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M2Po2A-02: Design of a 40-MW-Class Electric Wire Interconnect System for Liquid-H2 Fuel-cell Aircraft Propulsion

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The aerospace industry is the last major transportation industry working to implement hybrid-electric technology for propulsion. Nearly exponential growth is occurring recently for electric aircraft, with reportedly with more than 600 vehicles being developed as of 2022. As of Jan 2023, pre-orders for electric aircraft exceeded 8,900 aircraft and $52B sales, even though only a handful of electric aircraft have been certified for flight so far.

The electric-wire-interconnection-system (EWIS) of an electric drivetrain is known to have by-far the largest mass fraction of an electric system, and can be 2-3% by weight of entire aircraft. This paper studies the EWIS of a 40-MW-class electric drivetrain, and compares different wire technologies including cryogenic metals, superconductors, and 'conventional'metals at ambient temperatures. The mass and heat loss scaling laws of the components of the electric drivetrain are presented for varying power/voltage/ampacity levels (0-20 kA) and power-wire distribution architectures. Electric power system components studied thus far include metal conductors (Cu-clad-Al (CCA), Al 99.999% 'hyperconductor'), busbars, current leads, superconducting wires of various materials including (Y,RE)-Ba-Cu-O, tee-junctions, circuit breakers, fault-current-limiters, low/high voltage insulation, and cryoflex tubing. A weight and efficiency analysis of a 40 MW EWIS system will be provided, and material options for will be compared. Some of the complexities of cooling the EWIS system using cryo-liquids or cryo-gases, will be described.

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