Cranfield
Transport
Systems

The future of airport firefighting in a hydrogen infrastructure

Dr Jim Nixon

Airport fire services

Hydrocarbon fuels are a key risk, but…

- We know a lot about them
- Mature distribution networks
- Mature safety procedures
- Known hazards and mitigations
- Key factor in airport design
- Key factor in aircraft design

Some alternative fuels

Biofuels produced from plant materials.

Can cover carbon cost of burning.

Electricity storage.

Source of electricity governs sustainability.

Hydrogen: liquid, gaseous, fuel cell.

Sources could include water, ammonia. Again energy source to create governs sustainability.

Where are we?

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Aerospace & Defence + Add to myFT

Airbus to test hydrogen-powered engine on A380 superjumbo

European plane maker has teamed up with Safran and GE in push to bring zero emissions aircraft into service by 2035

The modified A380 will have four conventional turbines, while a fifth engine, adapted for hydrogen, will be mounted on the rear fuselage © Regis Duvignau/Reuters

Sylvia Pfeifer in London FEBRUARY 22 2022

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Press release

Plans unveiled to decarbonise UK power system by 2035

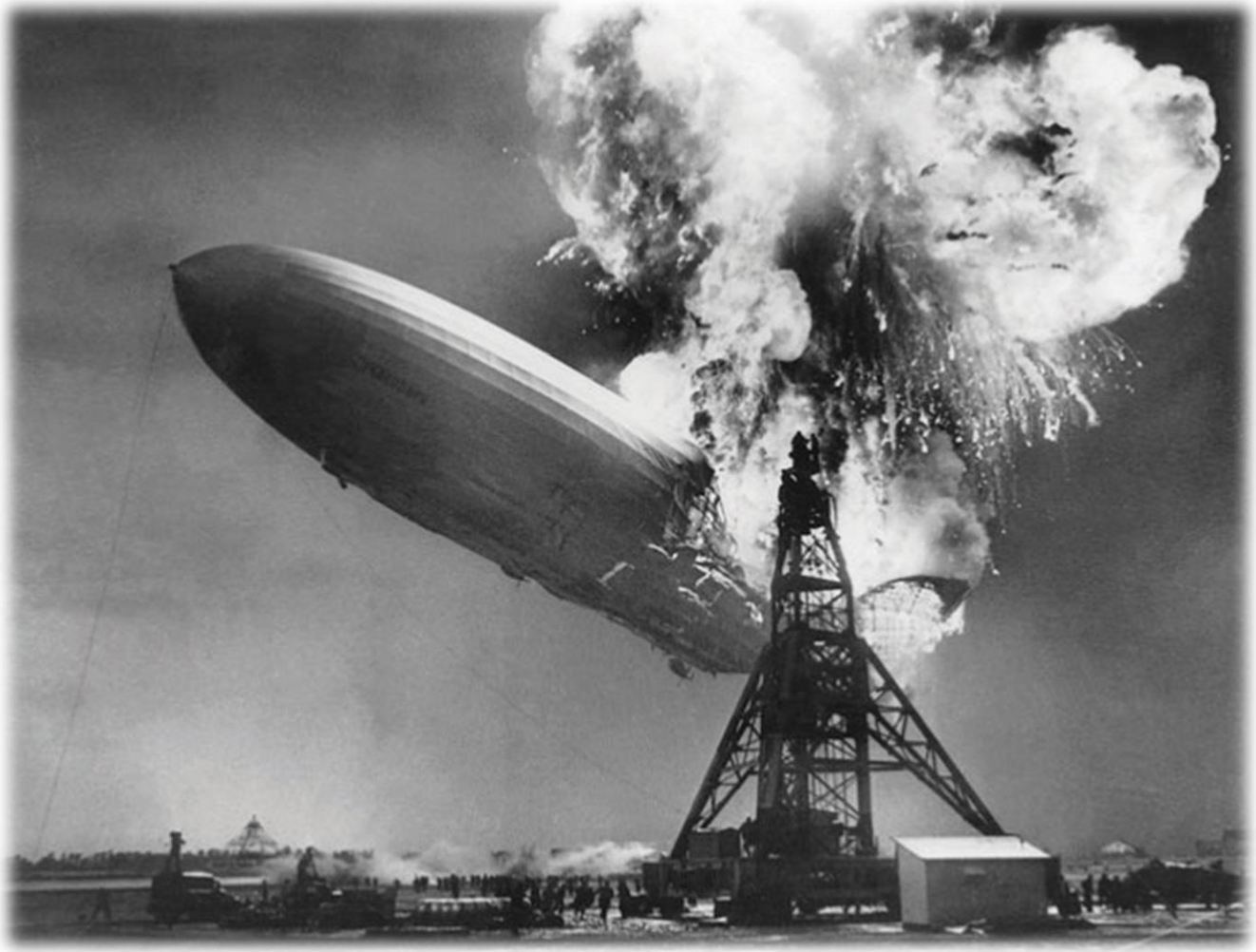
The plans will focus on building a secure, home-grown energy sector that reduces reliance on fossil fuels and exposure to volatile global wholesale energy prices.

From: Department for Business, Energy & Industrial Strategy and The Rt Hon Kwasi Kwarteng MP

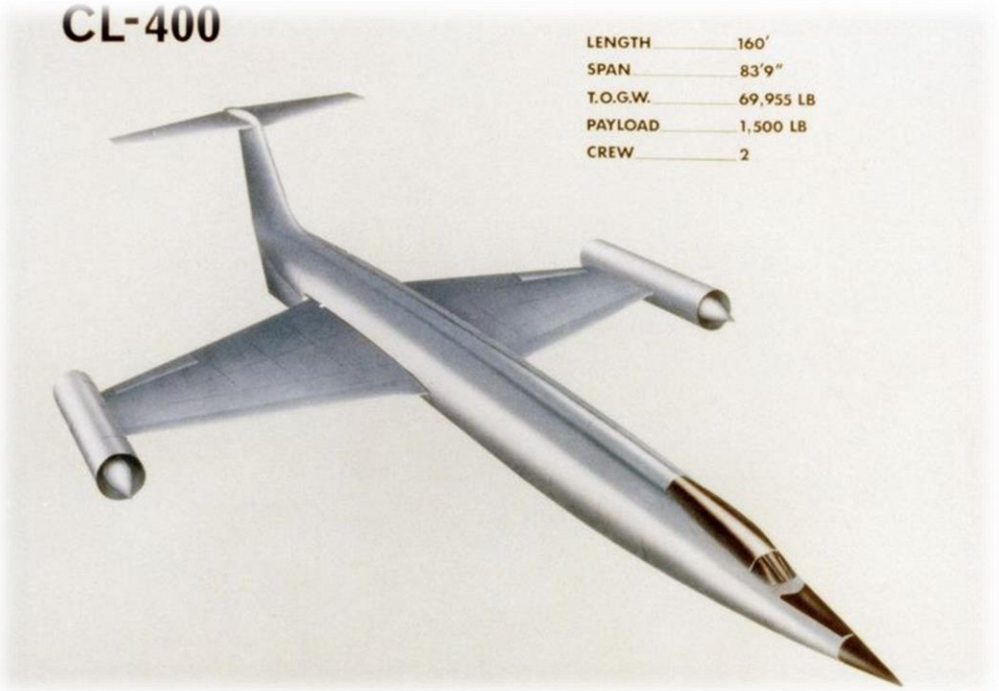
Published 7 October 2021

- UK commits to decarbonise electricity system by 2035
- home-grown, green technologies such as offshore wind and

Let’s talk about the hydrogen image problem

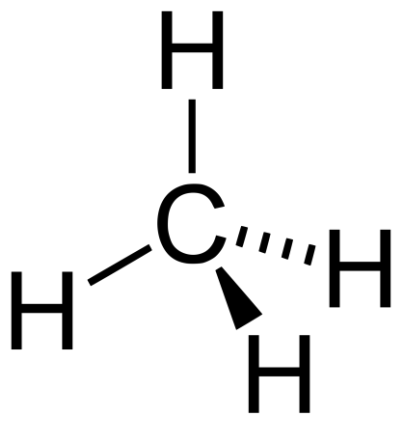


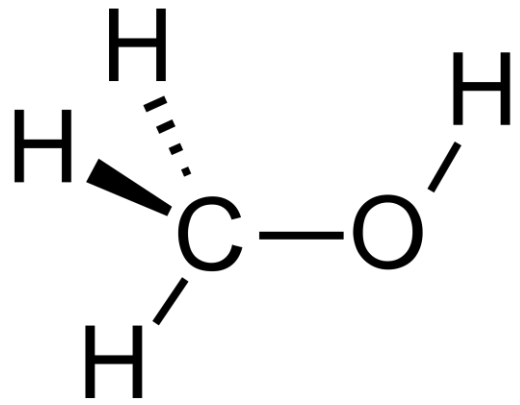
Hydrogen is not a new fuel, but it is unusual

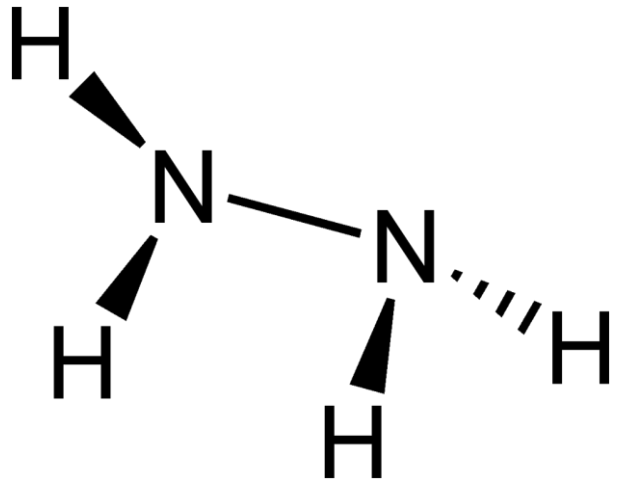


HyResponder

Can we learn from other hazardous substances?



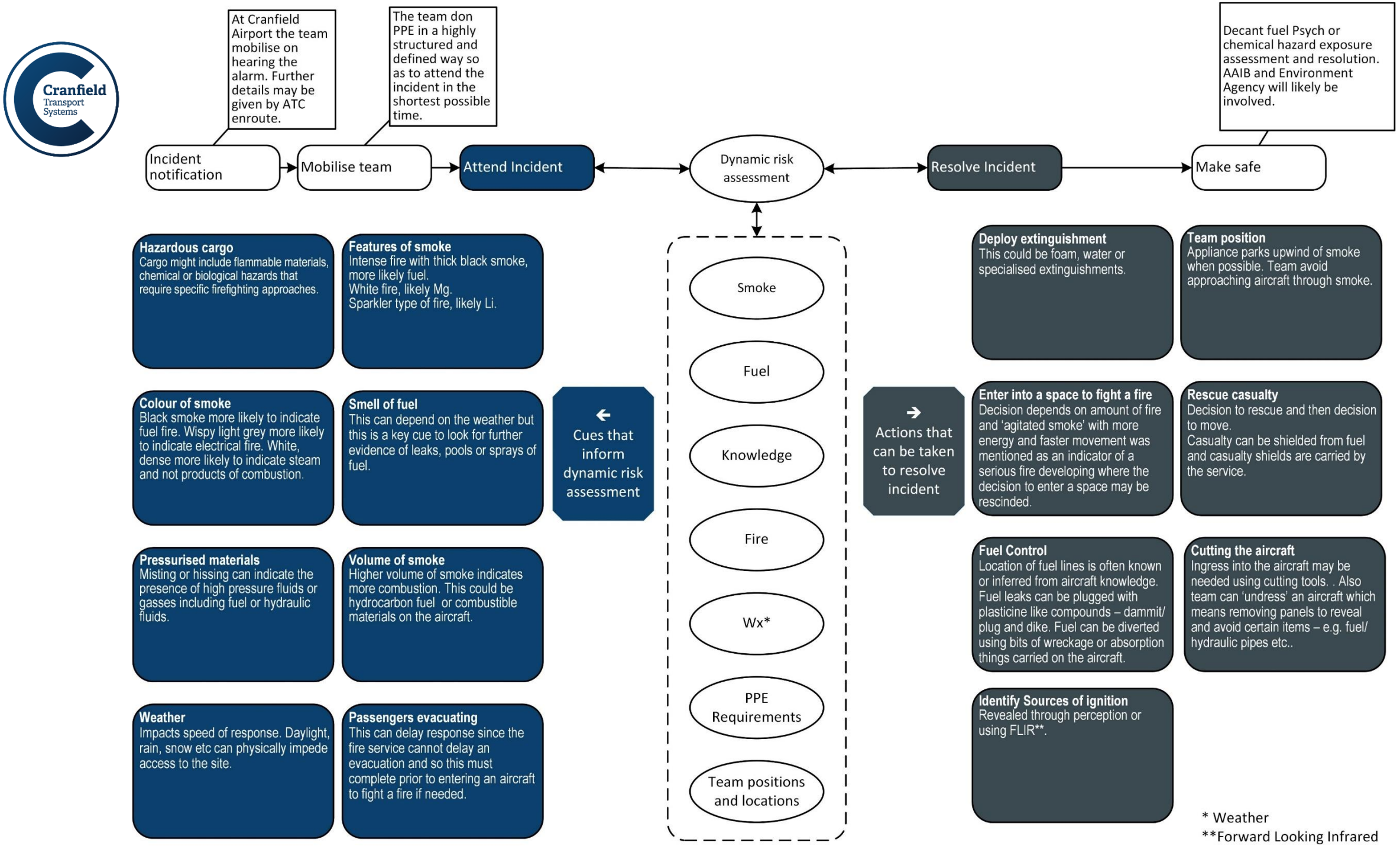




methane, acetylene, methanol, hydrazine

Returning to airport firefighting

- How do firefighters assess current risk with hydrocarbon fuels?
- If hydrogen were to be used, what would change?
- What do we need to do differently with a hydrogen infrastructure?


At Cranfield Airport the team mobilise on hearing the alarm. Further details may be given by ATC enroute.
The team don PPE in a highly structured and defined way so as to attend the incident in the shortest possible time.
Decant fuel Psych or chemical hazard exposure assessment and resolution. AAIB and Environment Agency will likely be involved.
Incident notification
Mobilise team
Attend Incident
Dynamic risk assessment
Resolve Incident
Make safe
Hazardous cargo
Cargo might include flammable materials, chemical or biological hazards that require specific firefighting approaches.
Features of smoke
Intense fire with thick black smoke, more likely fuel.
White fire, likely Mg.
Sparkler type of fire, likely Li.
Colour of smoke
Black smoke more likely to indicate fuel fire. Wispy light grey more likely to indicate electrical fire. White, dense more likely to indicate steam and not products of combustion.
Smell of fuel
This can depend on the weather but this is a key cue to look for further evidence of leaks, pools or sprays of fuel.
Pressurised materials
Misting or hissing can indicate the presence of high pressure fluids or gasses including fuel or hydraulic fluids.
Volume of smoke
Higher volume of smoke indicates more combustion. This could be hydrocarbon fuel or combustible materials on the aircraft.
Weather
Impacts speed of response. Daylight, rain, snow etc can physically impede access to the site.
Passengers evacuating
This can delay response since the fire service cannot delay an evacuation and so this must complete prior to entering an aircraft to fight a fire if needed.
Cues that inform dynamic risk assessment
Smoke
Fuel
Knowledge
Fire
Wx*
PPE Requirements
Team positions and locations
Actions that can be taken to resolve incident
Deploy extinguishment
This could be foam, water or specialised extinguishments.
Team position
Appliance parks upwind of smoke when possible. Team avoid approaching aircraft through smoke.
Enter into a space to fight a fire
Decision depends on amount of fire and 'agitated smoke' with more energy and faster movement was mentioned as an indicator of a serious fire developing where the decision to enter a space may be rescinded.
Rescue casualty
Decision to rescue and then decision to move.
Casualty can be shielded from fuel and casualty shields are carried by the service.
Fuel Control
Location of fuel lines is often known or inferred from aircraft knowledge. Fuel leaks can be plugged with plasticine like compounds – dammit/ plug and dike. Fuel can be diverted using bits of wreckage or absorption things carried on the aircraft.
Cutting the aircraft
Ingress into the aircraft may be needed using cutting tools. . Also team can 'undress' an aircraft which means removing panels to reveal and avoid certain items – e.g. fuel/ hydraulic pipes etc..
Identify Sources of ignition
Revealed through perception or using FLIR**.
* Weather
**Forward Looking Infrared

Live simulations

360 filming in the Ground Operations (Go) Lab, DARTeC

Simulated response to a suspected hydrogen fire

‘FRESSON’ aircraft

What might change?

Cue	What may change with hydrogen aircraft?	What may remain the same?
Smoke	**Hydrogen fires do not produce the large volumes of black** smoke produced by the carbon content of hydrocarbon fuels like kerosene.	Smoke will still be produced by combustible materials on the aircraft or the aircraft itself.
Fuel	**Hydrogen cannot be seen and is buoyant** unlike kerosene fuels. Sources of hydrogen are likely to be under pressure and as such, new technology may be required to identify temperature differentials that would indicate that hydrogen is present. Explosive atmospheres may also be produced by concentrations of hydrogen gas representing new threats and different management techniques.	Fuel will still present a key fire risk and threat to life.
Fire	Hydrocarbon fuels burn in a visible and well-known way. No such assumptions can be made with hydrogen. **Hydrogen may dissipate rapidly prior to combustion** or indeed be manually released by the aircrew in response to a predicted crash-landing. Hydrogen fires do not burn with a visible flame and so more use of FLIR technology may be needed.	Fire will still present a key risk and threat to life. Fire will still be sustained by combustible materials on the aircraft or the aircraft itself.
PPE Requirements	As hydrogen has a very low minimum ignition energy and is easily ignited, **anti-static and fire retardant PPE** will be required when responding to hydrogen incidents. This could include; - Cryogenic eye protection - Gloves - Boots and anti-static overalls	Risks that include fire, falling objects, heights, un-survivable environments will still be present in the fire service role. PPE will still need to mitigate these risks and protect crew.
Technology	It is likely that **greater use will be made of imaging technology** for both lower and higher temperatures to detect hydrogen leaks and fire.	The fire service currently use thermal imaging technology to assess risk.

Beyond the airport fire service

- Fuelling procedures
- Aircraft design and evacuation
- Airport fuel farms
- Airport stand design
- Fire warning systems and airport evacuation procedures

Conclusions

- Hydrogen is a viable fuel for sustainable aviation
- Airport fire services represent a key mitigation for hazards associated with fuel and fuel systems
- The fire service training, knowledge and expertise is focused on hydrocarbon fuels in line with their properties and hazards.
- To achieve hydrogen fuelled operations by 2035, this will need to change: new procedures and equipment are needed to maintain high levels of safety.
- The future is ragged and dirty – I find it likely that hydrocarbon fuelled, electrical propulsion and hydrogen will need to co-exist.

Cranfield Transport Systems

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