Fuel Cell Industry Working Group Updates

International Aircraft Systems Fire Protection Working Group
Cologne, Germany
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Fire Safety Branch
http://www.fire.tc.faa.gov

Industry Working Groups

- **EUROCAE/SAE WG80/AE-7AFC – Hydrogen Fuel Cells**
- **FAA Energy Supply Device ARC**

EUROCAE/SAE WG80/AE-7AFC

Committee formed 12/2008 to provide design, integration and certification guidance for hydrogen supplied fuel cell systems on board transport category aircraft

Points of Contact:

- Co-Chairperson: Olivier Savin (Dassault)
- Co-Chairperson: Joe Breit (Boeing)
- Secretary: Tony Fallon (Parker Aerospace)

EUROCAE/SAE WG80/AE-7AFC

- **Short-term:** Development of safety guidelines related to the issues around installation of fuel cells on board aircraft and storage in the airport environment; consolidation of existing power system requirements and review of fuel cell performance against baseline requirements.
- **Medium Term:** Review of fuel cell technology maturity related to aviation requirements; definition of future on board electrical applications, which could be supported by fuel cells.
- **Long-Term:** Development of detailed specifications for safety assessment and certification of fuel cells on board aircraft.

EUROCAE/SAE WG80/AE-7AFC

- **SAE AIR-6464 – Aircraft Fuel Cell Safety Guidelines**
  - Published June, 2013
  - Provides comprehensive reference and background information pertaining to the installation of Proton Exchange Membrane (PEM) hydrogen fuel cells on-board aircraft for the purposes of supplying auxiliary power rather than using separate ground power systems.

EUROCAE/SAE WG80/AE-7AFC

- **SAE AS6858 – Installation of Fuel Cell Systems in Large Civil Aircraft**
  - Published March, 2017
  - Defines the technical guidelines for the safe development, testing, integration, validation and certification of PEM fuel cell systems, including fuel storage, fuel distribution and the integration of electrical systems into the aircraft.
  - This document only covers gaseous H2 systems

EUROCAE/SAE WG80/AE-7AFC

- **Moving forward, this group will be working on an update to AS6858 (possibility for it to be a standalone document) with the intent to expand to cover things such as:**
  - Liquid H2 storage and conversion to gas
  - On-board reforming
  - Material based H2 storage

Energy Supply ARC

Formed by FAA to provide a forum for aviation community to provide recommendations to the FAA

Objective is to determine appropriate airworthiness standards and guidance, identify hazards and determine design and operational principals to safeguard against these hazards

Points of Contact:

Co-Chairperson: Stephen Slotte (FAA)

Co-Chairperson: Joe Breit (Boeing)

http://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/committee/browse/committeeID/457

Fuel Cells – Energy Supply ARC

- **ARC was chartered April, 2015**
- **Initial kickoff meeting was held Sept., 2015**
- **Group split the effort into five tasks:**
  - Define types of fuel cell devices to be studied
  - Hazard analyses and mitigation
  - Rulemaking support
  - Cost/Benefit Analysis
  - Program management/Final reporting

Fuel Cells – Energy Supply ARC

- **Group has decided to focus on PEM and SOFC fuel cells**
  - Explanation of hazards, mitigation strategies, applicable airworthiness standards, guidance and other information required to address safety issues associated with hydrogen fuel cell applications on board commercial aircraft
- **Document is nearing completion with the final report to be submitted to FAA in July, 2017**

Fuel Cells – Areas of Research

- **Some areas of hydrogen research, pertinent to fire safety have been identified through the ARC and SAE Committees:**
  - Flammability of Hydrogen at Sub-atmospheric Pressures and Reduced Oxygen Concentrations *(see DOT/FAA/TC-TT14/36)*
  - Flammability of materials in a low-level hydrogen environment *(See proceedings of 2016 Fire & Cabin Safety Research Conference)*
  - Adequacy of current fire test standards for designated fire zones

Hydrogen within a DFZ

- **Current testing is typically conducted with a kerosene based burner to represent the existing fire threat**
- **If Hydrogen is used with the fire zone, is this current testing adequate, or is there a correlation that can be developed in order to utilize the current standards?**

Hydrogen within a DFZ

- **The adiabatic flame temperature of hydrogen/air mixture can reach 2045°C (3712°F) [ISO/TR 15916].**
  - similar to that of Jet A-1 (AFT ~2230°C), however the flame has different thermal exchange value (radiation and convection) than jet A-1
- **The adiabatic flame temperature of hydrogen/oxygen mixture can reach ≈ 3200°C (5792°F).**
  - hydrogen/oxygen mixture can reach much higher temperature and we might need to cover it differently
- **Testing is proposed to examine the fire generated from an H2 leak from a 0.3 and 8 mm orifice under 2-12 bar pressure.**
- **Comparison of damage to materials from this H2 fire and the existing oil burners will be examined.**

Questions?

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