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

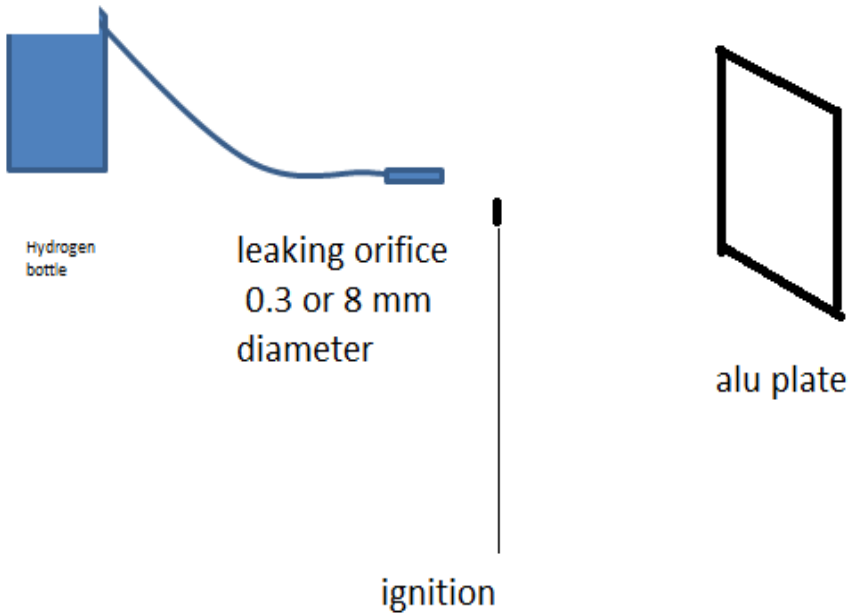
- **Current testing is typically conducted with a kerosene based burner to represent the existing fire threat**
- **If Hydrogen is used with the fire zone, is this current testing adequate, or is there a correlation that can be developed in order to utilize the current standards?**

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.**

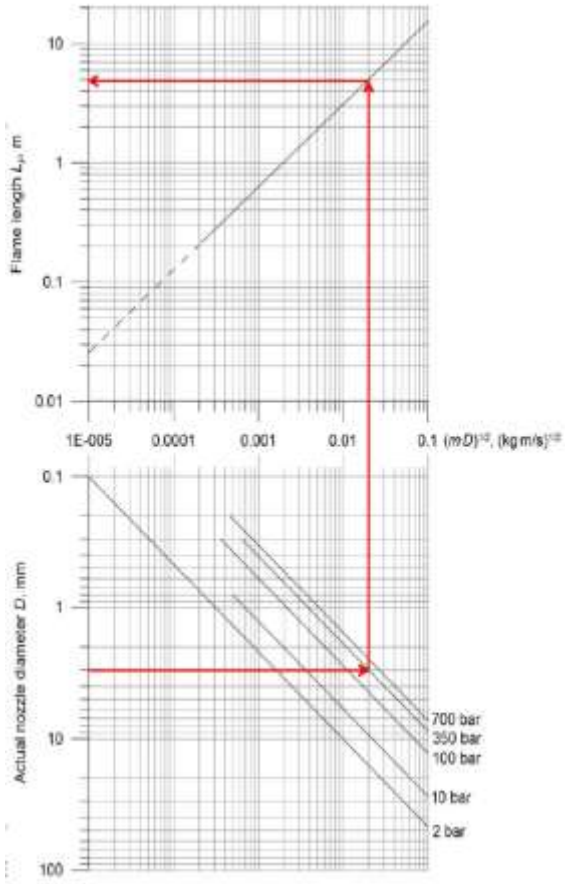
Fire and flammability test plan

- 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