

A Turbo-Brayton Cryocooler for Aircraft Superconducting Systems

Designed to lower aircraft emissions, fuel consumption, and noise

Hybrid turboelectric aircraft—with gas turbines driving electric generators connected to electric propulsion motors—have the potential to transform aircraft design. Decoupling power generation from propulsion enables innovative aircraft designs, such as blended-wing bodies, with distributed propulsion. These hybrid turboelectric aircraft have the potential to significantly reduce emissions, decrease fuel burn, and reduce noise, all of which are required to make air transportation growth projections sustainable. The power density requirements for these electric machines can only be achieved with superconductors, which in turn require lightweight, high-capacity cryocoolers.

Creare, Inc., designed, built, and tested two compact, lightweight, high-performance recuperators for the Cryoflight turbo-Brayton cryocooler. This will provide an enabling technology for the superconducting systems needed for hybrid turboelectric aircraft to be feasible.

Applications

NASA

The highly reliable and space-proven turbo-Brayton cryocooler is ideal for the following NASA applications:

- ▶ Aircraft demonstrations:
 - Design trade studies
 - System demonstrations
 - Superconducting aircraft demonstrations
- ▶ Cryogen liquefaction and storage for:
 - Planetary and extraterrestrial exploration missions
 - Crew exploration vehicles
 - Extended-life orbital transfer vehicles
 - Inspace propellant depots
 - Extraterrestrial bases
- ▶ Cooling for spaceport cryogen storage and transportation systems:
 - Demonstrations of hydrogen production and transportation systems

Commercial

The cryocooler is ideally suited for situations where high-temperature superconducting (HTS) materials are used, including:

- ▶ Power conditioning and power transmission systems
- ▶ Large-scale offshore wind turbines
- ▶ High-efficiency data centers
- ▶ Navy ship systems
- ▶ Turboelectric aircraft

Beyond HTS, this technology also can be used in the following applications:

- ▶ Cooling for laboratory and industrial-scale gas separation, liquefaction, cryogen storage, and cryogen transportation systems
- ▶ Liquid hydrogen fuel cell storage for the automotive industry
- ▶ Commercial orbital transfer vehicles and satellites



Phase II Objective

- ▶ Develop and demonstrate a compact, lightweight recuperator optimized for a turbo-Brayton cryocooler for hybrid turboelectric aircraft

Benefits

- ▶ Reduces CO₂ emissions
- ▶ Decreases fuel consumption
- ▶ Lowers noise

Firm Contact

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