World Civil Aviation Fire Chiefs Forum 7 October 2025
Novotel Stevens Hotel, Singapore

Tactical Approach to Firefighting in modern and future composite aircraft

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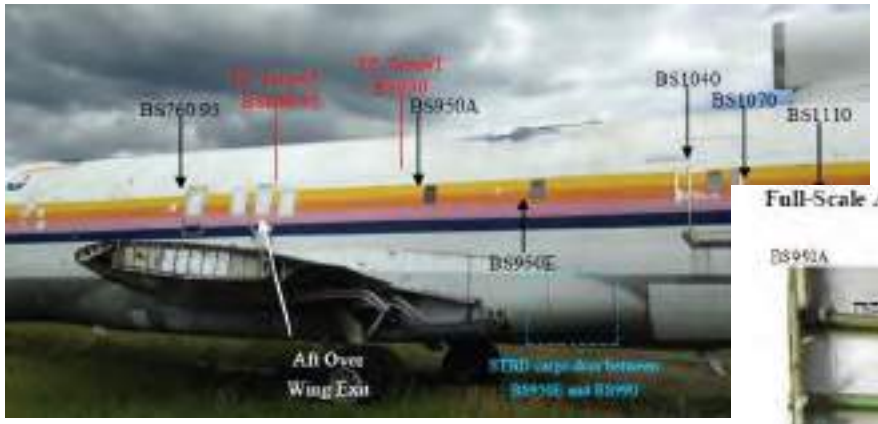
ARFF & Training consulting

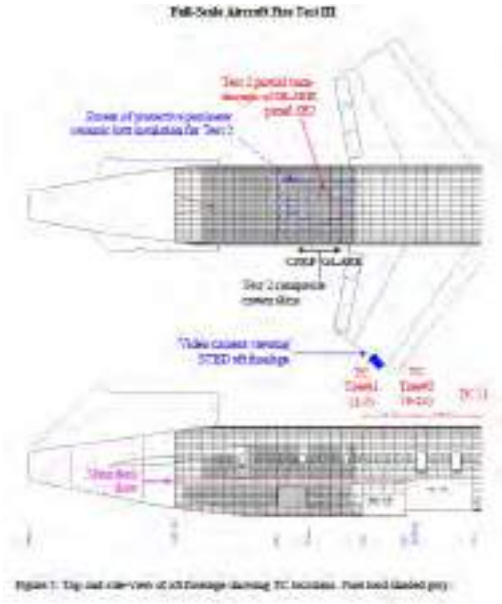
Lessons learned from the Joint ARFFWG & IAFPA conference in Copenhagen 2017

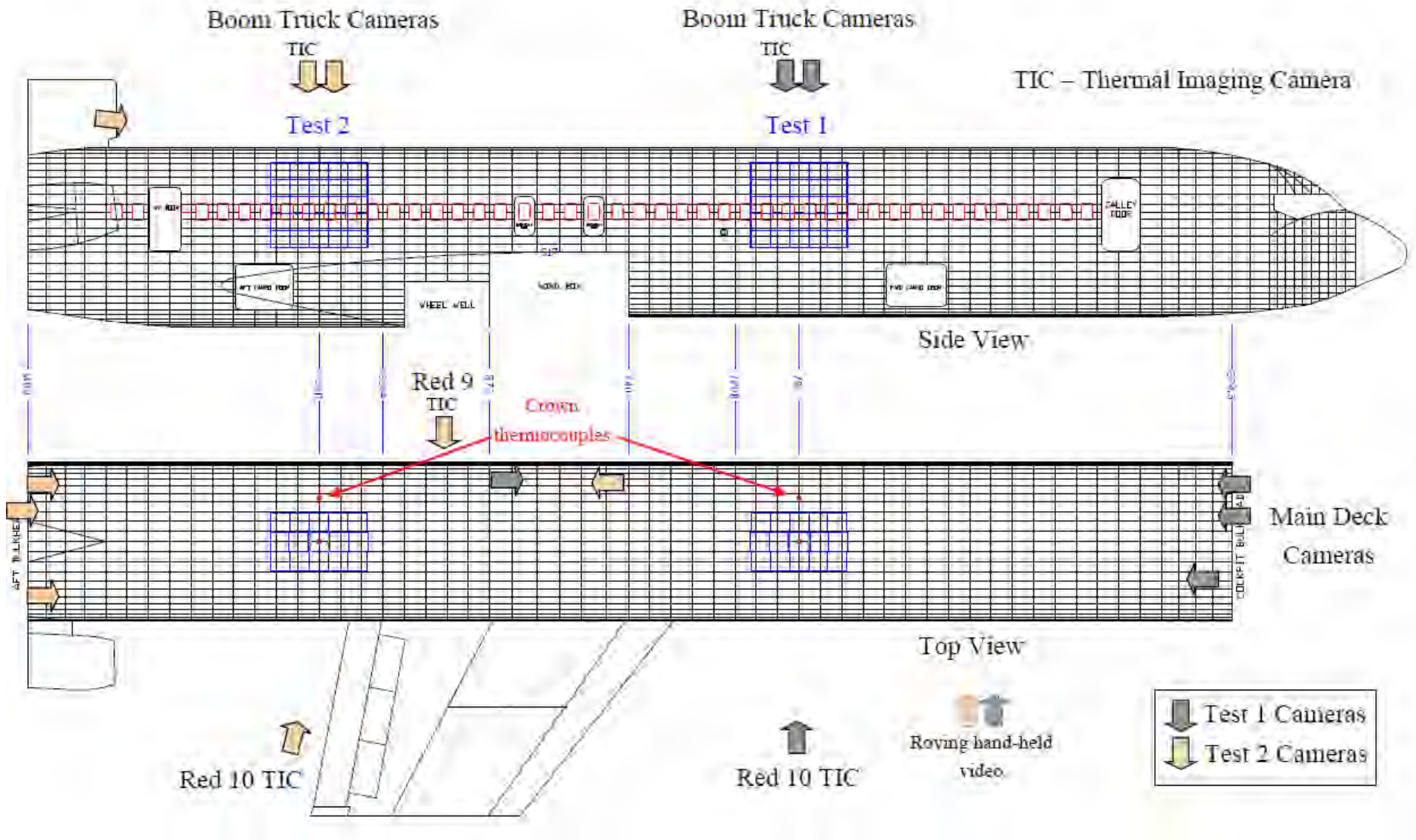
- Testing – composite aircrafts fires CFO Francois Jacquet, Ottawa Airport and Ron Gould, Aerospace Canada

Testing – composite aircrafts fires
”The Big Burn”
Ottawa Canada

Testing – composite aircrafts fires
”The Big Burn”
Ottawa Canada

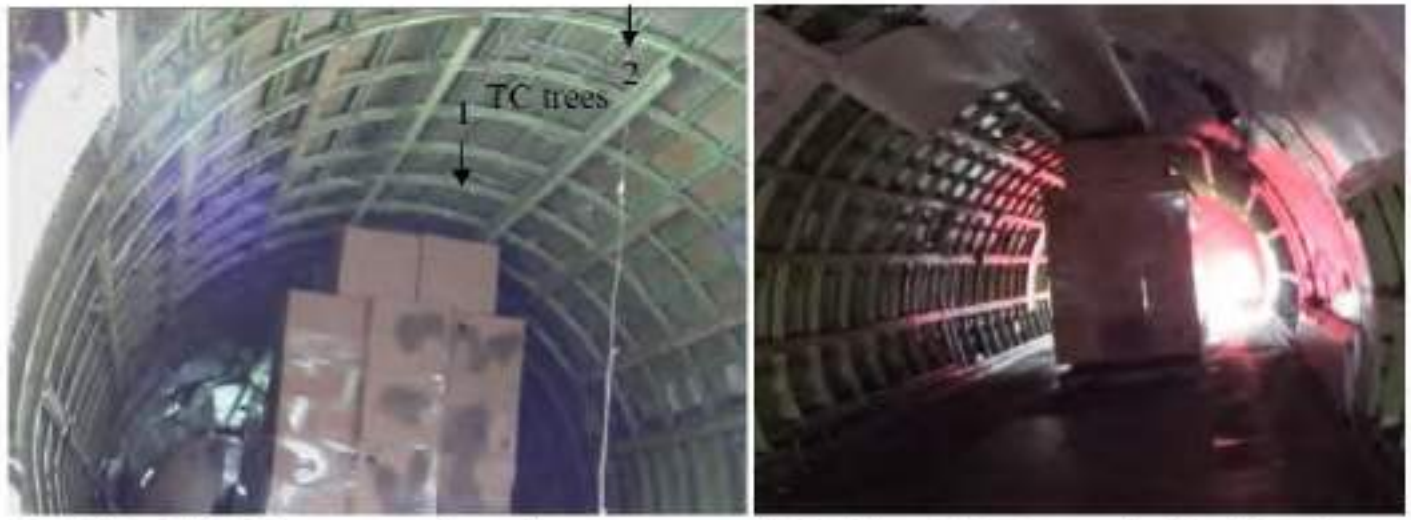





Boom Truck Cameras
TIC
Test 2
Boom Truck Cameras
TIC
Test 1
TIC – Thermal Imaging Camera
Side View
Red 9
TIC
Crown
thermocouples
Main Deck
Cameras
Top View
Red 10 TIC
Red 10 TIC
Roving hand-held
video
Test 1 Cameras
Test 2 Cameras

a) Fire-Starter in ventilated box with shredded paper. b) Post-fire condition.

Figure 7: Lithium primary battery fire starter.



a) looking FWD from over-wing exit b) looking AFT from cockpit bulkhead

Figure 8: Views of FWD main deck prior to test.

Testing – composite aircrafts fires
”The Big Burn”
Ottawa Canada

Lessons learned:

- We have to have a different tactical approach to internal fires in composite aircrafts – dos not burn through like in aluminum aircrafts.

- We have a different environmental and health problem with fires in composite aircrafts, than aluminum aircrafts – micro composite fibers.

Crisis Management and preparedness

- Assessment and evaluating training and emergency planes will always be an ongoing process.

- To have the best possible - with the resources an ARFF service has or is given – must be the goal.

- Preparedness is a must!

  We have to adjust with development in the industry, in order to ensure aviation safety in the future.

- We must all stay focused on this task.

- This is something that everyone expects!

CTIF Airport Commission meeting
Oslo Norway 15 May 2024

- Fire Chief Andreas Lochmier from Zurich Airport gave a presentation about recourses and the A350 accident at Hando Airport in Tokio.

- Andreas did a great presentation, addressing the problems with tactical approach to firefighting in modern composite aircrafts and challenged the question of having resources the enough (ICAO and EASA recommendations).

- Composite aircrafts have been in the Aviation Industry for many years, 30 years or more and therefore nothing new. As most developments in aviation, it started with military aircrafts and slowly moved to the civilian aircrafts.

- I remember that the US FAA Research Dept. presented on burn through time in composite material about the same time when we saw the first Boeing 787´s.

- But, the accident at Hando Airport in Japan last year, was an eyeopener that we all should learn something from! And the presentation from Andreas shows clearly why.


Tokyo Haneda Airport
02.01.2024

Aircrafts

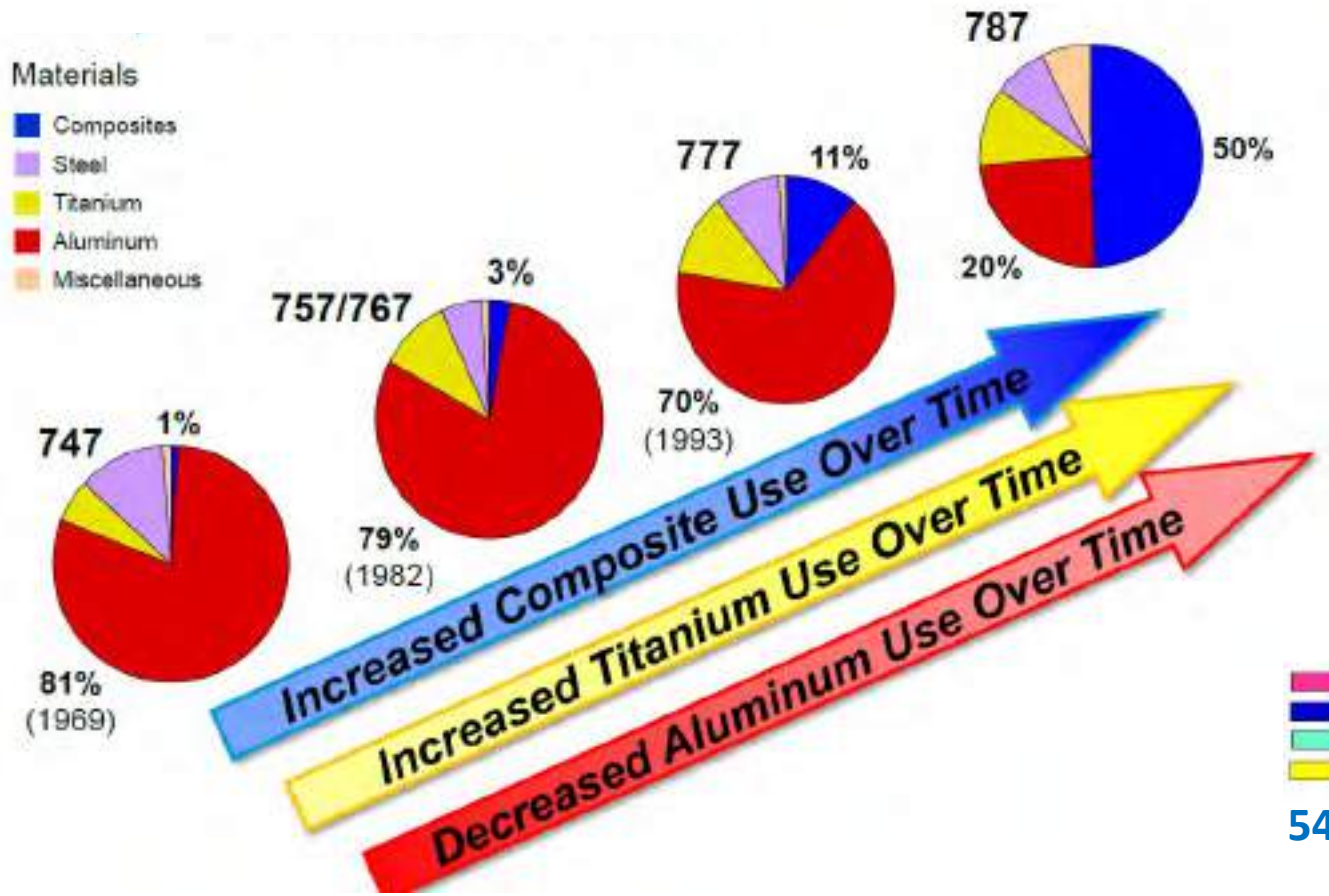
Japan Airlines A350-900
367 Passengers
12 Crewmember
~210'000 kg

Japan Coast Guard
Dash- 8
6 Crewmember
~19'000 kg

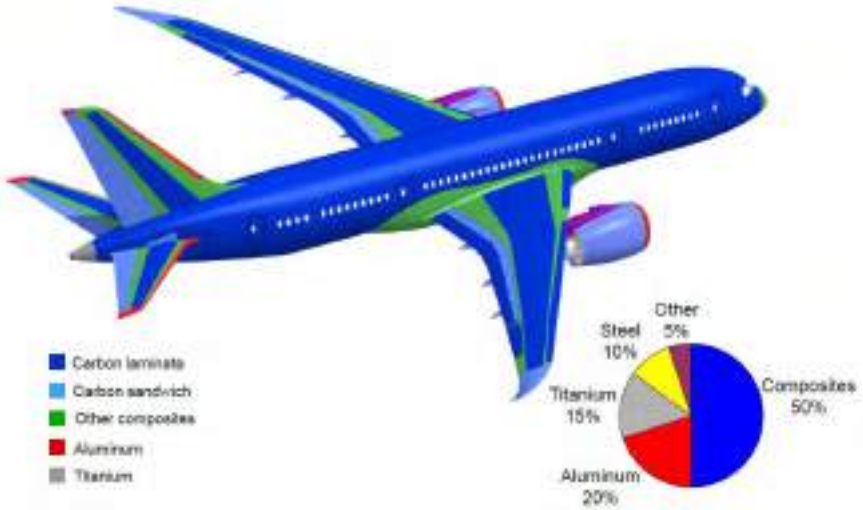
Questions

- What happened between these two images?
- Was the material (fiber composite) the difficulty or the problem?

Composite structure

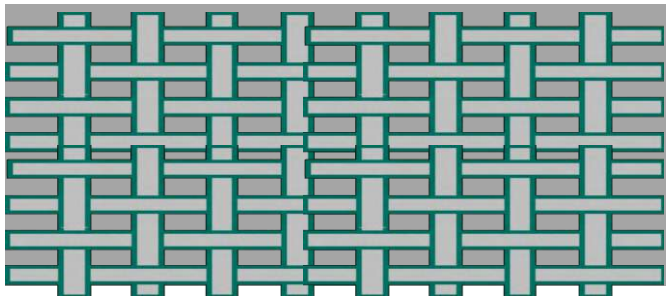


B787



A350

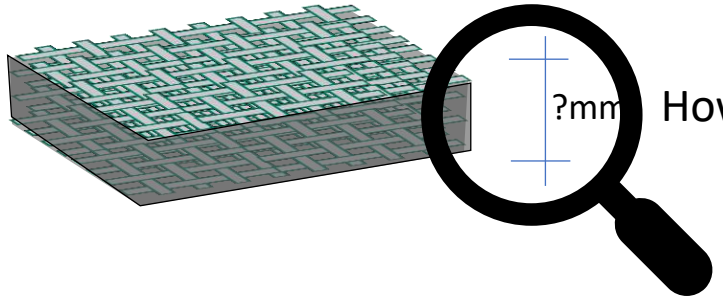
What is composite material?



- Carbon fibers 0.15mm
- Resin 34%

Composite structure
Carbon fiber reinforced plastic CFRP

What is composite material?

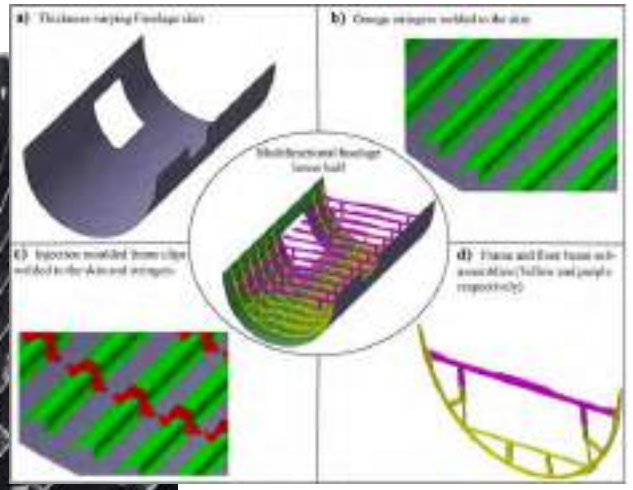


How thick is the layer?

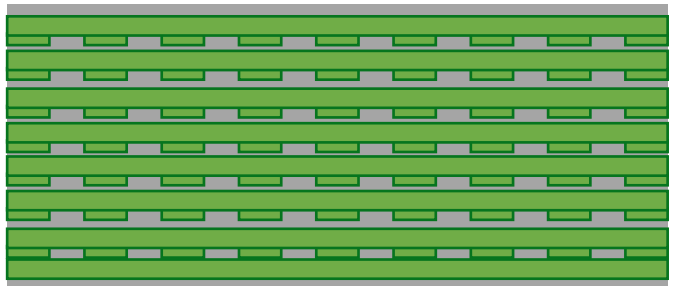
- Cargodoor Area **24.05mm**
- Door and window area **11.09mm**
- Aircraft fuselage **1.95mm**

What is composite material?

What is composite material?

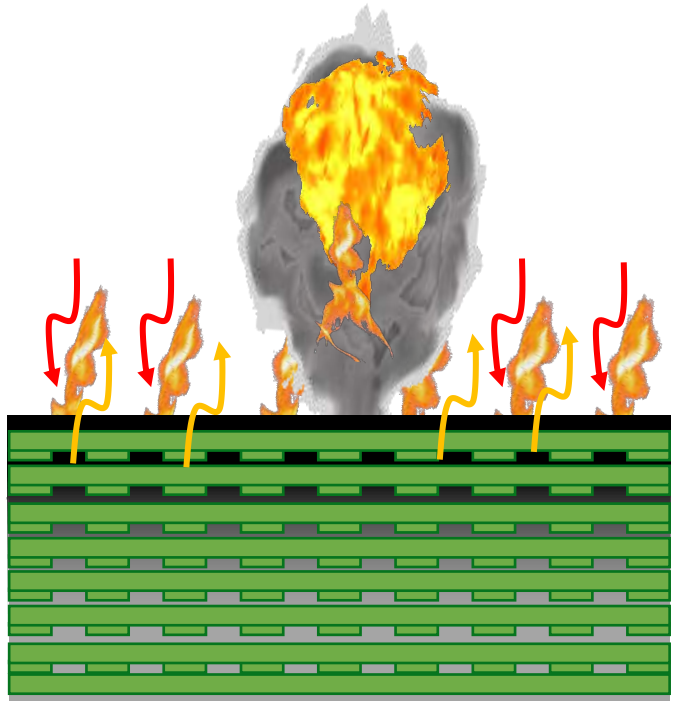


Composite material in the fire



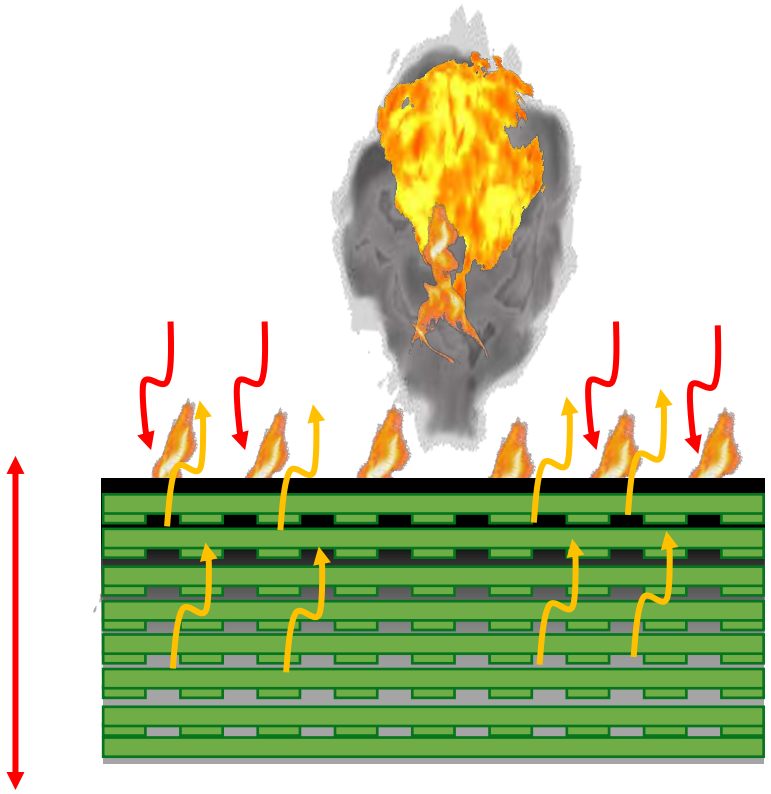
- Extensive tests were carried out even before the first flight of the B787 in 2008.
- Test pieces were exposed to flames and their behaviour in the event of fire was examined.

Composite material in the fire



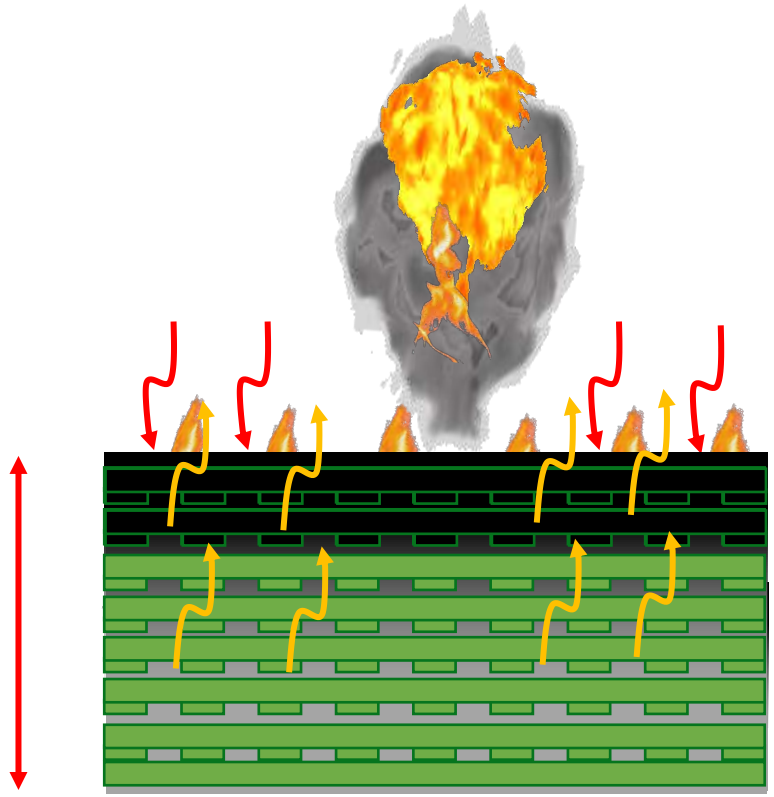
- High heat acts on the composite material.
- The composites do not burn, but the resin between them vaporises and forms pyrolysis gases.
- These can ignite on the surface.
- A hard and dense carbonisation forms on the top layer, which also has a heat-insolation effect and can reduce vaporisation.

Composite material in the fire



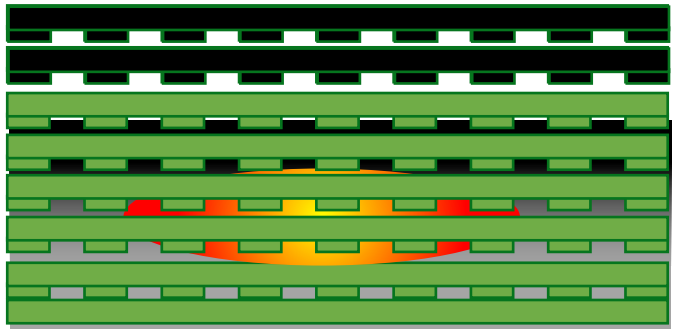
- As the vapours seek to escape, higher pressure is developed in the composites, increasing material volume (swelling of composites).

Composite material in the fire



- Unlike aluminum fuselage that melts, the composite fuselage skin seem to stay in place.
- The resin burns under the effect of the heat and fire. The fire surface is damaged and carbon fibers become brittle.

Composite material in the fire



- Burnt CFRP has a high isolating effect.
- Even 30 minutes after the fire is over 600°C are still possible inside
  Danger of IGNITION inside

Tests and Recommendations

ICAO AN 179 circular 3.15 § 3.5.7 & 3.5.8.

Published by Airbus in 2019

AIRBUS

2, Rond point Dewoitine
31703 Blagnac Cedex
France

FROM: Airport Operations
DATE: 18th June 2019
REF: V00ME1916322
ISSUE: Issue 2.0

Subject: A350 XWB Airframe Composite guide for firefighters

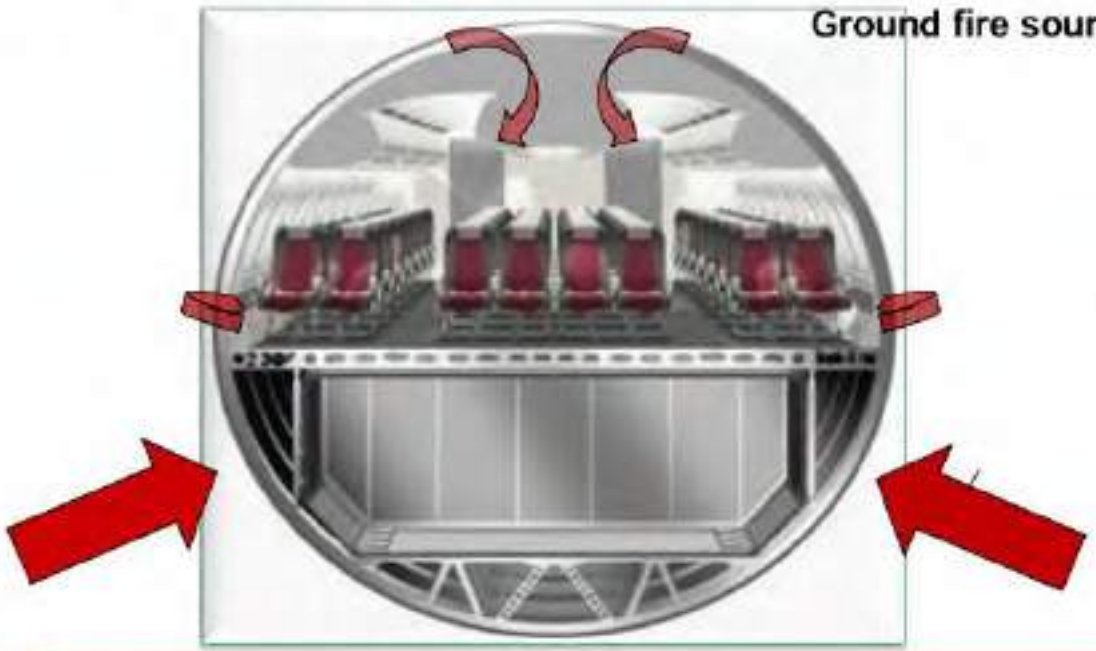
Objective:

The purpose of this document is to give firemen practices and fire behaviour to fight on CFRP material structure.

For any question, please contact airport operations department
airport.compatibility@airbus.com

Tests and recommendations

Certification requirements for structure integrity



Certification requires a structure integrity of **5 minutes** considering external fire.

Burn through requirement applies to the lower half of the shell only.

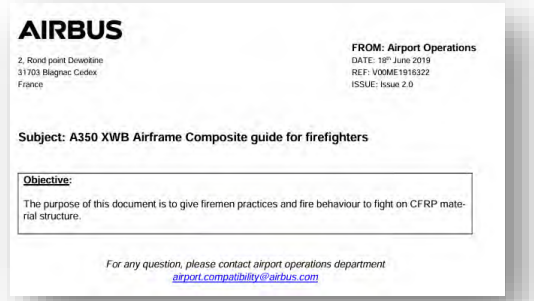
A350 certification test demonstrates an **equivalent** level of safety in comparison with aluminium fuselage.

AIRBUS

Tests and recommendations

- Flames do not spread.
- The CFRP Composite structures has an increased resistance penetration with aluminum structures.
- There is no spontaneous fire reignition.
- Tests have demonstrated that hazards of aircraft with CFRP Composite structures is comparable to aluminum fuselage.
- **However, specific care should be taken in case of intense a long-lasting fires.**

Test



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real life

What is really different?

Aluminum begins to degrade at 300°C to 400°C and can **melt** beyond 600°C. The degradation temperature that causes the burning of carbon fibers is between 400°C and 1000°C, depending on the strength of the fibers.

Tokyo Haneda Airport 02.01.2024

What is really different?

Experience from accidents

In the investigation report:

...due to the trapped heat in the composites, significantly more water was required than in a comparable case...

23.02.2008 B-2 Spirit of Kansas
Andersen Air Force Base

The question about the spread

- Are the composite materials the cause of the large fire spread and destruction?

No, there were other reasons

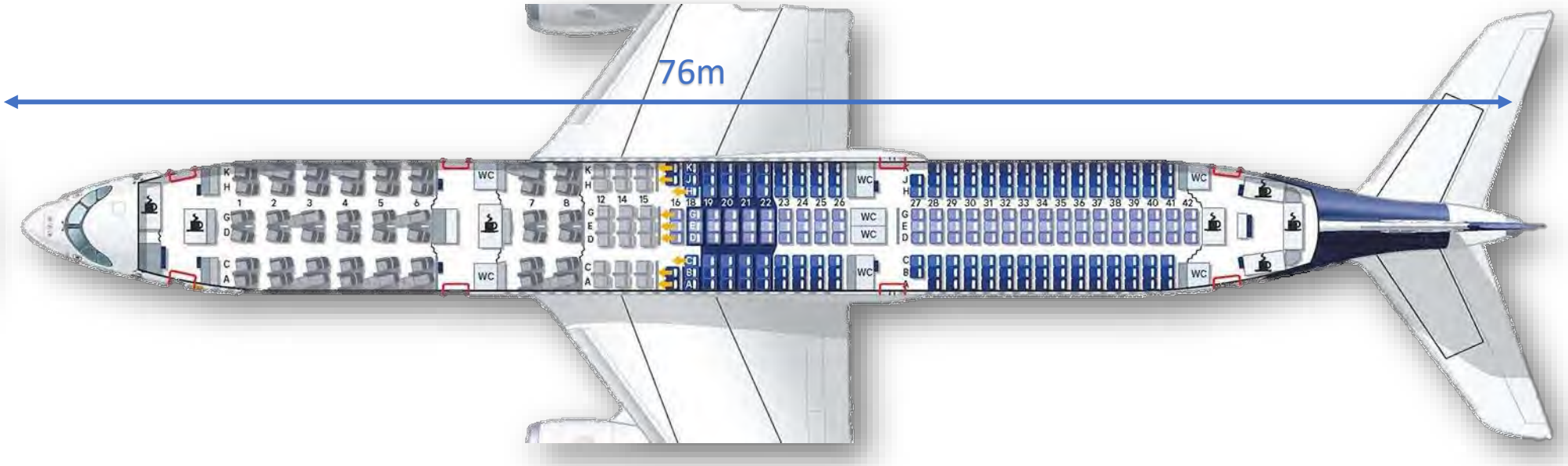
immediately after the evacuation

hours later

The problem started here

Missing constructional fire protection

60m



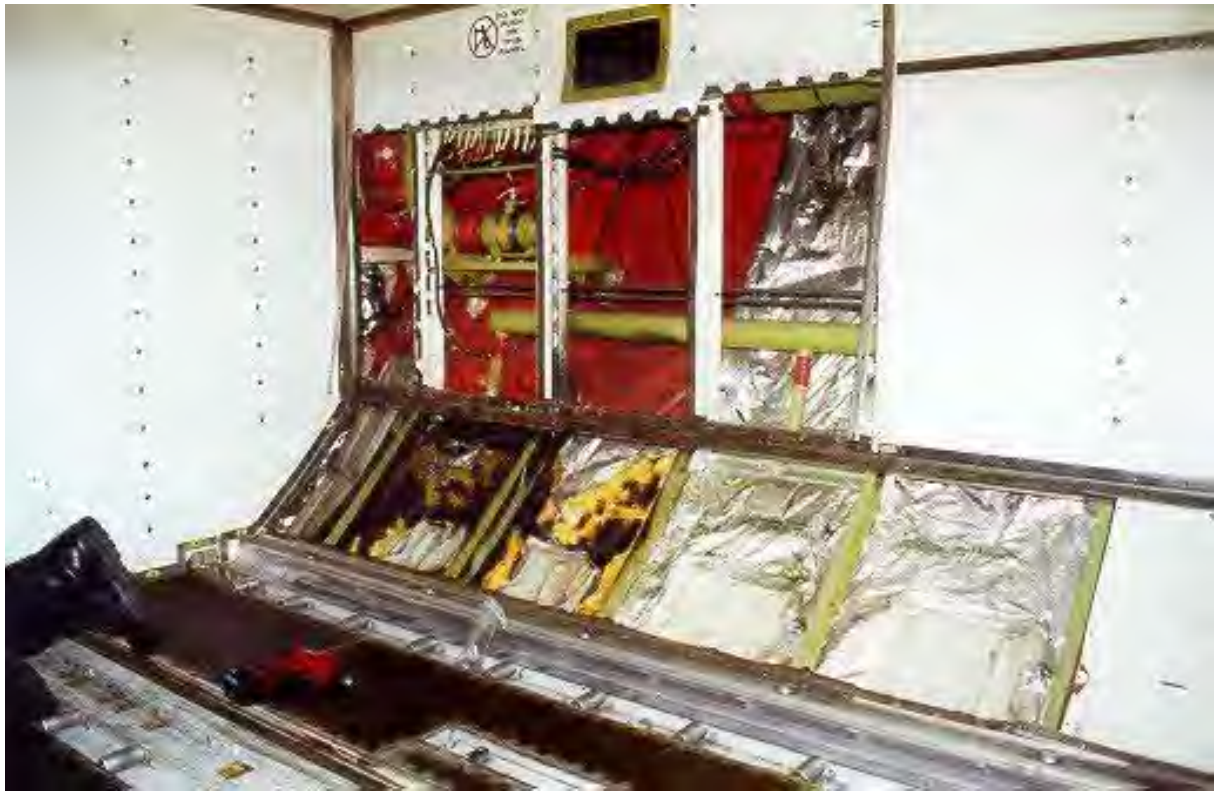
Using extinguishing water effectively

Fighting where the fire burns

HRET

Aware of Weight and Balance

Fighting where the fire burns



Typical tools

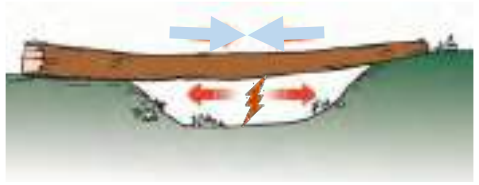
- Composite materials can by cut by conventional machining processes with hand machines and specific tooling (drilling, sawing, hand tools, etc.

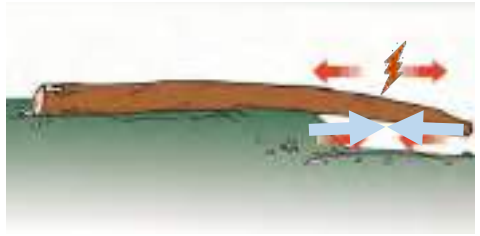
We assume that everyone is saved, we let it burn?

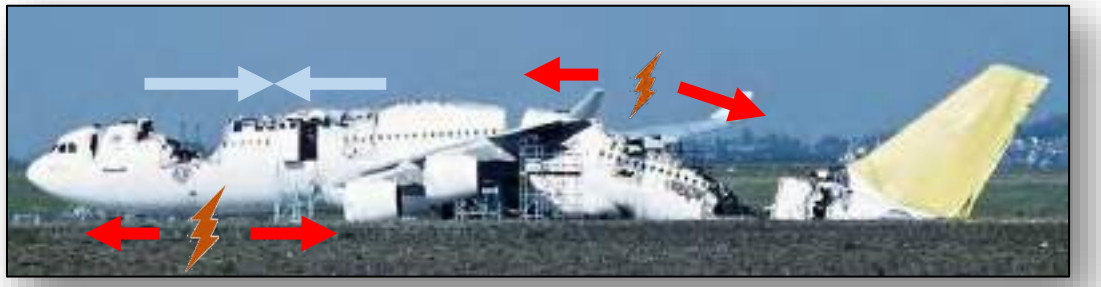
We assume that everyone is saved, we let it burn?

Is it safe enough to go in?

Traction and pressure zone

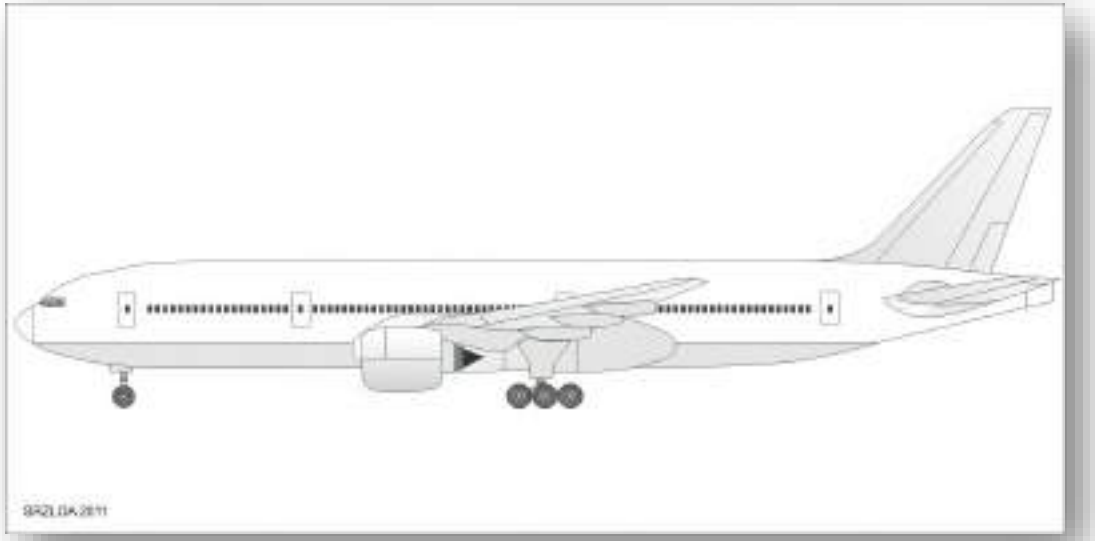


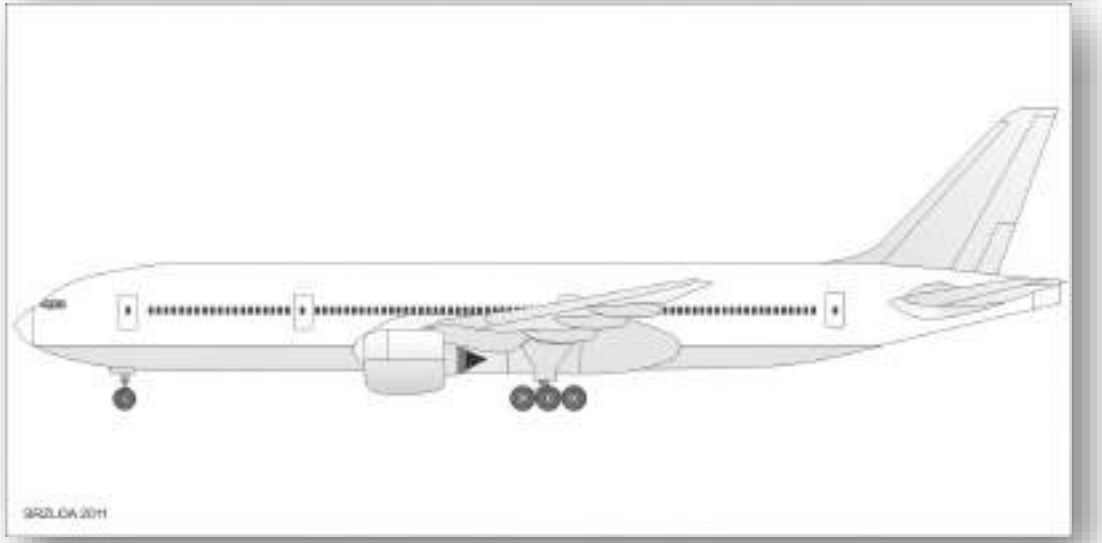




- An airplane has the same statics as a tree that has been felled
- Whether an aircraft breaks apart depends on the location of the damage.

Is it safe enough to go in?





We let it burn?

- Is that what the airport management wants?
- On the stand, at the gate?

Its possible

Its possible

Stadt Zürich
Schutz & Rettung

What is enough water?

Fire Chief
Andreas Lochmeier
Zurich Airport
Switzerland

Regulations

Regulations were copied

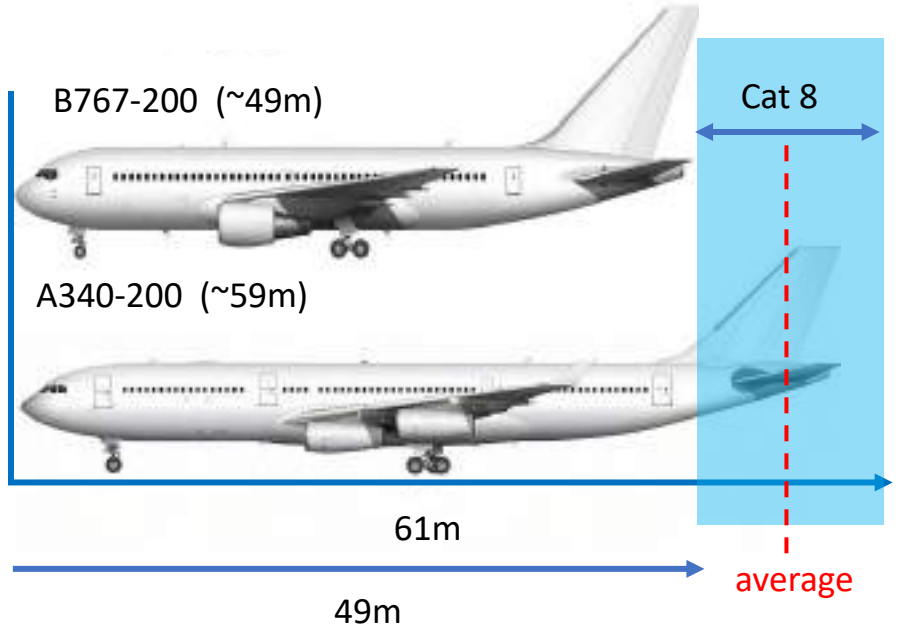
…but not all explanations

Airport category and amounts of water

Minimum usable amounts of extinguishing agents								
	Foam meeting performance level A		Foam meeting performance level B		Foam meeting performance level C		Complementary agents	
Aerodrome category (1)	Water (L) (2)	Discharge rate foam solution/ minute (L) (3)	Water (L) (4)	Discharge rate foam solution/ minute (L) (5)	Water (L) (6)	Discharge rate foam solution/ minute (L) (7)	Dry chemical powders (kg) (8)	Discharge rate (kg/sec) (9)
1	350	350	230	230	160	160	45	2.25
2	1 000	800	670	550	460	360	90	2.25
3	1 800	1 300	1 200	900	820	630	135	2.25
4	3 600	2 600	2 400	1800	1 700	1 100	135	2.25
5	8 100	4 500	5 400	3 000	3 900	2 200	180	2.25
6	11 800	6 000	7 900	4 000	5 800	2 900	225	2.25
7	18 200	7 900	12 100	5 300	8 800	3 800	225	2.25
8	27 300	10 800	18 200	7 200	12 800	5 100	450	4.5
9	36 400	13 500	24 300	9 000	17 100	6 300	450	4.5
10	48 200	16 600	32 300	11 200	22 800	7 900	450	4.5

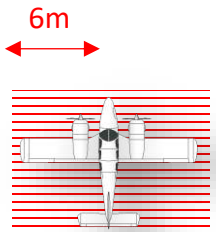
Note: The quantities of water shown in columns 2, 4 and 6 are based on the average overall length of aeroplanes in a given category

Aerodrome category for rescue and fire fighting		
Aerodrome Category (1)	Aeroplane overall length (2)	Maximum fuselage width (3)
1	0 m up to but not including 9 m	2 m
2	9 m up to but not including 12 m	2 m
3	12 m up to but not including 18 m	3 m
4	18 m up to but not including 24 m	4 m
5	24 m up to but not including 28 m	4 m
6	28 m up to but not including 39 m	5 m
7	39 m up to but not including 49 m	5 m
8	49 m up to but not including 61 m	7 m
9	61 m up to but not including 76 m	7 m
		8 m



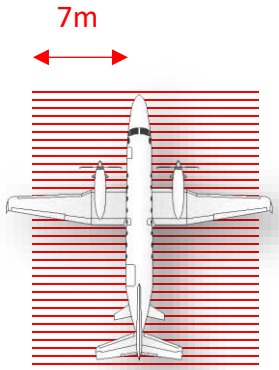
Critical Area

Critical Area
12m + W
X L



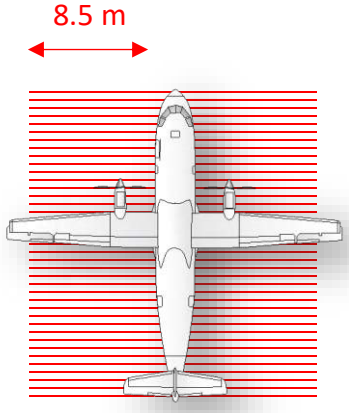
Overall length
0 – 12m

Critical Area
14m + W
X L



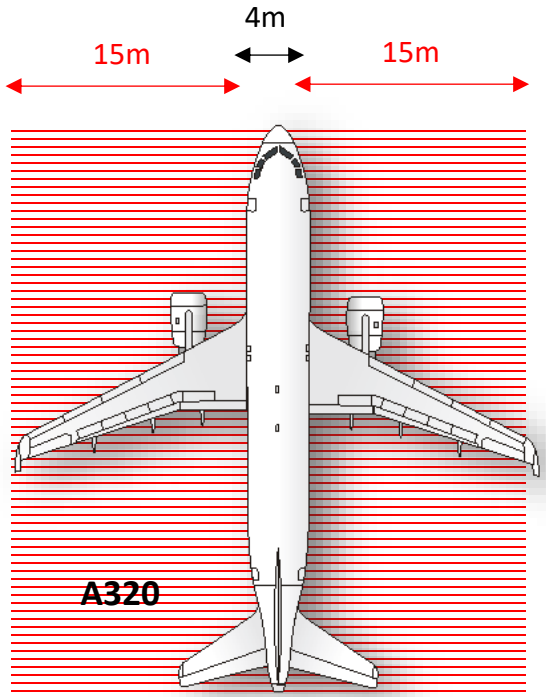
Overall length
12 – 18m

Critical Area
17m + W
X L

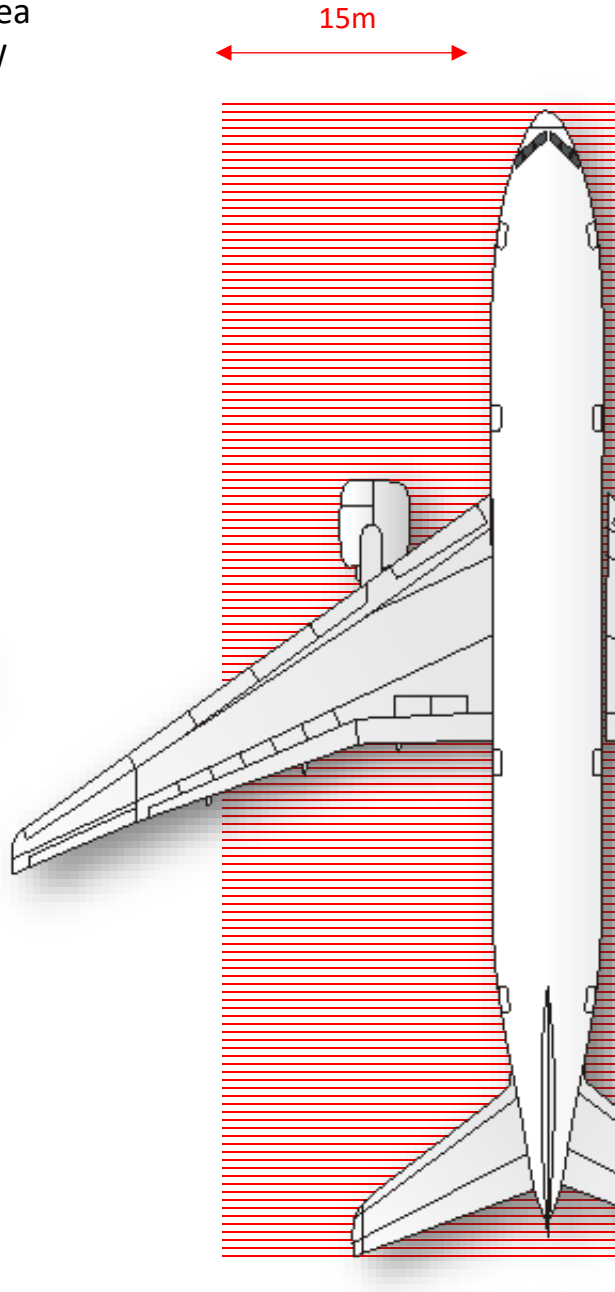


Overall length
18 – 24m

Critical Area
30m + W
X L



Overall length
> 24m

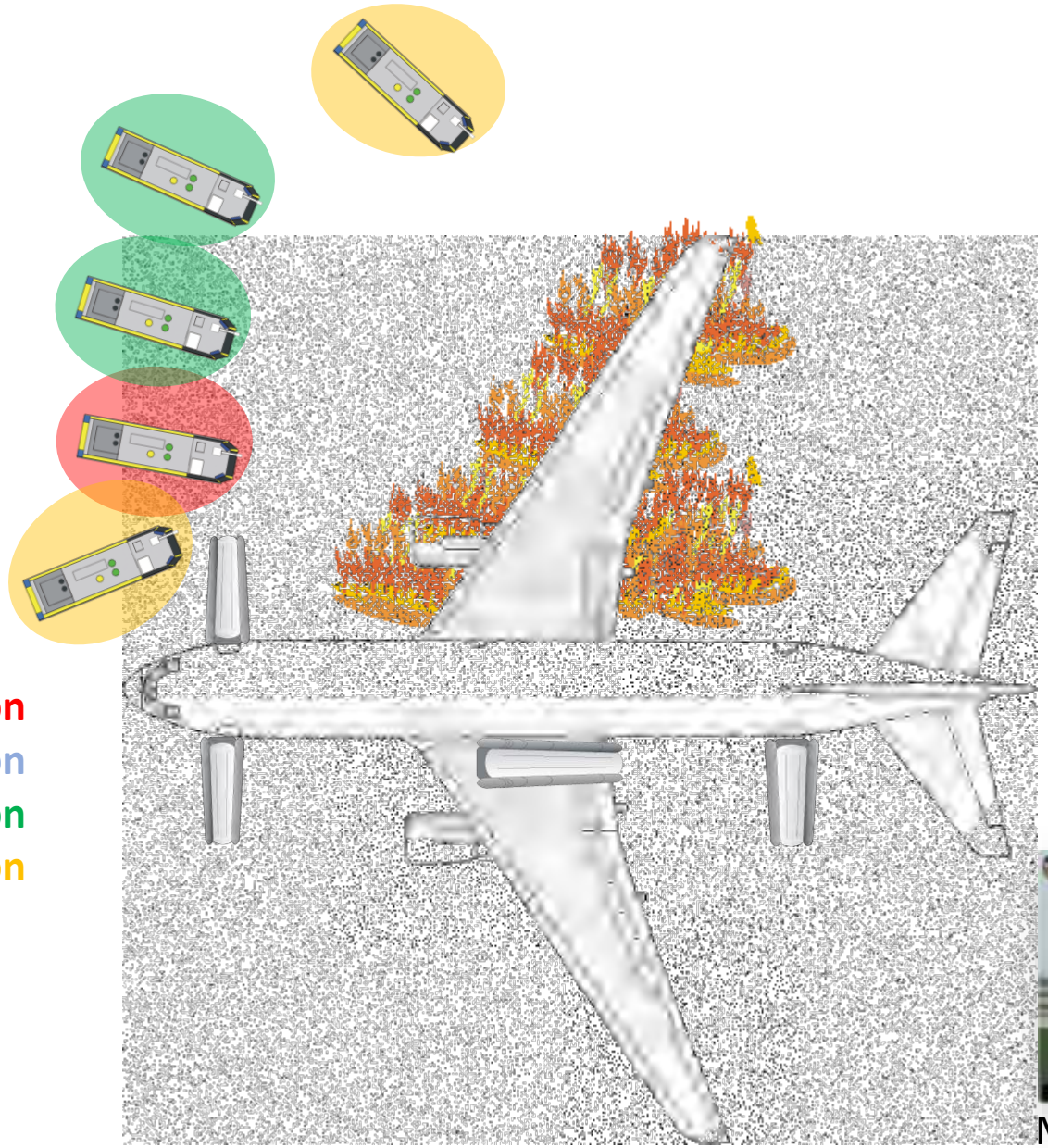


Real life – HUMAN FACTOR – real problems

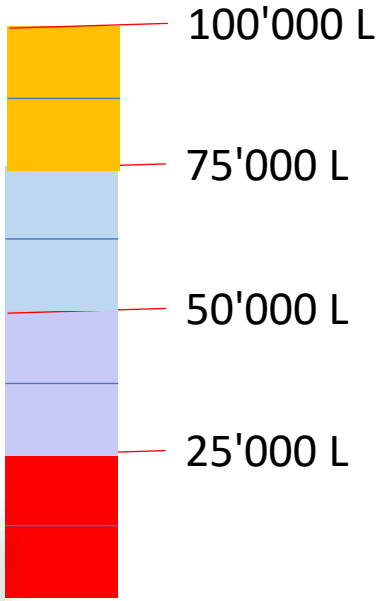
- The biggest problem in the calculation is the human factor.
- It has the greatest influence on water consumption
- A lack of training or uncoordinated management during operations leads to a massive increase in water consumption, which can quickly increase by a factor of 4x - 10x.

Real life – HUMAN FACTOR – real problems

1. **Station**
2. **Station**
3. **Station**
4. **Station**



Movie



Crisis Management and preparedness

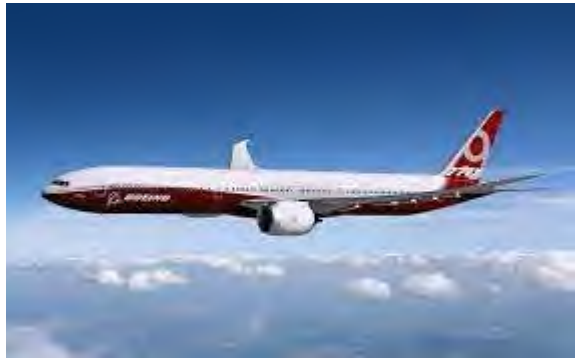
- ARFF is a highly specialized component of the fire service.
- An aircraft accident presents itself with a different hazards that threaten the aircraft occupants, the community, the environment and the emergency responders.
- ARFF crews must respond quickly and with precision to minimize loss of life, injuries and dangers.
- Fortunately, serious accidents are fairly rare, but that benefit means that experience can only be built through training and learning from others rather than from actual accident experience.

Testing and adjusting to new technology

New advanced technology for Aircrafts

- Aircraft design – next generation
- Cockpit design – computerized
- Composite materials
- BIO fuels

New advanced technology for Aircrafts
Aircraft design – next generation



Testing and adjusting to new technology

New advanced technology for Aircraft Rescue Fire Fighting

- ARFF vehicle design
- HRET - High Reach Extendable Turret
- High flow turrets
- Hydro-Chem systems
- CAFS - Compressed Air Foam Systems
- High pressure and Ultra-high pressure hand line systems
- FLIR - inferred cameras

New advanced technology for Aircraft Rescue Fire Fighting ARFF vehicle design

New advanced technology for Aircraft Rescue Fire Fighting

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New advanced technology for Aircraft Rescue Fire Fighting

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Tradition & Regulations?

- Aviation Fire Services regulations and legislation has its roots within the ICAO recommendations. These are usually put into a country's national law.

- Most airlines require ICAO recommendations as a minimum airport standard.

- Sometimes Fire Service traditions interferes with progress and makes changes difficult.

  "If its not in the ICAO recommendations – then we don't do it and can not get it funded" and *"We've always done it that way"'*

- Is just keeping up with tradition or regulations enough?

Lack of ICAO recommendations on Tactical Approach to Firefighting in modern and future composite aircraft?

- Almost all ICAO documents Anex 14 and Airport Service Manuals are based on aircrafts from the pasted!
- There is a lack of recommendations from ICAO on all the equipment and technology from the industry developed.
- ICAO recommendations need to be updated!
- We need to be looking forward and not backward. We need better recommendations from ICAO, to insure global understanding on Tactical Approach to Firefighting in modern and future composite aircraft.