The Development of a Lightweight Flight Recorder

Developing a lightweight flight recorder based on experimental characterization and simulations using COMSOL Multiphysics®.

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INTRODUCTION

Serma Ingénierie is a subsidiary of Serma Group, specializing in electronic, electrical, and mechanical engineering. Their primary focus is on guiding clients in developing high-quality technological products and ensuring compliance with standards and regulations.

This work presents the development of a Lightweight Flight Recorder (LFR). A recent legislative change has highlighted the need for this type of equipment. The main challenge involved miniaturizing the technology to make it compatible with light helicopters and ensuring it meets the ED-155 standard. According to this standard, the equipment must successfully pass shock, crush, and fire tests. This presentation aims to describe the work conducted regarding the fire tests, which require the equipment to withstand a flame of 1100°C and 158 kW/m² for 15 minutes.

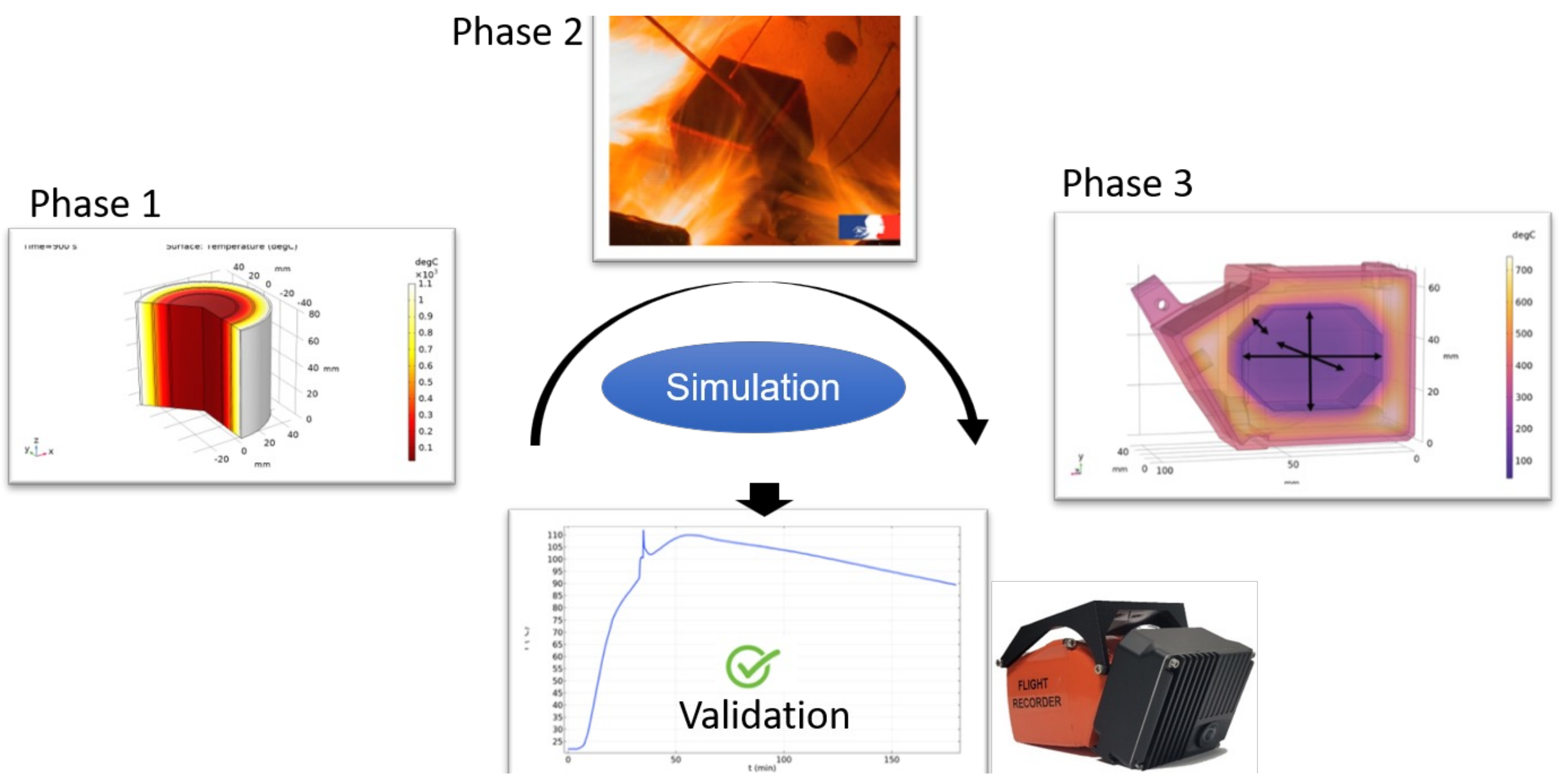

FIGURE 1. Development assisted by COMSOL Multiphysics® for the design of a Lightweight Flight Recorder

METHODOLOGY

To achieve this design, extensive work was done in various domains, such as researching high-performance materials, optimizing configuration and geometry, and conducting materials and flame thermal modeling. The latter was one of the most significant challenges to propose a design capable of passing the ED-155 fire test. This was made possible through a combination of experimental measurements and Finite-Element Method simulations using COMSOL Multiphysics®.

Phase 1: Preliminary study on simplified geometry models.

Phase 2: Fitting of experimental curves to define precise materials models.

Phase 3: Shape optimization.

RESULTS

The main difficulties in developing the flight recorder were creating thermal models for the flame and for the materials protecting the recording card. COMSOL Multiphysics® software was crucial to the development process. In phase 1, rapid simulations using the Heat Transfer Module allowed us to select the materials and arrangements best suited for the equipment. In phase 2, the Optimization Module greatly aided in developing precise thermal models of the materials. By fitting experimental curves, accurate thermal behaviors of the arrangement were determined. Finally, in the last phase, the Optimization Module helped us find the optimal ratio for the internal material dimensions.

The development phase was successfully concluded. A device that passed ED-155 thermal tests was fabricated. Its dimensions are approximately 140x90x80 mm³.

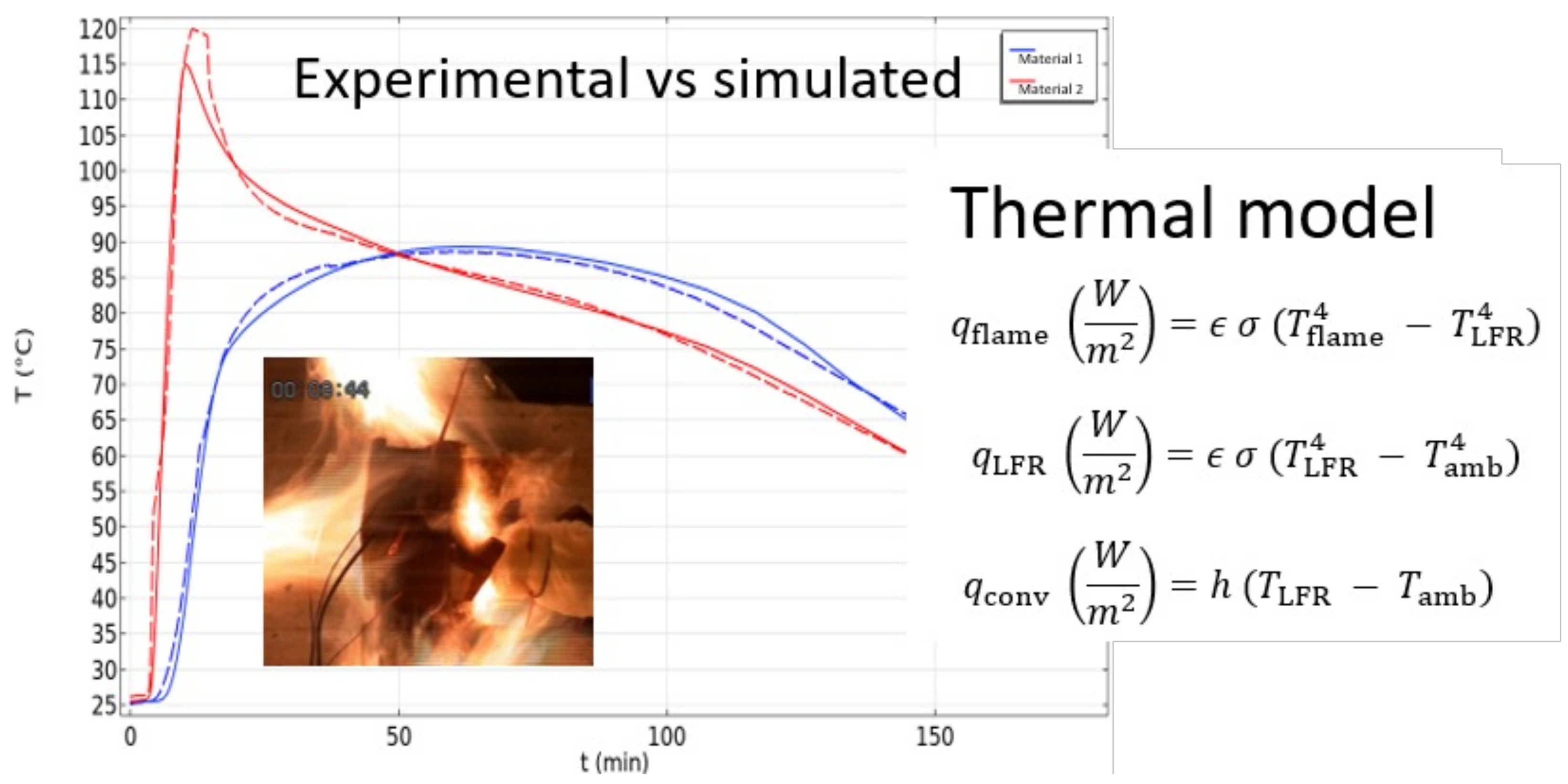

FIGURE 2. Temperature as a function of time during a flame test at the interface between different internal materials. Dotted curves are experimental and straight lines are simulated.

REFERENCES

1. S. Bourbigot et al., "Foamed geopolymers for fire protection: Burn-through testing and modeling", Fire and Materials, Volume 46 Issue 7, Pages 1011-1019 (2022).

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