**21-3: Development Unit for In-Space Pneumatic Helium Transfer Compressor**

**Project PI:** Brian Nufer (brian.nufer@nasa.gov)

**Activity Type:** New Start

**Primary STMD Taxonomy:** TX13.1.4 Propellant Production, Storage and Transfer

**Start TRL:** 2 **End TRL:** 3

**Executive Summary:** High-pressure gaseous helium (GHe) plays a critical role in spacecraft propulsion due to its near exclusive use for pressurization of propellant tanks. Several different designs for helium compressor technologies have been developed for use on Earth; however, significant design changes are required to meet the power, thermal/heat dissipation, vacuum, vibration/shock, size, mass, and efficiency requirements needed for space and launch environments. Currently, no capability exists for mass efficient on-orbit GHe (or xenon) transfer, nor has it ever been attempted. This effort proposed several challenging requirements for the vendor to develop a one-of-a-kind pneumatic compressor prototype.

In order to develop a compressor prototype at a TRL 4, a partnership with Air Squared, Inc. was established. This CIF project concluded with the receipt of a prototype along with a proposed design for a flight unit; however, it will not be built due to funding limitations.

The vendor had moderate success with initial testing of the prototype at lower pressures (with shimming configured for low pressure). There were delays with testing since the unit was built for higher pressures and the low pressure shimming was challenging to implement. It was found that operation of the compressor at lower pressures caused increased friction on the motor shaft which resulted in the unit drawing more power (current). This was initially thought to be a motor or controller defect. Subsequent high pressure testing at KSC showed that the friction was reduced for the optimal design point (with a high pressure shimming configuration) and the motor (and controller) performed nominally. Following the vendor testing, the unit was tuned/shimmed for a nominal inlet pressure and shipped to KSC for high pressure testing using the custom-designed setup in the Vehicle Assembly Building. The unit performed well, showing the capability to achieve over higher pressure of compression. The pressure differential could likely increase, however, the maximum output of the power supply used for testing was reached, limiting the compressor motor’s capability. Following the GN2 testing, the test setup was converted to GHe with at high pressure. It was shown that although the unit was unable to achieve similar high pressure differentials due to reverse leakage of the GHe through the scroll tip seals, it did achieve the desired GHe compression. This may still be useful for some applications, however, for the purpose of on-orbit GHe transfer, the single stage design would need to be changed to include multiple stages to achieve the compression goals initially proposed by the project.