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C3Po1B-06: Development of a Portable Stand-Alone 20 K Brayton Cycle Helium Refrigeration System

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Development of a Portable Stand-Alone 20 K Brayton Cycle Helium Refrigeration System
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From 2012 to 2015, NASA funded development of the Ground Operations Demonstration Unit for Liquid Hydrogen (GODU-LH2) at Kennedy Space Center that scaled up and matured Integrated Refrigeration and Storage (IRAS) technology. IRAS involves the integration of an external helium refrigeration system with a cryogenic storage tank via an internal heat exchanger, and allows advanced operations such as zero boiloff and densification of the liquid. The refrigeration system employed for GODU-LH2 was a Linde LR1620 piston-Brayton cycle machine with an RSX helium compressor. Rated capacities for the LR1620/RSX are 390 W at 20 K without liquid nitrogen (LN2) precooling, and 880 W with precooling; actual performance of the GODU-LH2 unit was 883 W and 466 W with and without precooling respectively. The GODU-LH2 system was broken up into two separate shipping containers—one housing the cold-box, compressor, and gas management hardware, and the other the water chiller unit—with 480 VAC and 120 VAC electrical power fed from external hardware at the test site, and data capture and controls achieved using four different, independent software packages. From 2017 to 2019, in support of a densified hydrogen loading test program, the entire system was repackaged in to a single, 40'(12 m) shipping container, including the refrigeration system, water chiller, and electrical power distribution hardware, and controls were consolidated into a single Allen Bradley PanelView. This new system constitutes an easily portable, stand-alone, 20 K Brayton cycle helium refrigeration system, with the only external interfaces being vacuum jacketed helium lines to/from the cold-box, 480 VAC electrical power, LN2 feed, and shop air or nitrogen pressure for valve actuation. Details regarding the design, build-out, and testing of the system will be presented and discussed.

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