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Cryogenic system options for a superconducting aircraft propulsion system

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Environmental and economic pressures lead to a need, in the aerospace industry, to develop ever more efficient passenger aircraft. Further progress in this regard may necessitate a move away from the conventional configurations seen today toward more radical designs. Aircraft with distributed propulsion may lead to fuel savings by allowing the exploitation of aerodynamic improvements. However, the transfer of propulsive power in the order of MW and 10s of MW poses significant challenges. A fully superconducting electrical system, from generators through distribution to fan motors, may be light and efficient enough to allow such a system to be economical in the future, but the provision of cryogenic temperatures in an aircraft is expected to be the greatest hurdle to its successful implementation. Losses at cryogenic temperatures in the order of kW must be expected.

A consortium consisting of Airbus Group Innovations, Rolls-Royce and Cranfield University are involved in the Distributed Electrical Aerospace Propulsion (DEAP) project. The use of a superconducting power architecture aboard a distributed propulsion aircraft is considered, to study the possible benefits and drawbacks such a system could bring about at an aircraft level. The inevitable increase in system weight and the cryogenic system's power consumption must not be so high as to offset the aerodynamic and propulsive gains of the new aircraft configuration.

This paper will examine the cryocooling system choices that were considered in the DEAP project. Both a system with cryocoolers and a liquid methane heat sink, as well as a liquid hydrogen system will be compared and the advantages and challenges to their use in passenger aircraft will be discussed. The impact of the system's efficiency and mass on the aircraft's viability will be detailed. Technology targets for the successful implementation of superconducting aircraft will be presented to the community.

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