Fire Protection in Designated Fire Zones

Anne GUISEN/Marc LOCQUET
EASA Powerplant

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Fire mitigation threat

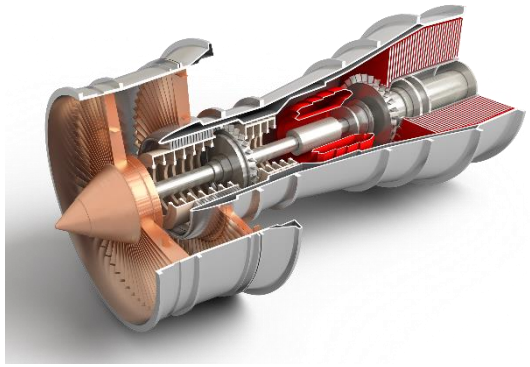
- Fire mitigation threat is based on two principles:
  - **Prevention**: to reduce the probability of occurrence
    - segregation,
    - firewall,
    - Fireproof & Fire resistant etc…
  - **Protection** : to reduce the consequence of occurrence
    - detectors,
    - extinguishing agent etc …

Fire known threats and new threats

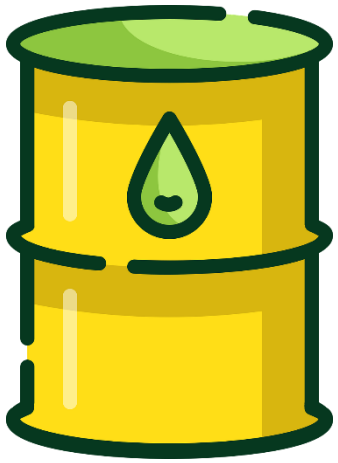
- → Characterisation of those fire threats depends on the design of the powerplant installation:
  - →Thermal engine,
  - →Fuel (tank, pipes, equipment's),
  - →Cooling system,
  - →Electrical motor (for propulsion),
  - →Battery (Battery for service, battery for propulsion)

New combination of design

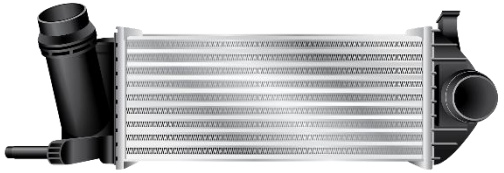
→ We will need to mix:



Thermal engine



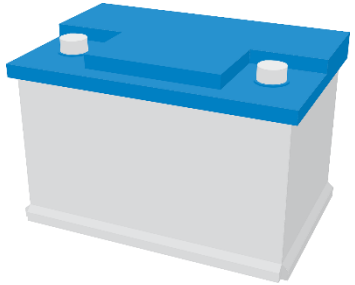
Fuel tank



Cooling system
(flammable fluid)

New technology

Electrical motor as
lift/thrust unit



Battery for propulsion:
- Higher voltage
- Larger volume

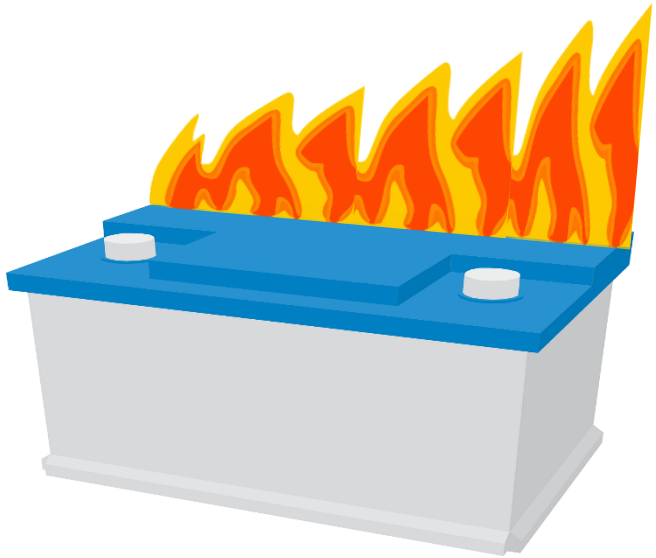
New combination of design 2/2

- To cope with the complexity of mixing existing technology with new technology a **step by step approach** is used.
- The MOC with VTOL.2330 will be developed in an incremental approach according to the following steps:
  - Step 1: Air cooled motor with rechargeable batteries as electrical energy storage system not liquid cooled,
  - Step 2: Air cooled motor with the liquid cooled battery (oil, glycol water, etc…),
  - Step 3: Other energy storage technologies (e.g. fuel cells, capacitors) or hybrid propulsion. For instance: liquid cooled motor with liquid cooled battery.

Step 1: Air cooled motor with rechargeable batteries

Threats induce per electrical battery or electrical motor:

- Heat
- Flame
- Sparks
- Smoke
- Toxic gases
- Corrosive gases
- Soot
- Fragment/ hot particles



Scale effect on the threat

1 Kwh

Currently maximum value in airliner

Used on airliner as **battery for service**

Fire risk level is lower

10 / 100 Kwh

Expected value for **propulsion battery**

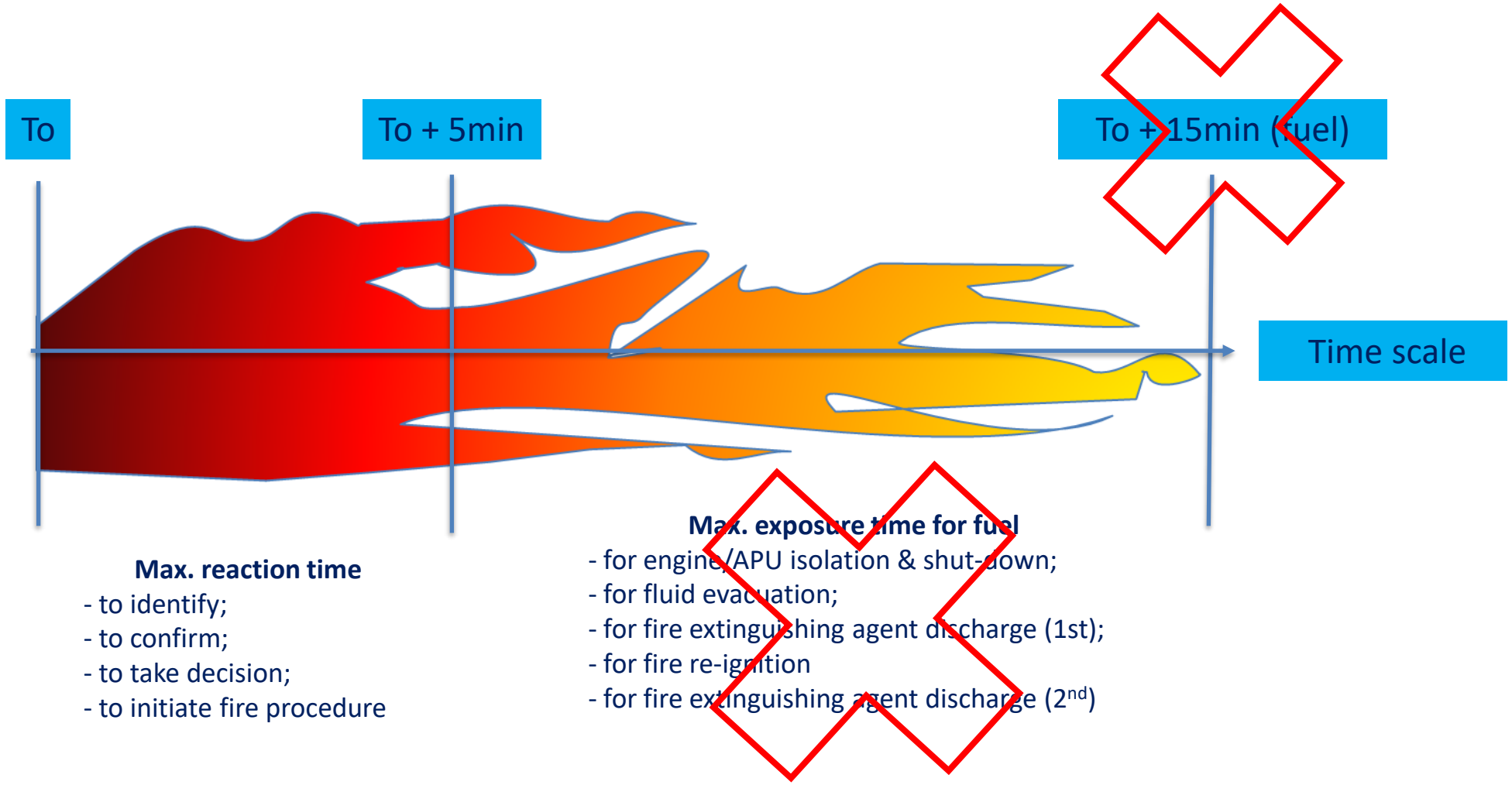
(+) Thermal inertia

(+) Voltage / Amps

(+) Inertia (electrical motor rotor)

(+) Combustible mass/material available

Fuel fire vs battery/electrical motor fire

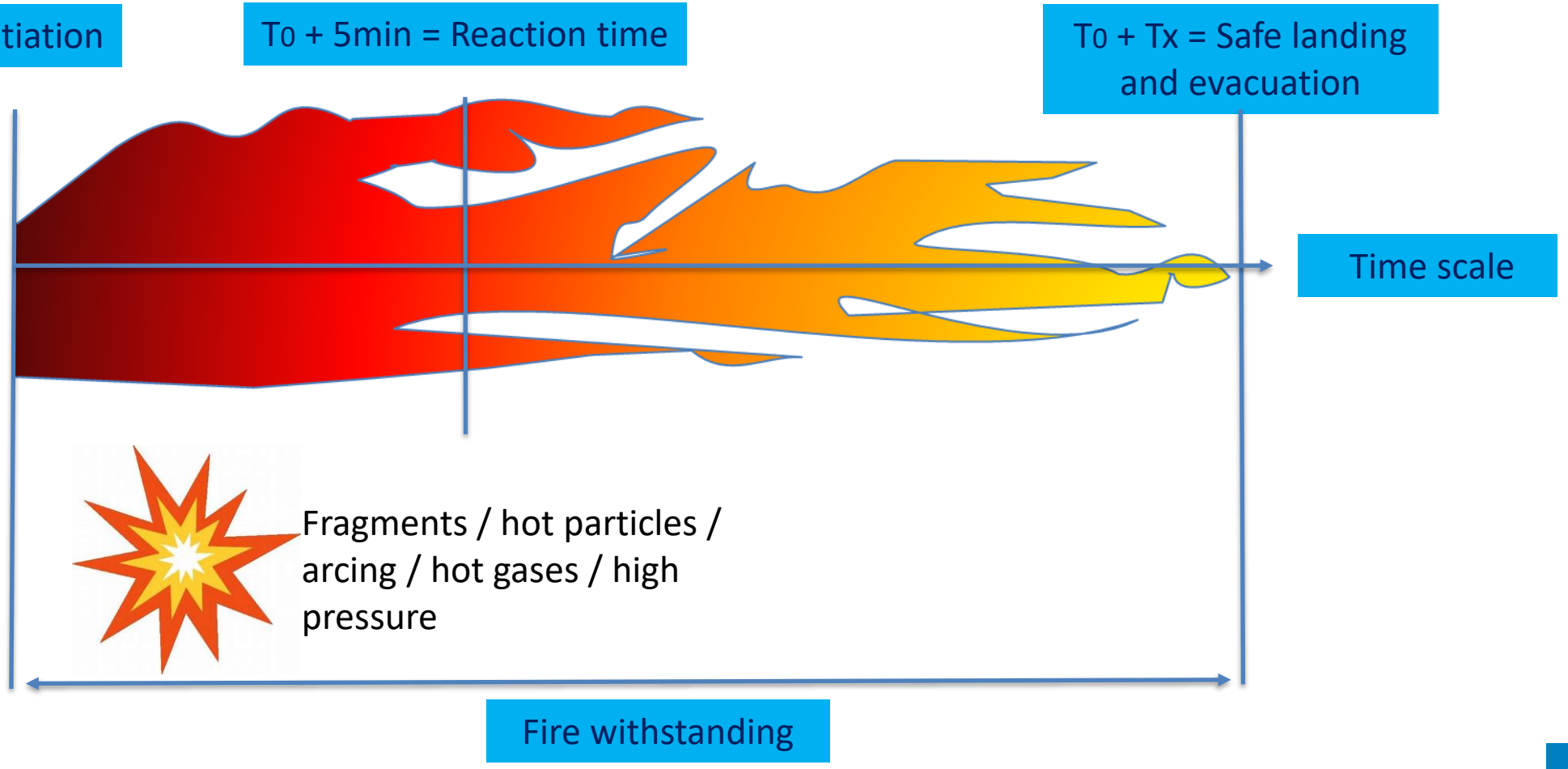


Max. reaction time
- to identify;
- to confirm;
- to take decision;
- to initiate fire procedure

Max. exposure time for fuel
- for engine/APU isolation & shut-down;
- for fluid evacuation;
- for fire extinguishing agent discharge (1st);
- for fire re-ignition
- for fire extinguishing agent discharge (2nd)

Battery/electrical motor fire

- Characterisation of flame,
- Chemistry (temperature, heat flux),
- Design, scale effect, others…



Impact on current definition

- **Fireproofness is not anymore valid for electrical propulsion step 1**
  - **“Fireproof”** : With respect to materials, components and equipment, means the capability to withstand the application of heat by a flame, for a period of 15 minutes without any failure that would create a hazard to the aircraft. The flame will have the following characteristics:
    - Temperature 1100°C ± 80°C
    - Heat Flux Density 116 KW/m2 ± 10 KW/m2

    For materials this is considered to be equivalent to the capability of withstanding a fire at least as well as steel or titanium in dimensions appropriate for the purposes for which they are used.

- **Fire resistance is partially valid for step 1 (green) needs to be rewritten**
  - **“Fire-resistance”:** With respect to materials, components and equipment, means the capability to withstand the application of heat by a flame, ~~as defined for ‘Fireproof’~~, for a period of 5 minutes without any failure that would create a hazard to the aircraft.

    ~~For materials this may be considered to be equivalent to the capability of withstanding a fire at least as well as aluminum alloy in dimensions appropriate for the purposes for which they are used.~~

MOC VTOL.2330

- For the purpose of MOC VTOL.2330 the following shall be implemented:
  - Fire threat currently defined in CS-Definition:
    - Fire resistance need to be updated
    - Fire withstanding need to be considered

MOC VTOL.2330 2/2

→ For the purpose of MOC VTOL.2330 the following shall be implemented:

- → Prevention :Explosive containment wall and withstanding wall
  - → To be considered from fire threat
- → Protection against the effect of fire:
  - → Drainage, ventilation, disconnect mechanism, cowling, fire detector and fire extinguisher to be adapted from CS -23 and 27

MOC VTOL.2330 Preliminary definitions 1/2

- **Fire withstanding: (Electrical lift/thrust unit fire)**
  - The fire withstanding will be dependent on the electrical lift/thrust unit flame characterisation. Characterisation will have to be performed using the design, the materials characteristics, power etc. … The time duration is dependent on VTOL aircraft category and determined from the moment it would be subject to the fire effect.
- **Fire withstanding zone: (Electrical lift/thrust unit fire)**
  - Is a volume surrounding one or several electrical thrust/lift unit (without flammable fluid and/or EESS and or thermal engine) than could be open or closed and able to withstand the effect of a flame and/or sparks, heat, hot parts ejection.

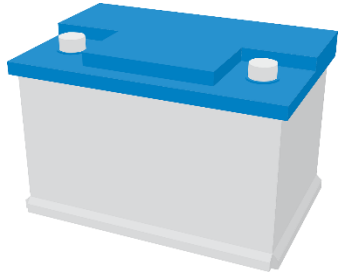
MOC VTOL.2330 Preliminary definitions 2/2

- **Explosive fire containment: (Electrical Energy System Storage fire)**
  - For a containment wall, the fireproofness will be dependent on the battery flame characterisation. Characterisation of the fire temperature, and pressure will have to be performed using the design of the battery (Chemistry, cells dimensions, cells design). The time duration is dependent on VTOL aircraft category and determined from the moment it would be subject to the fire effect.
- **Explosive fire containment zone : (Electrical Energy System Storage fire)**
  - Zone containing the EESS Is a volume surrounding an EESS with or without an electrical thrust/lift unit (without flammable fluid and or thermal engine) than closed and able to withstand the effect of a flame and/or sparks, heat, hot parts ejection.

Status / way for forward

- MOC VTOL.2330 in preparation at EASA
- At this point of time EASA needs support from industry in order to determine fire characteristics which could allow definition of proportional thermal protections for:
  - Electrical motor (electrical lift/thrust lift unit)

  - Batteries (Electrical Energy System Storage)



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European Union Aviation Safety Agency

Thank you for your attention

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