New materials for fire protection in cabin environment - Final requirements, selection and specification of tests and materials

I. Roese-Koerner (DLR), M. Hraska (VZLU), G. Mirra (ALENIA), J. Bachmann (DLR), M. Liebisch (DLR)

Short abstract: Future Sky Safety is a Joint Research Programme (JRP) on Safety, initiated by EREA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the EREA institutes and 2) collaborative research projects on European safety priorities.

This deliverable is produced by the Project P7 “Mitigating the risk of fire, smoke and fumes”. The main objective of this deliverable is to describe the test program planned to characterize some improved material solutions with respect to fire, smoke and fumes mitigation in the cabin environment.

Programme Manager	Michel Piers, NLR
Operations Manager	Lennaert Speijker, NLR
Project Manager (P7)	Eric Deletombe, ONERA
Grant Agreement No.	640597
Document Identification	D7.2-ES
Status	Approved
Version	2.0
Classification	Public

EXECUTIVE SUMMARY

Problem Area

Many studies on the current flights show that about 50% of the fatalities in case of aircraft accidents are linked to situations where fire is involved. Hundreds of fatalities could be saved per year if fire effects on the primary structure or in the cabin environment were mitigated. The development of larger, more electric and more lightweight aircraft (with an increase use of Carbon Fiber– Reinforced Plastic (CFRP) composite parts) raises several safety questions with respect to unknown behaviours of the materials and structures when exposed to fire. But the scope of this problem is large, embracing a variety of problems and solutions: the use of fireproof and less toxic materials, the early detection of fire, the simulation of passengers' evacuation, etc.

Future Sky Safety Project P7 "Mitigating the risks of fire, smoke and fumes" will focus on effects of fire on new materials with improved fire properties (production of heat, toxic fumes and smokes), and on the effect of fire on mechanical behaviour that can endanger the passengers' life. The scope of the works will cover both primary structures materials (e.g. epoxy resin, carbon fibre reinforced polymers) and cabin materials (e.g. phenolic polymers, glass fibre reinforced plastics). The objective of WP7.2 is to develop and utilize novel and innovation material solutions with high potential for mitigating risks of fire, smoke and fumes in the cabin environment. To achieve this aim, proposed highly resistant materials will be tested according to prescribed test plan, which will allow to address their mechanical properties with respect to fire exposure. The scope and magnitude of proposed test plan respect industrial safety requirements and usage of state-of-the art simulation tools.

Description of Work

The objective of this study is the selection and description of final requirements and specifications of the tests and studied materials to mitigate and protect from fire, smoke and fumes in cabin environment (plus toxicity). This includes the definition of the plan for the experiments and data content.

Results & Conclusions

This study provides the requirements and specifications of the tests and studied proposed highly resistant materials. The scope and magnitude of the test plan defined for the experiments and the data content respect industrial safety requirements and usage of state-of-the art simulation tools.

The material tests are described considering the test methods, the specimen size, and the realisation. Test requirements have been defined for interiors panels (lining), in terms of certification rules and relative test in compliance with them, and the definition of material characteristics that must be measured during the test useful to the numerical correlation of numerical model.

Future Sky Safety has received funding from the EU's Horizon 2020 Research and Innovation Programme, under Grant Agreement No. 640597.

The present results of actions taken during preparation of this study are related to definition of suitable and innovative material systems with high potential to mitigate and protect from fire, smoke and fumes in cabin environment while respecting industrial safety requirements and usage of state-of-the art simulation tools. A summary of planned experiments is shown in Table 1.

This report covers all needed actions for fulfilling the next steps in the planned activities, where first and second batch of material samples will be tested and evaluated.

Table 1: Plan of experiments

Test	*Test method*	*Parameter*
Flame Propagation / Flammability	AITM 2.0002A (vertical, 60 sec)	Fire properties
Flame Penetration Resistance	CS 25 Appendix F, part III	Fire properties
Heat Release Rate	AITM 2.0006	Fire properties
Smoke Density	AITM 2.0007A	Fire properties
Smoke Toxicity	AITM 3.0005	Fire properties
Back surface temperature profile	DLR test method	Fire properties
Mechanical properties after fire exposure	DLR test method	Fire properties
Tension	ISO 527-4 ASTM D 3039	Mechanical properties
Compression	PrEN 2850 ASTM D 6641	Mechanical properties
Flexural (3PB)	ISO 178	Mechanical properties
Lap shear	DIN EN 6031	Mechanical properties
Impact (CAI)	AITM 1.0010 ASTM D 7137	Mechanical properties
Shear	DIN EN 6031	Mechanical properties
DMA	ISO 6721, Part 3	Mechanical/thermal properties
TMA	DIN 57752	Mechanical/thermal properties
DSC	VZLU test method	Mechanical/thermal properties
TGA	VZLU test method	Thermal properties
Density	Hydrostatic weighing	Material value

Applicability

On the basis of the requirements and tests defined in this document, the tests will be executed. Aim of the tests will be:

- Verification of the compliance with the certification requirements;
- Measure of the material characteristics.

The applicability is dual:

- Evaluate the material capacity to withstand at high temperature/fire condition;
- Use the material characteristics measured as input data for activity of experimental/numerical correlation of the simulation model.