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 a 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.
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.
Fire and flammability test plan

- However:
  - A 8 mm dia associated to a 12 bars pressure should lead to a 5 meters flame length ... with Flame width ≈ 1/6th of its length thus 0.8 m
  - It is not obvious that it is « on the small and less severe side of the spectrum” compared to kerosene fire