Numerical Simulation for Fire Suppression Agent Propagation in an Aircraft Cargo Compartment

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Cargo fire extinguishing systems installed in aeroplanes generally use Halon 1301 as fire suppression agent. One widely used method to ensure efficiency of Halon 1301 cargo fire suppression systems requires an initial concentration of five percent by volume in order to knock down a cargo fire. Subsequent concentration levels should not drop below three percent by volume for the remainder of the flight in order to suppress a cargo fire until it can be completely extinguished by ground personnel following a safe landing.

During aircraft development phase, fire extinguishing system overall design and agent quantity sizing is determined based notably on cargo compartment design characteristics. The verification of fire extinguishing systems compliance against the required concentration thresholds is then generally verified by dedicated tests on aircraft during the flight test campaign.

The purpose of this paper is to present the methodology developed by Airbus for the prediction of accurate fire extinguishing agent concentration in aircraft cargo compartment. This methodology is based on predictive simulation of fire extinguishing agent in the compartment that will help to ensure correct design sizing during aircraft development phase, secure flight test campaign and contribute to success of aircraft certification process.

In the first part of this project, a full sensitivity analysis has been performed to identify the main drivers of the phenomenon over the different halon bottle discharge phases and highlight the necessary inputs to reach satisfactory modelling accuracy. The required simulation tools to be used in the methodology have been also taken into consideration.

In a second part, the modelling process has been set-up based on physical analysis of the different phases of the discharge phenomenon. The simulation methodology has been divided in several steps that will be further detailed, and the mandatory inputs for correctness of the model will be also highlighted.

Finally, the methodology has been validated by comparison of available flight test data versus numerical simulation predictions. Correlation has been established enabling the validation of the approach.

Thanks to this study, Airbus has developed and validated a methodology allowing early concept studies and is in the position to ensure efficiency of the fire suppression agent propagation in the cargo compartment at early development phase.