Hidden fire program :Evaluation of materials located in inaccessible areas with the radiant panel

Anne Mansuet
Centre d'Essais Aéronautique de Toulouse
47, rue Saint – Jean BP 53123 31131 BALMA Cedex - France

Abstract

Accidents and incidents due to the development of fire in hidden areas have led the Authorities to investigate the fire behaviour of insulation systems.
In July 2003, the FAA published the final rules concerning flammability standards for thermal and acoustical insulation materials used in transport category airplanes.
Today, the need to ensure the same level of safety for all materials present in inaccessible areas in flight has been identified (2).
The DGAC has proposed a working program (1), which involves the Centre d'Essais Aéronautique de Toulouse, Airbus and materials suppliers. The objective of this research is twofold:

- To identify the materials and combination of materials which have to be assessed, then
- To conduct some representative tests in order to check their possible contribution to fire propagation.

This paper describes the tests conducted at the CEAT. Primarily used to evaluate the flame propagation on insulation blankets, the radiant panel offers several ways to check the behavior in terms of flame propagation of materials or systems located near the insulation systems . The first results and future developments are presented in this paper.

Introduction

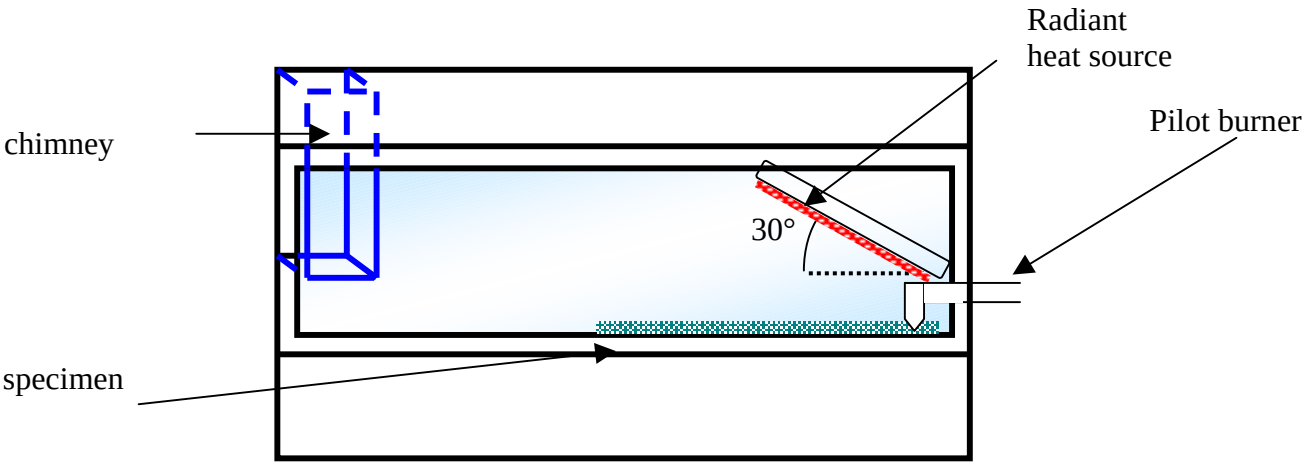
In survivable accidents of commercial aircraft, a significant number of fatalities are caused by the effects of fire. Investigations conducted after the accident of the Swissair MD11 at Peggy's Cove-Nova Scotia, Canada in 1998 showed that the fire developed between the fuselage and the passenger cabin. The insulation was involved in the propagation of the fire.

Till 2003, the fire properties measured on these materials were only the self-extinguishing ability.
Numerous studies have been initiated in the US to find a new test able to evaluate, at first hand, the insulation blankets.
The aim was to improve the fire properties of acoustical and thermal insulation systems.
The radiant panel was selected after many investigations with other equipment (4) to measure two main parameters:

- the flame propagation
- the after flame.

The test results correlate the results with large scale test carried out at the Technical Center.
The FAA finally selected the radiant panel as a new regulatory test and the new regulation was published in July 2003.
To raise the fire safety level of all materials to that proposed for thermal acoustical insulation CEAT began to investigate the fire behavior of some of them with the radiant panel.

General description of the radiant panel



The fire source of this equipment is composed of an electrical radiant source and a pilot burner.
All the tests have been performed with the radiant panel.
At first in the standard conditions :
Radiant panel standards conditions :
17kW/m² at the 0 position
pilot burner applied 15 seconds
Secondly some of the tests have been performed with pre-heating before ignition

Materials other than insulation in hidden area.

The firs step was to identify the areas which present an interest for testing then, the materials or combination of materials located in these parts.

This picture represents the interior of an Airbus A320

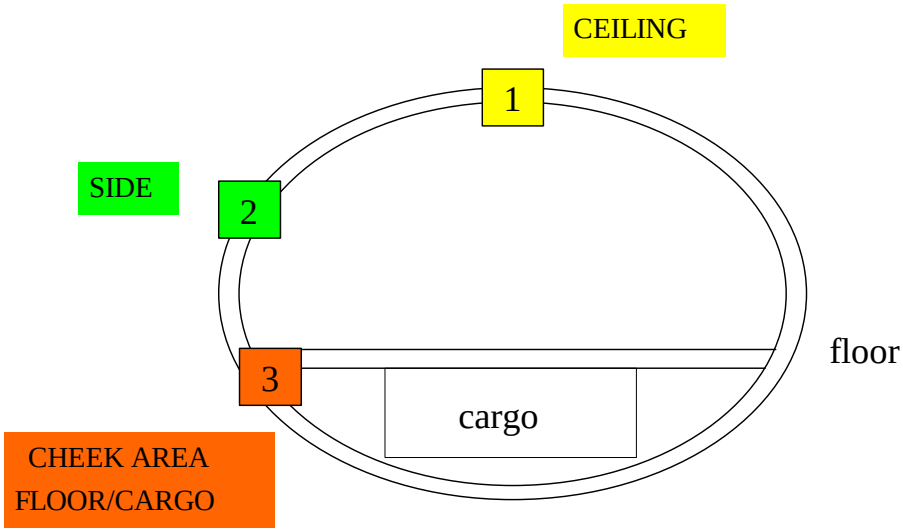


Figure 1

Figure 2

In the hidden area, three zones have been identified :
They are:
1- an area representative of the ceiling (upper zone)
2- area representing the lateral panels (side zone)
3- the area located between cargo and floor (cheek area)
Materials located in these parts:

- Ducting
- Air conditioning components
- Electrical components (bundled wires etc..)
- Foam
- Panels

The combination of materials representative of the first and second area is:

- fittings of wires on insulation blankets
- Air ducting materials with insulation foam and adhesive.
- Complex fittings of wires and different cable ties on insulation blankets

Materials fitted in the third zone have not been supplied yet.

Tests on wires

The types of wires tested are currently mounted on airplanes :

TK 26 1.8mm diam white polyimide/FEP	SJ20 1.8mm diam blue polyimide/FEP
CF10 3.2mm diam white polyimide/FEP	SJ22 1.5mm diam white polyimide/FEP
CF22 1mm diam green polyimide/FEP	

Construction of the specimen

10,14 and 30 wires are bundled with polyamide cable ties spaced out from 2 up to 5cm and located on insulation boards (n°1 to3) or insulation blankets (n°4 to 7).
Test results are not repeatable : after removing the pilot burner the cable ties melted with an after flame in some cases.

Test N°	Materials	Flame propagation	After flame	comments
1	14 bundled wires + 4 cable ties spaced out1,5 cm	0	0	
2	14 bundled wires + 4 cable ties spaced out 2 cm	0	1 min 40 seconds	The cable tie melted then burnt
3	10 bundled wires + 5 cable ties spaced out 2 cm	0	0	
4	10 bundled wires + 3 cable ties spaced out 2 cm +insulation blanket	0	3min 23 seconds	
5	14 bundled wires + 2 cable ties spaced out 5 cm +insulation blanket	0	0	
6	30 bundled wires + 2 cable ties spaced out 5 cm +insulation blanket	0	0	The cable ties melted without burning

Pre-heating five minutes and radiant panel standards conditions :

7	10 bundled wires + 3 colliers spaced out 2 cm	0	0	No differences compared to the others samples

A second series of test was carried out on 30 wires bundled with 5 cable ties spaced out every centimetre located on the insulation blanket made of PVF film+ 2 layers of fiberglass of 0,42 pcf.

In every test, the impingement of the burner is positioned on the cable tie.

Test	Materials	Flame	After flame	comments

N°		propagation		
8	30 bundled wires + 5 cable ties spaced out 1cm + insulation blanket	no	6 min 53 seconds	After removing the burner The flame propagates through the cable tie
9		no	4 minutes 32 seconds	
10		no	6 min 35 seconds	

Tests on the combination of materials representative of the upper zone and the side zone
Materials supplied :

- PEI and laminated glass phenolic for air ductings
- Insulation of air ductings consists of hypalon and polyimide foam
- Standard insulation blanket (2 layers of 0,42pcf fiberglass and PVF film)
- Polyamide cable ties
- Several types of polyamide and peek brackets

Reference	Sample description	flame time (DEF) flame propagation	Photos
R17	Insulation hypalon/foam+ insulation blanket + laminate	DEF 0 Propagation 0	
R18	Idem R17 + bundled wires + 3 cable ties every 1.5 cm	DEF 0 Propagation 0	
R19	Idem R18 avec PEI instead of laminate	DEF 0 Propagation 0	

R20	blanket polyamide + bundled wires	DEF 144s Propagation 0	
R22	blanket + black PEEK bracket and metallic ring	DEF 4 seconds	
R23	blanket +black cable ties from1,5 cm orange polyamide bracket	DEF153 seconds The flame remains on the orange bracket	
R24	Idem R22	DEF 6 seconds	
R25	Idem R23 without black cable tie	DEF 263 seconds The flame remains on the orange bracket	

Then two tests were carried out with **10 minutes** pre-heating before positioning the pilot burner on the sample.

R27	PEI + hypalon/foam + bundled wires + black cable ties	DEF 0	
R28	PEI alone	DEF 3 secondes	

Discussion

Tests on wires

A large scattering appeared in the test results.

As soon as the sample was placed under the radiant panel the cable ties melted and after removing the burner from the wires, we observed an after flame in two cases of more than 1minute.

In the case of a 1 cm cable tie separation, the PVF film melted first, then the cable ties melted too. After having removed the pilot burner, a flame remained and spread to the second clamp, and then the third .

The attachment clamps pitch seems to be in certain cases a factor of risk in flame propagation.

However, all the series of tests carried out with the radiant panel show that the wires themselves fitted on airplanes contribute neither in after flame nor in flame propagation.

Tests on combination of materials

In the case of development of after flame due to the polyamide brackets or the position of the cable ties, we can observe that the flame remained locally around the cable ties but did not propagate onto the insulation blanket.

Conclusion

None of the combinations tested showed any flame propagation.

The flame only involved the brackets but did not lead to ignition of the materials located nearby

The scenario which involved cable ties, bundled wires and insulation is a good example of what we can do with the radiant panel. Minimum distance criteria between two cable ties may be established when this type of material is fitted in hidden areas on planes.

Future developments

CEAT is continuing the test program by focusing on radiant panel. The following step will consist in :

- testing material representative of the cheek area
- Pre-heating the samples
- Igniting the samples with arcing instead of a pilot burner

Further test works are already planned to continue evaluating the materials located in hidden areas. However, the proceeding of this study depends on the supply of materials by manufacturers. A large part of these investigations will be conducted in the scope of the research program led by DGAC. Furthermore, these works should lead to the development of new standards which aim at obtaining the same level of safety as insulation blankets in each hidden area assessed.

References

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(4) Development of a test method to determine the flammability characteristics of aircraft thermal acoustical insulation materials june 99 - Severine Fiorletta