



Fuel Cell activities at Dassault Aviation

Joint CS / FCH Workshop on Fuel Cell & Hydrogen Technologies in Aeronautics

Lampoldshausen, Sept. 15, 2015

HIGHER TOGETHER™

Référence

Indice

Date



Dassault Aviation at a glance



- ***Dual Civil – Military activities***
 - Design, manufacture and support of combat aircraft (Mirage, Rafale) and business jets (Falcon family)
 - 69% of the revenue generated by the sales of Falcon
- ***Over 8,000 aircraft delivered worldwide since 1945***
 - 72% have been exported
 - 28+ million hours of cumulated flight time
- ***9,000 employees based in France + 2,600 in the US***



Logic for Fuel Cell introduction: Step 1



- **1. The Fuel Cell as a « non intrusive » system**

- It does not take part in the actual functioning of the aircraft
- It supplies power to « non essential » loads
- It addresses increasing needs of power in cabin



Falcon:

Power supply to cabin payload on Special Falcon

- MEDEVAC (Medical Evacuation)
- SURMAR (Maritime Surveillance)



Flight Tests
Dec. 2016

Introduction
2018-2020

Logic for Fuel Cell introduction: Step 2



- **2. The Fuel Cell as an « intrusive » system**
 - It does take part in some selected phases of the flight
 - It may supply power to « essential » loads
 - It addresses the needs for autonomy of some functions



Falcon:
Emergency power supply -
replacement of Ram Air Turbine

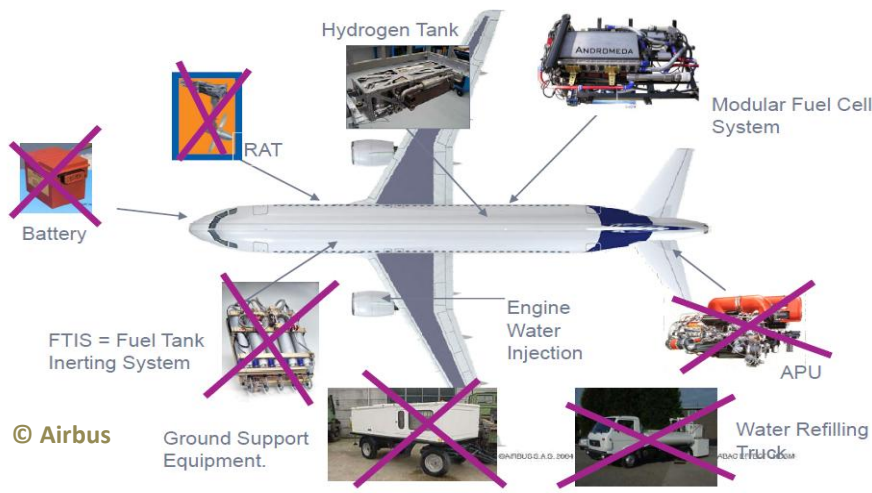


Introduction
2025

Logic for Fuel Cell introduction: Step 3

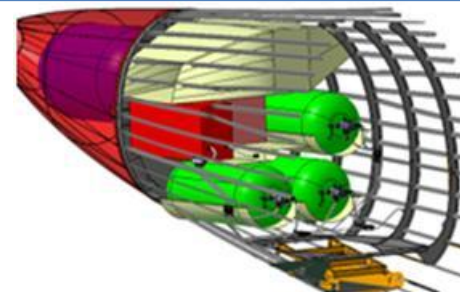


- **3. The Fuel Cell as a « very intrusive » system**
 - It is highly integrated in the aircraft platform
 - It does take part in all phases of the flight
 - It does supply power to « essential » loads
 - All by-products of its operations are used on-board



Falcon:

Multi-functional system, incl.
replacement of Auxiliary Power Unit
and Ram Air Turbine



Introduction
2030

Specificities of Falcon Business Jets



- ***Business Jets accessible airfields***
 - 10,000 airfields worldwide vs 1,000 for airliners
 - Most are poorly equipped airfields:
 - Aircraft operator may be the airfield operator
 - Pilot may have to do all aircraft preparation operations by himself
 - One can not rely on development of a H2 infrastructure for refilling on these airfields...
- ***Key driver to define future H2 refilling logistics***
 - Both the FC technology AND the H2 issue are of interest for Dassault
 - How to ensure availability of Hydrogen whenever refilling needed?
 - What type of infrastructure for business aviation? Associated business model?
 - Need early identification of on-board AND ground constraints

Logic for Fuel Cell introduction: Step 0



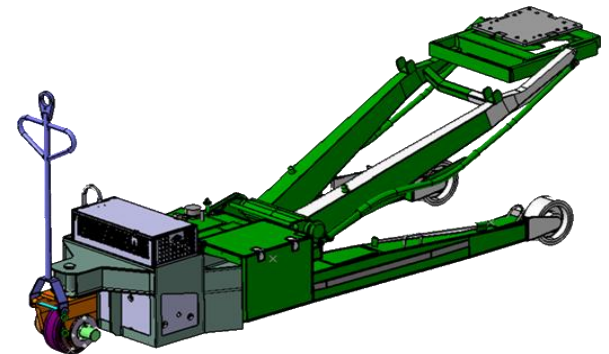
- ***How to best prepare for upcoming challenges ?***
 - Gain hands-on experience with operation of Fuel Cell systems in real environment
 - Devise entire Plug-and-Play Fuel Cell solution for Special Falcon application
 - Investigate BJ-specific H2 logistics early
 - Involve Dassault's Flight Test center personnel ahead of first flights (Dec. 2016)

=> Step 0 = « Ground Demonstrator » !

Dassault's Fuel Cell Ground Demonstrator



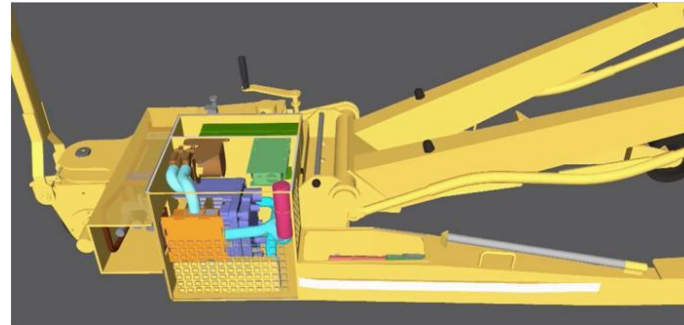
- ***Hydrogen-based Ground Support Equipment = « Hy-GSE »***
 - Modification of an existing lifting trolley for Rafale



- Use of an off-the-shelf Fuel Cell from Air Liquide (“GenDrive” for Material Handling market)



Rafale Lifting Trolley: end-product



Power Source

- Service time
(# loading / unloading operations)
- Filling time
- Operational availability
(8 aircraft fleet, 2 conf. / A/C / day)
- Service life
(# charging / discharging cycles)

Fuel Cell

80

2 min

99%

10,000

Battery

30

8 hrs

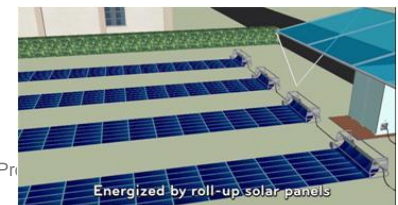
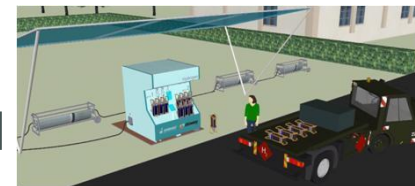
30%

500

Outcomes of Dassault's Hy-GSE Demonstrator



- ***Exposure to a wide range of stakeholders***
 - Involvement of various Dassault's operators, engineers, safety personnel,...
 - Exhibition at Paris Air Show (June 15-21)
 - Raised interest of many customers, partners
 - "Hydrogen 101" to high-profile visitors
 - Unique opportunity to demystify Hydrogen
- ***Progress in devising H2 solution for BJ***
 - Similarities between remote military air base and BJ airfield
 - Preliminary investigation of Hydrogen logistics issue:
 - Permitting, safety, training,...
 - HRS installation on airfield



Fuel Cell in Ground Support Equipment

- ***Benefits of Hy-GSE concept***
 - Foreshadows future applications of Fuel Cells in aeronautics
 - Help airframers / system designers investigate complete Hydrogen logistics solutions
 - Help demystify Hydrogen
 - Allows airfield operators to gain exposure to Hydrogen and refilling process

**=> Possible starting point for creating
Hydrogen infrastructure on airports !!**