

Title: Investigation of cargo hold fire suppression agent concentration profiles for Halon replacement

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The goal of this research is the replacement of today's cargo fire extinguishing agent Halon, a substance with high global warming potential of 7100. In the "Environmentally Friendly Fire Protection" project the distribution of new, environmentally friendly fire extinguishing agents and systems for the cargo area are experimentally investigated. Discharge characteristics and concentration profiles are measured under various climatic conditions. The aim is to highlight influences on the concentration profile in the cargo hold over the entire flight cycle until landing. For this purpose, the temperature of the cargo area and extinguishing agent storage bottles, the cargo load density and the extinguishing agents are varied. The unique low pressure vessel of the Fraunhofer Flight Test Facility allows the replication of a realistic cabin pressure profile, taking into account the ingress of fresh air during descent due to repressurization and the interaction with the cabin. Hence, the overflow of suppression agent into the passenger compartment could be assessed.

The project has enabled the investigation of various demonstrators such as:

- Nitrogen suppression system
- Use of the On-Board Inert Gas Generation System (OBIGGS), a technology derived from fuel tank inerting
- High-boiling point suppression agent

As a means to passively increase the fire suppression system performance, the so called Blower Door Method has been adapted to detect and seal leakages in the cargo liners. This method involves creating a pressure and temperature difference between the cargo hold and surrounding compartments. Leakages thus become visible by their infrared fingerprint. This method helps reducing the fresh air ingress leading to dilution of the fire suppression agent.

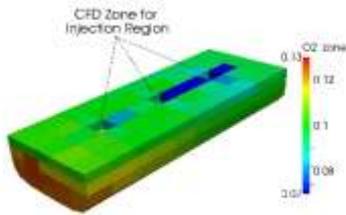
Besides the experimental campaign a model based design approach to predict the agent distribution in the cargo hold was validated against the test data. The models implement the zonal decomposition of the cargo hold, an agent distribution model and a CFD domain of the injection region. Such models enable the scalability of the test results to other aircraft platforms or transient mission profiles.



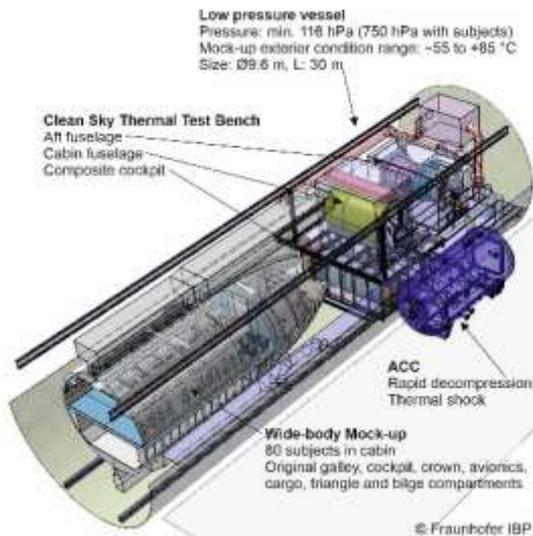
Photograph of the cargo hold in the Flight Test Facility



Infrared image for leakage detection („noses“ visible between the vertical and the inlined side liners)



Simulated concentration profile using the zonal model



Schematic view of the low pressure vessel in the Flight Test Facility, tests took place in the wide-body demonstrator



Image of the low pressure vessel