Air Force Research Laboratory Spacecraft Cryocooler Endurance Evaluation **Facility Closing Report**

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The Air Force Research Laboratory (AFRL) Spacecraft Component Thermal Research Group has been devoted to evaluating lifetime performance of space cryocooler technology for over twenty years. Long-life data is essential for confirming design lifetimes for space cryocoolers. Continuous operation in a simulated space environment is the only accepted method to test for degradation. AFRL has provided raw data and detailed evaluations to cryocooler developers for advancing the technology, correcting discovered deficiencies, and improving cryocooler designs. At AFRL, units of varying design and refrigeration cycles were instrumented in state-of-the-art experiment stands to provide space-like conditions and were equipped with software data acquisition to track critical cryocooler operating parameters. This data allowed an assessment of the technology's ability to meet the desired lifetime and documented any longterm changes in performance. The data summarized includes the seven cryocoolers tested during 2014-2015. These seven coolers have a combined total of 433,326 hours (49.5 years) of operation.



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Tom Fraser AFRL Space Vehicles Directorate

NGST MPT

To lift 1 W at 150 K requires greater than 5.5% more input power than initially required.

Cooler

NGAS HEC NGAS MPT NGAS HCC NGAS 6020 Ball 35/60 Sunpower CT L3 B1500



No change in cooler operation

A 0.3 W load applied to both the middle stage and cold tip, results in a 27.25% increase in cold tip temperature (rising from 36.2 K to 46.07 K) and a 5% increase in mid stage temperature (rising from 55.3 K to 58.03 K) when compared to the original load line testing



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Cold end (K)	Heat Load W	Reject (K)	Lifetime Hours (3/12/15)
95	10	300	80,128
150	1.0	300	82,858
35/85	2.0/17.0	300	34,120
60	2.0	300	103,421
35/60	0.4/0.6	300	87,216
77	4	300	6,603
110	2	300	38,980



NGST HCC No noticeable change in cooler operation

2015 marks the end of cryocooler characterization at AFRL. SCTR would like to thank AFRL for funding the endurance work started under Missile Defense Agency (MDA) over the years. We would also like to thank Ball Aerospace, Northrup Grumman and Raytheon for their many conversations and help with the coolers described here.

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