

Electrical System Trade Study for SUSAN Electrofan Concept Vehicle

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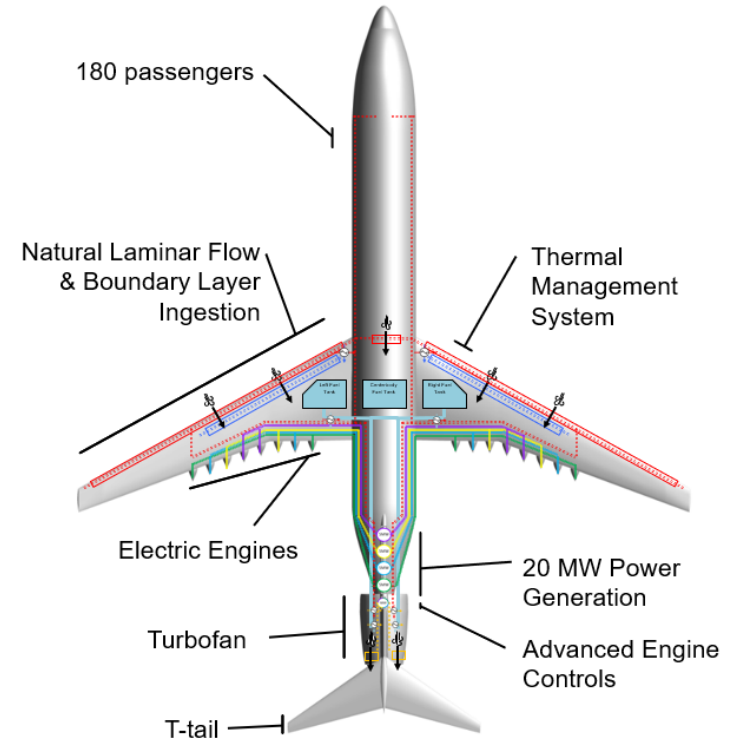
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Overview

- SUSAN Overview
- SUSAN EAP benefits
- Electrical System Overview
 - Architecture
 - Components
- Trade Studies
- Component Requirements
- Conclusion and Future Work

SUSAN Overview

- **S**ubsonic **S**ingle **A**ft **e**ngine
- Single turbofan engine
- 16 distributed electric engines
- End-to-end efficiency of ~95%
- Specific power 5-10x higher than SOA

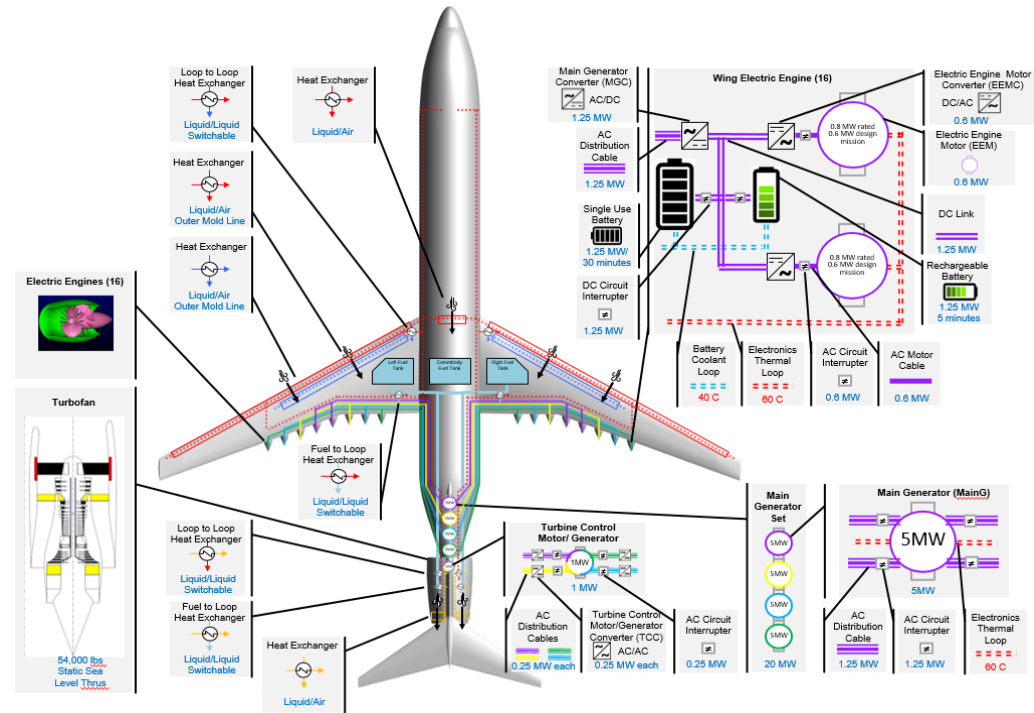


SUSAN EAP Benefits

- SUSAN Electrofan employs a hybrid EAP system to enable:
 - Single turbofan operation on a large transport category aircraft
 - Increased aerodynamic and propulsive efficiency through placement of electric engines
 - Optimized turbofan sizing and efficiency through control and electric boosting
 - Reduced control surface sizing through thrust augmentation

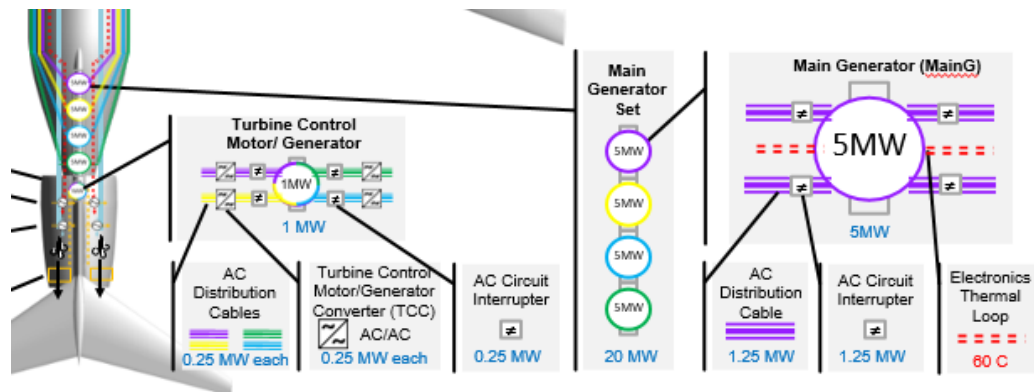
Electrical System Overview

- 20MW generation
- (16) electric engines
- (8) on each wing
- Each consists of (2) counter-rotating motors
- Rechargeable batteries
- Single-use batteries



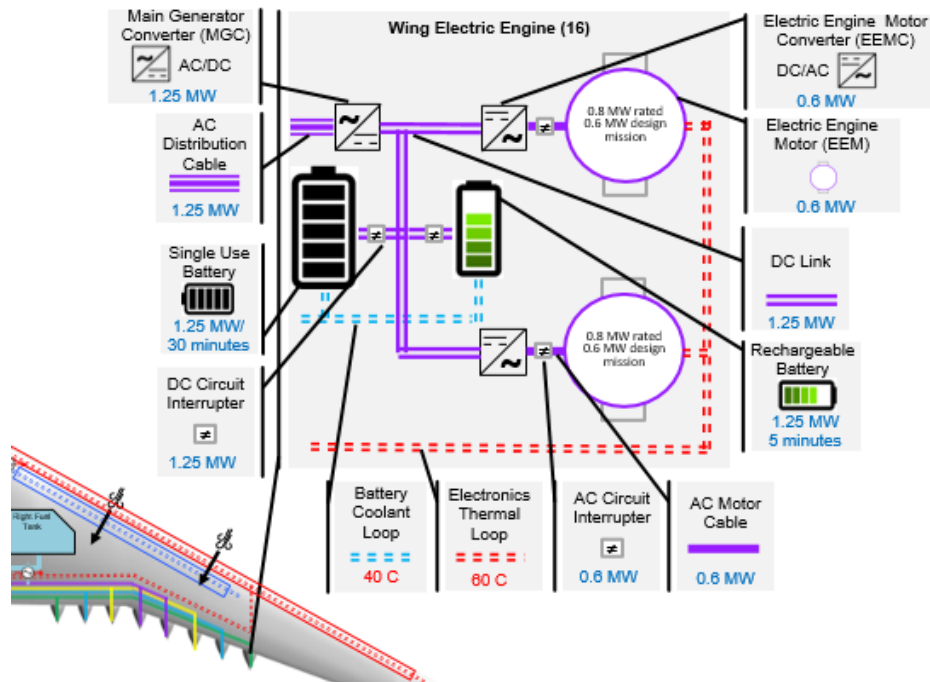
Electrical System Overview, Components

- Generation portion
- (4) 5MW machines
 - Driven by turbofan LPS
- (1) 1MW machine
 - Driven by turbofan HPS
- (4) AC/AC converters
 - 0.25MW each



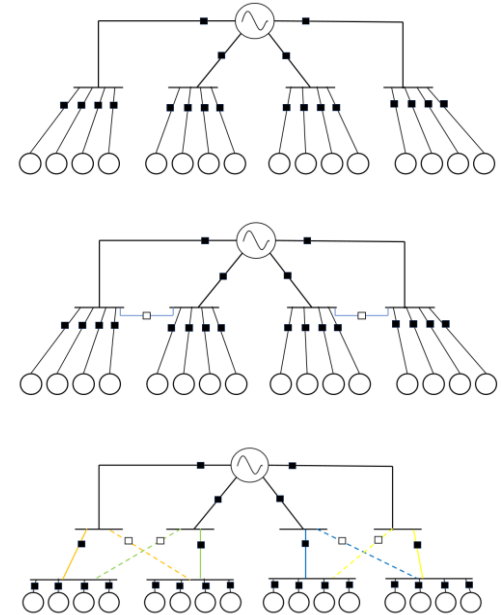
Electrical System Overview, Components

- Electric engine portion
- (16) electric engines
 - Each consists of (2) counter-rotating motors
- Single-use batteries
- Rechargeable batteries
- AC/DC-link/AC converter



Trade Studies, Architecture

- Three architectures considered
 - Direct distribution
 - Bus tie
 - Multifeeder
- Four buses assumed for this trade
- Trade based on complexity, weight, and redundancy
- Direct distribution chosen



Trade Studies, Number of Buses

- 1, 2, 4, 8, and 16 buses traded
- Trade based on weight and redundancy
- Key takeaway: higher number of buses results in lower weight penalty to account for a failed bus
- Results show that 16 bus architecture provides the lowest weight and highest redundancy

Component Requirements

- All components must have very high specific energy and efficiency
 - High specific energy → Lower weight
 - High efficiency → Less heat
- Electric machines must be up to 25kW/kg with 99% efficiency
- Converters must be up to 30kW/kg with 99% efficiency
- Multiple efforts to improve these key technologies are underway

Conclusion and Future Work

- Overall architecture and required components identified
- Two trade studies performed to optimize weight and redundancy
- Required energy densities and efficiencies identified
- Future work
 - Voltage Level
 - AC vs DC Distribution
 - Secondary Loads



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