Electric Propulsion (EP) Roadmap Topic Content Workshop Output

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Active Participation in F39.05/Tom Gunnarson (and F44 for integration)

Certification standards that capture the unique attributes of EP (single engine-out/failure/stall criteria, redundancy guidelines, partial energy loss, PAI effects).

Standards: Energy load management/bus, recharge connectors, power quality, energy state/reserve determination and interface to pilot decision making, fault accommodation management (potential for re-use of existing standards?)

Hybrid technologies (series/parallel architecture investigations), APU range extender (for cruise or for takeoff/landing augmentation) certification of non-flight critical and re-use of automotive engines (as TSO-like component?) manufactured with QA revisions, sensitivities of power split

Studies of optimal electric trajectories (constant GW vehicles without lapse)

Heat rejection/radiator design with low quality heat (and other unique attributes relating to electric propulsion thermal management)

Reserve requirements specific to short range electric aircraft (potential for special conditions that reduce IFR 45 min + alternate range which is > design range?)

High voltage issues identification (especially with altitude)

High power electric motors/controllers and Power electronics module reliability

Potential for a joint Generic Issue Paper focused on specific applications (ie. Electric VTOL or Thin-Haul Commuter?)
EP Roadmap: Pre-Competitive Topics

- Leveraging of other research initiatives (i.e. DOE) efforts, investigation and comparison of various battery chemistry efforts to meet aviation specific needs, establish our priorities versus others to better understand unique contribution
- Installation mass overhead reduction of mounting/integration of EP components
- Health monitoring, prognostic system development specific to EP components, maintainability, algorithms for determination of battery state/BMS research
- Noise and control coupling investigations (phasing variable rpm signature, propulsion control augmentation)
- Non propulsion energy management and conservation (i.e. cabin climate control and other vehicle system energy requirements)
- EP Infrastructure: High voltage chargers, battery swapping (with certification decoupling from vehicle?) with conformity standards relating to the original vehicle certification, TSO component process use for swappable components?
- Investigation of indirect power coupling
- Secure and affordable wireless and/or optical communications for distributed EP components
EP Roadmap: Pre-Competitive Topics

- **Best practices handbooks (leveraging SAE, IEEE, AIAA, and space power systems)**
  - Energy storage safety, installation and hybrid architecture practices
  - Bus architecture/stability in harsh environments, Separation and partitioning of EP from other non-propulsion electrical system components (i.e. avionics)
  - EMI and HIRF (High Intensity Radiative Fields) sensitivity, environmental testing
  - Lightning issues relating to high voltage systems, Static electricity buildup sensitivity
  - Reliability assessment of redundant systems, Preliminary safety assessment methods, MTBF basis of EP components
  - Maintenance standards, overhaul, inspections, life limitations, TSO-like EP component standards, ability to treat different battery types similar to alternate fuels for engines
  - Catastrophic failure containment (in distributed systems) without lower level of safety
  - Component design specifications/documentation/conformity (research determines level of specificity required across components and boundaries of use)
  - Methods for establishing worst case basis for distributed EP systems, safety criticality
  - EP component software certification guidance (based on implicit safety criticality)
  - Crashworthiness of energy storage systems (use of fuse links), protection solutions
  - Comparative component performance and expert EP component trend predictions