

Fuel Cell Industry Working Group Updates

International Aircraft Systems Fire
Protection Working Group
Atlantic City, NJ
November 1 – 2, 2017

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Fire Safety Branch
<http://www.fire.tc.faa.gov>



Federal Aviation
Administration



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: Massoud Sadeghi
(Dynamic Aerospace Services)

Secretary: Open



EUROCAE/SAE WG80/AE-7AFC: Prior Documents

- **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
- **SAE AS6858 – Installation of Fuel Cell Systems in Large Civil Aircraft**
 - Published March, 2017
 - Technical guidelines for the safe development, testing, integration, validation and certification of PEM fuel cell systems
 - This document only covers gaseous H₂ systems



EUROCAE/SAE WG80/AE-7AFC

- **Moving forward, this group is targeting work on three documents with the following objectives**
 - Describe general benefits and safety aspects of on-board hydrogen storage and fuel cells
 - Define technical guidelines for the safe development, testing, integration, validation and certification of liquid H₂ based systems
 - Define technical guidelines for the safe development, testing, integration, validation and certification of onboard reformation systems



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 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 December, 2017**



Fuel Cells – Areas of Research

- **Some areas of hydrogen research, pertinent to fire safety identified through the ARC and SAE Committees:**
 - Hazards resulting from failure conditions at fuel cell stack (see [DOT/FAA/TC-16/24](#))
 - 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](#))
 - Feasibility of using byproducts for cargo fire protection (see [proceedings of 2016 Fire & Cabin Safety Research Conference](#))
 - Adequacy of current fire test standards for designated fire zones



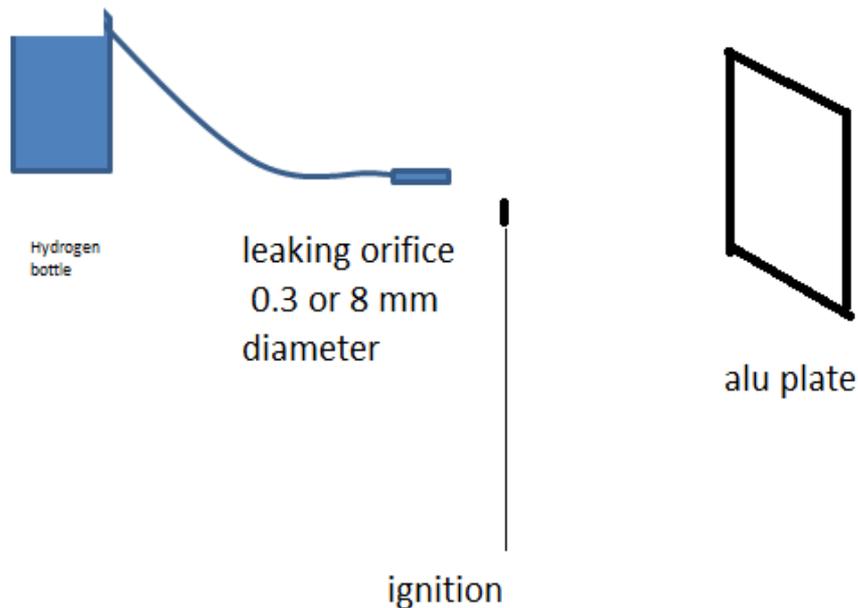
Hydrogen within a DFZ

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



Test Proposal

- A proposal was made to consider that a typical H₂ fire could be generated from a 0,2-0,3 mm diameter orifice leak under 2 & 12 bars (probable case) and worst case (unlikely) a 8 mm pipe rupture under 2 & 12 bars, and a test outline proposal was made to gather knowledge on the resulting flame / fire.



- It was highlighted that a high pressure (350 bars) leakage shall be prevented by design means (double sealing, double wall ...) and the resulting leakage shall be extremely improbable



Test Setup

- **Test buildup is underway outside B202 at the tech center**
- **Ability to vary**
 - Orifice diameter
 - H₂ pressure
 - Test article distance from flame



Flame Visualization

- **H2 combustion occurs in a narrow section of the UV band (305-310 nm wavelength)**
 - Invisible to naked eye and to most camera systems
- **Obtained a UV-capable ccd camera, UV lens and 310nm bandpass filter**



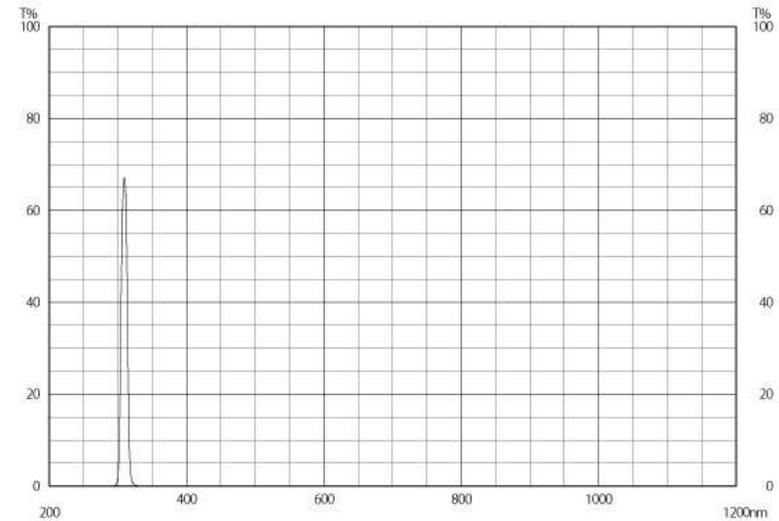
Sony XC-EU50
(response down to
300 nm)



Edmund Optics
fixed focal length
lens (230 – 1200 nm)



Asahi Spectra 310
Bandpass filter
(310 +/- 10 nm)



Questions?

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