermal propelled vehicles for deep space exploration, as well as cryogenic propellant storage for conventional LH2/LOX chemical propulsion systems. NASA's Technology Roadmaps call "Zero Boil Off storage of cryogenic propellants for long duration missions" and "Nuclear Thermal Propulsion components and systems" the #2 and #7 ranked technical challenge for future NASA missions. CLRMLI could provide 92% lower heat flux than current SOFI insulation for in-air use and 97% lower heat flux in-space. CLRMLI might be a preferred thermal insulation for future NASA mission use, with a combination of high thermal performance, good structural strength, operable in both in-air and in-space environments, and it can be engineered for specific mission requirements.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Several aerospace prime contractors have interest in Quest/Ball IMLI and related insulation systems. CLRMLI could significantly improve launch vehicle insulation, reduce cryopropellant boiloff and increase mission capabilities. High performance CLRMLI system can replace SOFI in cryogenic upper stages such as AC, ACES and SLS. CLRMLI is ideal insulation for LH2 powered aircraft such as Boeing's Phantom Eye, and for LNG fueled aircraft. Advances in thermal insulation developed for space cryogenics thermal control have relevance to terrestrial industrial applications. Reducing thermal conductivity and heat leak could have significant impact on Earth-based heating and cooling industrial processes and needs, for green energy and high energy efficiency. IMLI and derivatives might be able to provide improved thermal insulation for storage and preservation of cryogens for a variety of industrial uses. LNG tanks could benefit from improved thermal insulation, and CLRMLI might benefit LH2 storage for hydrogen fueled aircraft and ground vehicles.

Management Team

Program Executives:
- Joseph Grant
- Laguduva Kubendran

Program Manager:
- Carlos Torrez

Principal Investigator:
- Scott Dye

Technology Areas

Primary Technology Area:
Thermal Management Systems (TA 14)
└ Cryogenic Systems (TA 14.1)
  └ Passive Thermal Control (TA 14.1.1)
    └ Load Responsive Insulation (TA 14.1.1.1)

Secondary Technology Area:
In-Space Propulsion Technologies (TA 2)
└ Supporting Technologies (TA 2.4)
  └ Propellant Storage and Transfer (TA 2.4.2)

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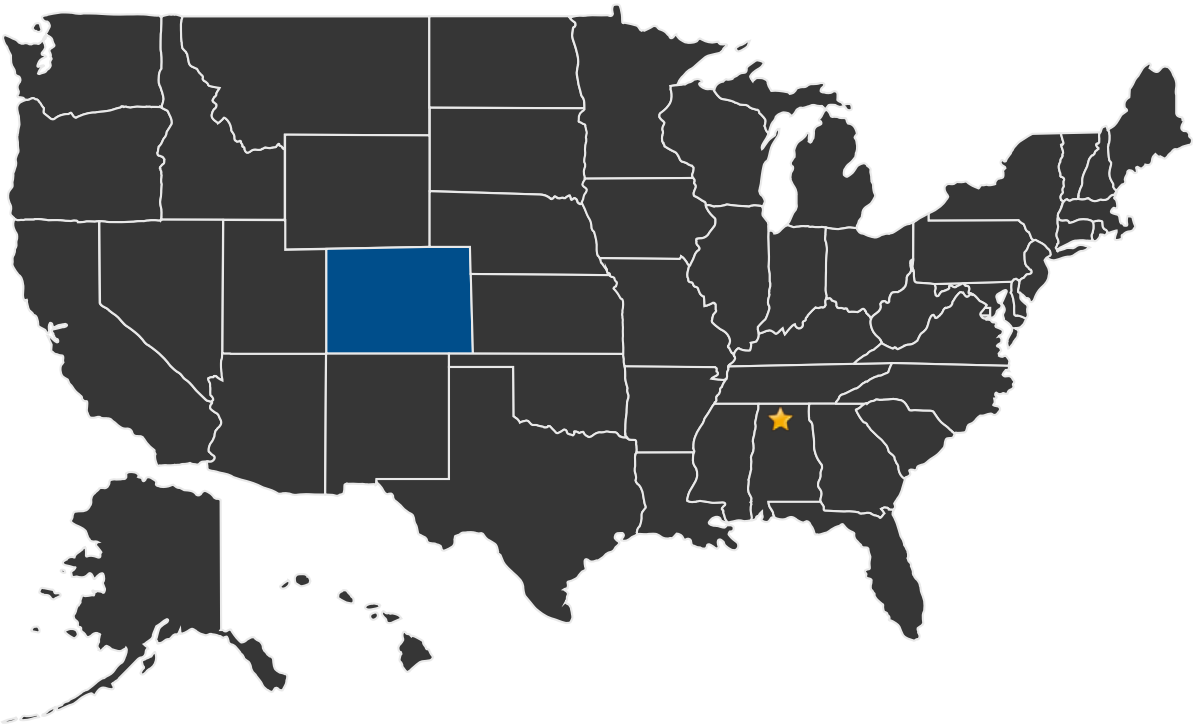
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Marshall Space Flight Center

Other Organizations Performing Work:

- Quest Thermal Group (Arvada, CO)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17799)

DETAILS FOR TECHNOLOGY 1

Technology Title

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