A350 fire in Japan: Do fire test standards need upgrading to protect lives?

FIRE AUSTRALIA2024

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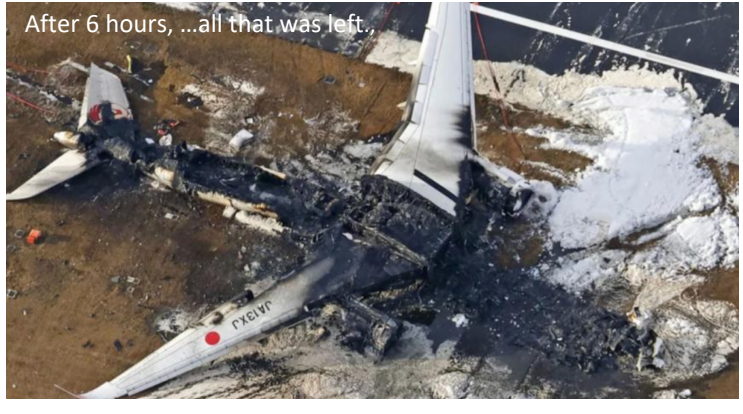
Discussion outline…

- **We rely on firefighting foams to work quickly and effectively to protect lives** in major fire incidents – *including ours!*
- **Why did this A350 aircraft burn for over 6 hours?** …*until almost completely destroyed*.
- **Composite materials are increasingly used** in modern aircraft, but smoldering proves difficult to extinguish.
- **Are existing ICAO and new MilSpec fire test standards fit for purpose?** …Or should they be reviewed and overhauled?
- **A review of the events and research highlight real concerns…**

Flaming A350 on runway after fireball collision , Tokyo airport, Japan -2Jan.2024


After 6 hours, …all that was left.,

Are we risking lives by inadequate fire testing?

Let's find out…

What happened in Japan?

Flaming A350 on runway after fireball collision , Tokyo airport, Japan -2Jan.2024

Reportedly:

- A **runway collision** on landing caused a fireball.
- Dash-8 destroyed instantly; **tragic loss of 5 lives**.
- A**ll 379 passengers and crew on the A350 escaped safely**.
- F**ull passenger load evacuation (up to 440) of A350 in 90 secs**, *tested using half exits at night*.
- E**fficacy being questioned by experts …**"*often bare little resemblance to real-life incidents*."
- Only 3 exits usable; **NO hand luggage; evacuated in 5 minutes**. …***Most experts agreed this saved lives***.
- **Speedy evacuation is critical**. Safety agencies warn "*pausing to get luggage risks lives*".
- **Consider locking overhead bins upon emergency exits activation?**

Catastrophic disaster was narrowly averted

Why did it keep burning?

- "*The **JAL A350 is the 1st hull loss of a composite airliner …by fire***." Reportedly taking 6 hrs to extinguish "*leaving **the wings as only identifiable remains** of the charred and broken fuselage*."
- Metal fuselages burn through quicker than composites, but resins etc. may increase flammability?
- Composite experts are asking "*The **fire brigades of the airports actually have to look at why couldn't they stop the fire***." Japan normally uses C6 AFFFs, …seems didn't work. …**Why not?**
- **How would alternative foams that met a weaker standard, or F3 technology have faired?**
- Learning Investigation lessons could still be months, …perhaps years away.

We need fast understanding, …to increase survivability, and save more lives.

Composite materials use: GROWING

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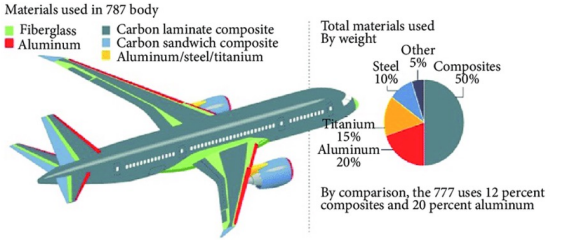
GROWTH in modern aircraft, driven by KEY needs: LESS weight; LESS fuel; LESS maintenance; LESS corrosion - so flying becomes <u>MORE efficient – WITHOUT compromising safety</u>.

- A350 comprises 53% composites
- A380 with 25%, A320 has 28%
- B787 has 50%
- B777 uses 12% composites



Composite material use increasing everywhere for rigidity, strength, corrosion resistance, less maintenance, replacing steel, even concrete:

- Commercial and residential buildings
- Bridges, structures, wind turbines
- Ships, cars, buses & trucks
- Sport & recreation: kayaks, bikes, tennis racquets, fishing rods, gyms…
- Offshore platforms, topsides, wind-turbines
- Pipes, valves, fittings, process vessels
- Storage tanks, batteries, oil & gas, bearings
- Power poles, propellers, exhausts
- Aquaculture, desalination, wastewater

Growing Lithium ion battery use in aircraft cabins, ‘carry on’ & cargo holds!

Evidence shows this has worrying concerns for public safety.

Composite materials complexity

2012 - **FAA** found smoldering composites difficult to extinguish, risking sudden re-ignition in evacuations.

2014 – **EU 'AircraftFire' project** found "***Composites are an efficient fire barrier, but:***

- ***Resin warming destroys cohesion between carbon fibres, mechanical stress can break fibres as soon as first layers de-correlated,***
- ***Fast heat penetration in the composite induces off-gassing of potentially toxic and flammable gases with possible fire propagation in the cabin within few tens of seconds***. ...***potentially having a fatal effect on passengers and crew survivability***." Also...
- **Excess fuselage skin fuel increases heat & plume volume, increasing escaping passenger & firefighter danger. ...2014: ICAO extended extinguishment , 60 to 120 secs.**

This has worrying concerns for public safety.

Composite materials research

<u>2019</u> – **US Navy** found carbon fibres exposed to fire/heat can release MEKP – a polar solvent liquid ***needing AR foam***. MEKP attacks regular AFFFs/Fluorine Free Foams (F3s***) = less effective***.

<u>2019</u> - **US Defense Analysis** found flammability varied. Higher fire hazards from higher heat release rate composites. Reduced by expensive flame-retardant polymers and/or ceramic-fibre blankets. **<u>F3s vulnerable to burnback: controlling composites re-ignition, a BIG Challenge</u>**.

<u>2020</u> - FAA ARFF Strategy confirmed "*…components of advanced composites are all affected by fire. Resins & Epoxy will burn, particularly in the presence of an aviation fuel fire*. ***Pooled fuel fires should be controlled first, then burning composites***. "

This has worrying concerns for public safety.

Ferocious composite fire

$1.4 Billion B2 bomber -mostly composites: **destroyed** (Guam, 2008)

- Crashed into runway soon after take-off
- **Large fire, burned for 6 hrs - complete loss**
- "*Full tank likely exacerbated fire on crashing.*"
- Required **314,155L water & 9,463L AFFF** to finally extinguish this small aircraft.

Large A350 under NFPA 460:2024 (Cat.9) requires:

- **MilSpec/Level C: 36,200L water; 1,086L 3%AFFF**
- ***ICAO level B: 46,500L water; 1,395L 3% foam***

7-9 times LESS foam & water than needed for B2!

Re-inforces …Composites HARD to extinguish

A GROWING trend …ferocious fires

2 new Naval ships (mostly composites) - **both complete fire losses**. US Defence Analysis reported:

- "*One **burned for 24 hrs** before capsizing, breaking apart and then sinking. …**Fires so intense, on-board firefighting measures were not enough to overcome them**.*"
- Electrical short caused other vessel fire while docked, during fit-out for sea trials. "***Fire was large and intense**, overcoming fire protection measures available, **so entire ship was lost**.*"

Re-inforces Composites hard to extinguish

USS BHR fire (2020) re-fit in dock– Fire attack delayed 2 hrs. Became uncontrolled, temps reached 700^{o}C melting steel, spread to 60% ship in almost 5 days before out: $1.2B loss.

Don’t we need fire test Standard improvements? (eg. ICAO Level B & C)

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More intense, harder to control composite fires NEED improvements to existing fire test standards.

- ICAO **uses single Jet A1 fire test at cool 15ºC**, premixed at 3% precisely, on 4.5m2 fire.
- **NO** aged concentrates, **NO allowance for proportioning variations** (lean/rich).
- **NO repeat fire test verifying original result**, ***NOR*** **5-yearly interval to retain compliance**.
- **NO rapid extinguishment within 60secs** to facilitate survivability, 120 secs for edge flickers out.
- **NON-representative nozzle – 10:1 expansion NOT 5:1 like most ARFF nozzles** (easier to pass).
- **NO compatibility fire test with Dry Chemical** (often used on engine fires - *BUT often attacks F3s*).
- **No gasoline fire test -**relevant for busy drop-off/ pick-up areas and multi-storey terminal car parks.
- Max. wind speed 3m/sec (6.7mph) facilitates foam performance, but **NOT representative of windy airports**.


Edge flickers on ICAO Level B fire test

...WHY NO fire testing on composite materials?

Don’t we need fire test Standard improvements? (eg. new F3 MilSpec)

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New F3 MilSpec (MIL-PRF-32725 Jan.23) for land-based **freshwater (potable) use only**
Seems MORE representative than ICAO Level B, …but *LESS so than AFFF MilSpec*

- MIL-PRF-32725 6 January 2023 **uses 9 fire tests (2 on gasoline, rest Jet A) at chilly 5ºC**, with fuel at 10ºC.
- 3% induction, lean (1.5%), rich (6%) fire tests with new AND aged concentrates.
- Fire test application rate similar to ICAO Level B, NOT Level C like existing AFFF MilSpec.
- **4-yearly repeat fire test** retains compliance. 8x 2.6m2 and 1x 4.64m2 fire tests – **NOT Just 1** (ICAO).
- Rapid extinguishment within **30secs on Jet A**; **60secs on gasoline** and 4.64m2 Jet A fire
- ***BUT AFFF MilSpec requires 30sec out on gasoline (2.6m2) 50sec out ULG 4.64m2 in seawater.***
- **Nozzle at 7:1 not 5:1 like most ARFF nozzles and AFFF MilSpec**
- **Includes Dry Chemical compatibility fire test - used on engine fires, *often shown to attack F3s*.**
- **Includes Gasoline fire test -** relevant for busy drop-off/pick-up and multi-storey terminal car parks.
- **NOT representing windy airports -** wind speed 2.23m/sec (5mph) **half AFFF MilSpec** (easier pass).

1st Revision apparently underway.

…WHY NO fire testing on composite materials?

Summers getting hotter

Its forecast to become hotter more frequently, so **significant changes needed to ensure continued passenger safety.**

- New York Times (Jan2023) headlined "***The last 8 years were hottest on record***."
- European Weather Centre confirmed (Jan2024) "***2023: hottest year on record since 1850 …1.48ºC warmer than 1850-1900 pre-industrial level***" – a whisker below the agreed Paris 1.5ºC (averaged) increase.
- **Wild weather ahead in 2024**. US NOAA forecasting above average temps until June. Scientists astonished by record ocean temperatures rising.

Research shows: Foam performance drops as temperatures rise

Aircraft performance: *DECREASES*

As it gets hotter, pilot's aircraft control reduces = risk more accidents?

- 2023 research explains "***It is urgent and crucial to understand the effects of increasing temperature on the complicated and comprehensive performances of aircraft. As air warms, it becomes less dense***. *Low density air conditions further lead to reduced lifts of aircraft, which significantly influences the maximum take-off weight (MTOW) of an aircraft.* ***The warming air leads to the MTOW reducing and take-off distances increasing.*** *…****the take-off distance does not change linearly with temperature but shows a stronger increase with higher temperature***."
- Extended take-off distances , reduced maneuvrability on landing, **increases risk of over-runs and unexpected accidents** under such challenging conditions.

NFPA 460:2024 increased application rate

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- NFPA® 460:2024 (Annex B.6) explains "*...limited full-scale testing of ICAO C foams, tests to date have reflected extinguishments on Jet A* ***within 1 minute*** *at ICAO application rates of 0.092gpm/ft2 (****3.75L/min/m2****). The 0.13gpm/ft2 (****5.5L/min/m2****) application rate requirement for AFFF meeting MilSpec in NFPA 403 is* **[ONLY]** ***40% higher****."* **Safety factor erosion is a major public safety concern**
- AFFF MilSpec has **330% safety factor** to cover unexpected challenges when fire strikes.
- Low **40% Level C safety factor may NOT be effective**? Composites, wind, hot summers?
- ***Might Level B foam safety factor within 1 minute*** ***...effectively be non-existent***?
- Is this WHY NFPA 460:2024 (Annex B.6) **recommends increasing ICAO Level B design application rate 35% for AFFF/F3s to 7.5L/min/m2** (0.18gpm/ft2), ***NOT 5.5L/min/m2?***

- *Latest* ***NFPA 460:2024*** *(merging 403, 405 & 412) endorses 2018 recommendations in Annex B.6*

Presumably it applies to new F3 MilSpec also? (*as similar test rate to ICAO level B*)

MORE realistic firefighting training needed

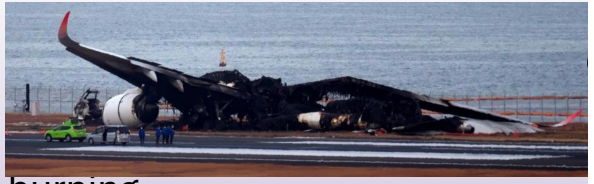
- Increasing complexity of aviation firefighting comes from larger aircraft, more passengers, higher fuel loads, new composite materials, …busier airports.
- **Coincides globally with more near-misses, impaired maintenance, runway incursions**, more vehicular traffic, hotter summer temperatures, ***less effective F3s***.
- **Don't we need EXTRA training** to better understand F3 weaknesses, **improve fire test Standards** while conducting **MORE** live fuel and composites firefighter training?
- Plus funding to act on areas of needed improvement.

Providing FASTER, MORE EFFICIENT fire control - helps AVERT future tragedies.

Conclusions



Many factors demand fire test Standard improvements, incl.:



- Adverse heat stress inside cabins from hotter temperatures.
- **Aircraft performance drops as temperatures rise**.
- Potential life loss and adverse environmental impacts from longer burning.
- Reduced survivability from composites**: increased toxicity and rapid flammability in cabins.**
- Surely **composites re-ignition & near removal of safety factors help explain 6hrs burning?**
- Disruption, delay and **dangers to passengers, crews & firefighters more likely**, …**major fire incidents could increase …*so aren't fire test improvements vital?***

Rigorous testing, frequent realistic training are critical to saving lives under more challenging aircraft fire conditions. *That's our future, …lets prepare NOW!*

Any Questions?

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Have your chances of survival Improved?

Contact Mike at: …willsonconsulting26@yahoo.com.au