Department of the Navy SBIR/STTR Transition Program

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NAVSEA #2024-0349

Topic # N211-041
Tactical Cryogenic Cryocooler for HTS Applications
Creare LLC

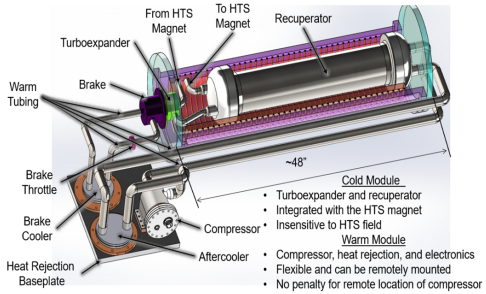
WHO

SYSCOM: NAVSEA

Sponsoring Program:

Transition Target:

TPOC: (215) 897-7556



Other Transition Opportunities: As the Navy demands increase the production rate above several cryocoolers per year, Creare will seek to establish strategic partnerships with production vendors that can produce the turbomachines (or critical components thereof) in quantity. For other efforts Creare would act as the cryocooler system integrator working with several of our partner vendors who have the required capabilities to manufacture and distribute operational systems.

Notes:

WHAT

Operational Need and Improvement: Commercial regenerative cryocoolers are the baseline approach for current Navy HTS applications. However, these cryocoolers can not operate near a magnetic field, and they can require large and bulky vacuum jacketed transfer lines and external cryogenic circulation loops to provide refrigeration to the HTS magnet. Moreover, they fall short on achieving the cryogenic cooling requirements (~100 W) that are needed for future tactical HTS magnets. Because their individual cryocooler components are not physically separable, COTS cryocoolers are also very difficult to integrate into compact tactical HTS magnet system designs. Lastly, COTS cryocoolers cannot readily survive the harsh shipboard environment or operate near the HTS magnetic fields that approach 2T.

Our development approach combines novel cryocooler integration approaches with our reverse Brayton cryocooler. This architecture allows the overall system to be configured to meet a broad range of refrigeration, integration, and environmental requirements that are not achievable by other types of cryocoolers.

Specifications Required: Scalable, compact, high-efficiency, low-cost cryocooler compatible with maritime environments.

Technology Developed: A compact and highly efficient cryocooler that combines novel integration approaches with our reverse-Brayton cryocooler (RBC). The key cryocooler components include two turbocompressors with aftercoolers and drive electronics; a compact, high effectiveness recuperator; and a turboexpander comprised of an integrated turbine and compressor brake which has the advantage of containing no components with magnetic susceptibility, or alternatively, a turboalternator that utilizes a small generator to absorb the work of the gas expansion. The RBC architecture allows the overall system to be configured to meet a broad range of refrigeration, integration, and environmental requirements that are not achievable by other types of cryocoolers.

Warfighter Value: Our solution provides superior cryocooling for Fleet vessels.

WHEN

Contract Number: N68335-23-C-0751 **Ending on:** Sep 25, 2024

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Concept developed, System requirements defined	Medium	Phase II Award	3	1st QTR FY23
Fabrication trials complete	Medium	Established reduced cost, and weight, is feasible	3	1st QTR FY23

HOW

Projected Business Model: Initial production units will be provided by Creare, as we anticipate that initial production rates will be relatively low (i.e., several units per year). During this time, Creare would likely produce the turbomachines using primarily in-house facilities and personnel resources. We currently anticipate using commercial heat exchanger technology to minimize unit cost. Creare would act as the cryocooler system integrator and work directly with the HTS system integrator to integrate the cryocooler with the HTS machine or other HTS system. This general strategy is very similar to the approach we currently use for our spacecraft cryocoolers.

Company Objectives: The primary goal of the overall program is to quickly transition the technology into the HTS degaussing, minesweeping, and power systems at the Naval Surface Warfare Center and other military or commercial end users. A key element of our transition approach is a Phase II demonstration to provide the cooling requirements for the Navy's HTS magnetic systems. Such a demonstration is possible in a Phase III program. Once the technology has been demonstrated in the laboratory environment, we will work with the Navy under a Phase III program to transition the technology into the commercial marketplace.

Potential Commercial Applications: -Power Transmission. In the civilian field, superconducting transmission lines are a good example of a very large potential market with a need for this technology. Losses in the power grid cost the nation more than $10 billion annually. Nearly half of this loss may be recovered if standard copper transmission cables are replaced with HTS cables.
-Commercial Ship Propulsion. HTS motors for commercial ship drives have substantial potential to improve propulsion efficiency and ship maneuverability. The greatest potential benefit is in pod propulsion systems where there are numerous secondary benefits provided by an HTS motor.
-Power Conditioners and Generators. HTS generators for utility power generation have many attractive features such as substantially higher efficiency and a smaller footprint.

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