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Quest presents paper on Load Responsive MLI Phase II results at Space Cryogenics Workshop

Aerospace cryogenic systems require lightweight, high performance thermal insulation to preserve cryopropellants both pre-launch and on-orbit. Current technologies have difficulty meeting all requirements, and advances in insulation would benefit cryogenic upper stage launch vehicles, LH_2 fueled aircraft and ground vehicles, and provide capabilities for sub-cooled cryogens for space-borne instruments and orbital fuel depots. This paper reports the further development of Load Responsive MultiLayer Insulation (LRMLI) that has a lightweight integrated vacuum shell and provides high thermal performance both in-air and on-orbit.

LRMLI is being developed by Quest Thermal Group and Ball Aerospace under NASA contract, with prototypes designed, built, installed and successfully tested. A 3-layer LRMLI blanket (0.63cm thick, 77°K cold, 295°K hot) had a measured heat leak of 4.81 W/m^2 in vacuum and 29.1 W/m^2 in air at one atmosphere. In-air LRMLI has an 24X advantage over Spray On Foam Insulation (SOFI) in heat leak per thickness and a 22X advantage over aerogel. On-orbit LRMLI has a 144X lower heat leak than SOFI per thickness and 8X lower heat leak than aerogel.

The Phase II development of LRMLI is reported with a modular, flexible, thin vacuum shell and improved on-orbit performance. Structural and thermal analysis and testing results are presented. LRMLI mass and thermal performance is compared to SOFI, aerogel and MLI over SOFI.