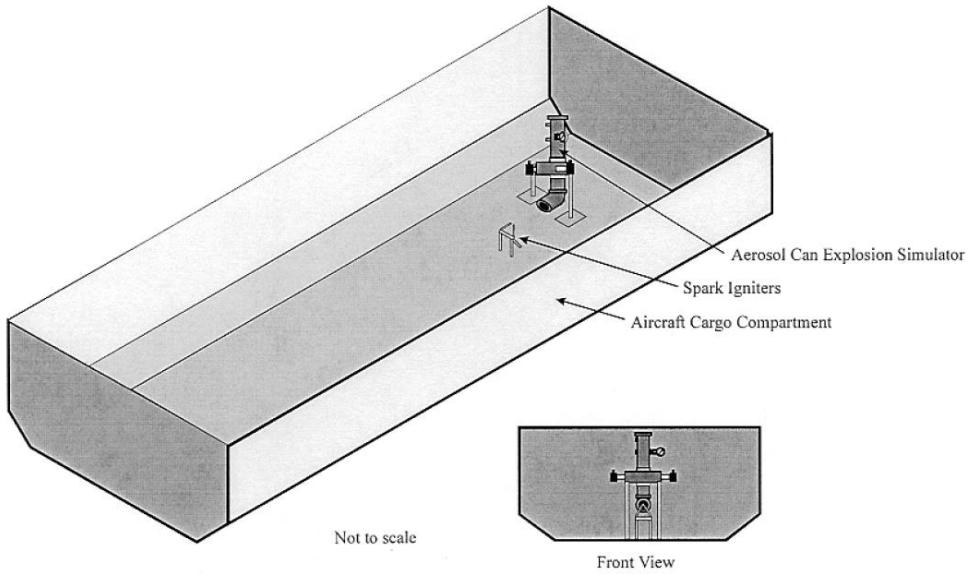
Aerosol Can Explosion Simulation Test Proposed MPS Changes



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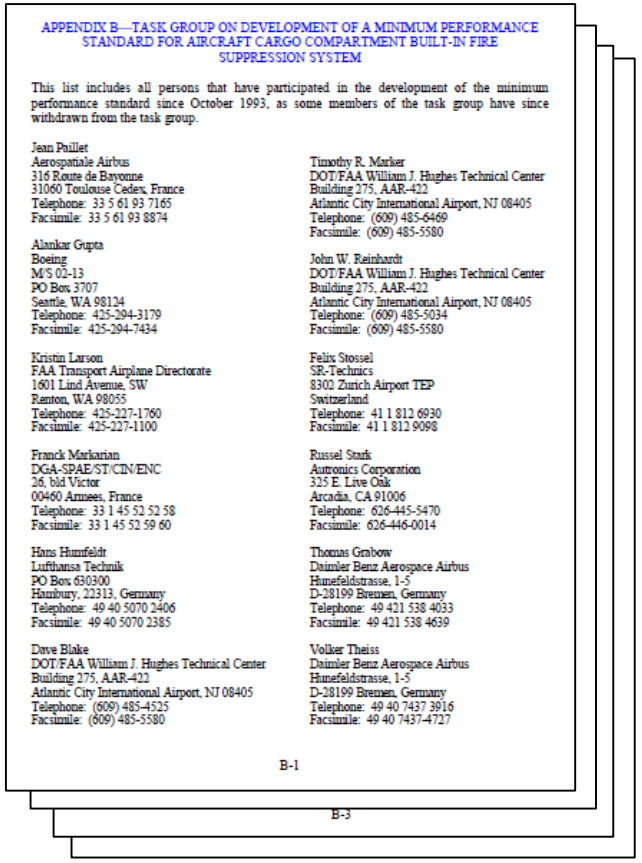
Acknowledgement

- All figures in this presentation are from FAA Testing at the FAA William J. Hughes Technical Center and have been provided by the FAA

The following FAA Technical Notes have been used in this presentation:

- DOT/FAA/AR-00/28, “Development of a Minimum Performance Standard for Aircraft Cargo Compartment Gaseous Fire Suppression Systems”, John W. Reinhardt, David Blake, Timothy Marker September, 2000.
- DOT/FAA/TC-TN12/11, “Minimum Performance Standard for Aircraft Cargo Compartment Halon Replacement Fire Suppression Systems (2012 Update)”, John W. Reinhardt, May 2012.



APPENDIX B—TASK GROUP ON DEVELOPMENT OF A MINIMUM PERFORMANCE STANDARD FOR AIRCRAFT CARGO COMPARTMENT BUILT-IN FIRE SUPPRESSION SYSTEM

This list includes all persons that have participated in the development of the minimum performance standard since October 1993, as some members of the task group have since withdrawn from the task group.

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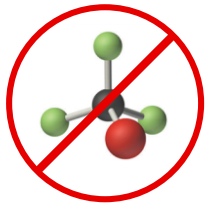


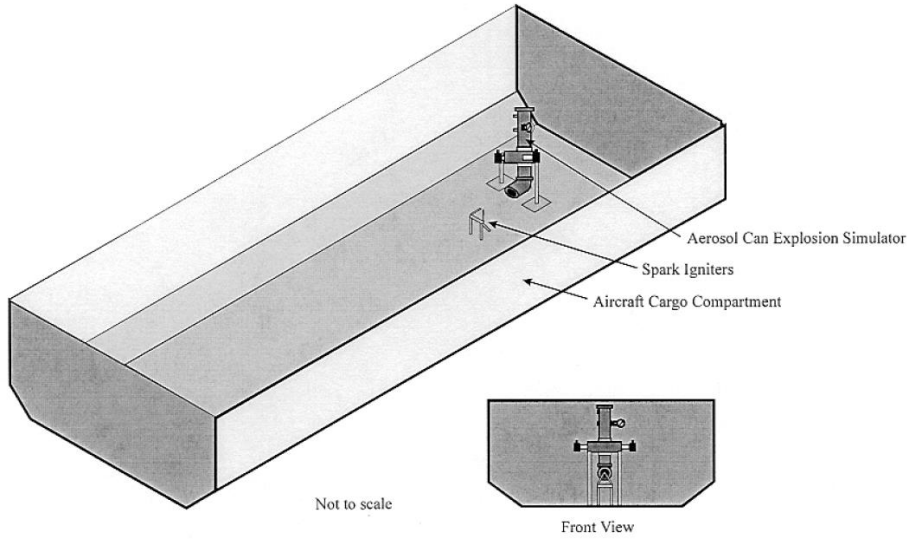
Challenges with the Current Cargo MPS Aerosol Can Explosion Simulation Test

- Some clarification is needed in how to run the Short Version of the Aerosol Can Explosion Simulation Test in order to avoid unrealistic settling of the agent

- The criteria in the Aerosol Can Simulation Explosion Test if interpreted literally, is unnecessarily constraining. As written, Halon 1301 can't meet the criteria to have no reactions. Replacement agents will have the same challenge.

Challenge With Agent Settling During The Test

- Typical Test Protocol:
  - Agent is discharged into compartment with no mixing mechanism. Agent is heavier than air, so it will settle with time.
  - While the MPS document does not preclude metering, it would be difficult to meter and not exceed the minimum design concentration at the igniter
  - The simulator Propane/Ethanol/Water mix is heated to 240 PSI pressure and released at least 2 minutes after agent discharge



Initially mixed

2 minutes – concentration gradient has developed

Longer delay – concentration gradient is greater

Results During Development of the MPS

- Halon baseline testing was at 3% average
  - Time delay of 5+ minutes from discharge
  - Stratification evident in the data

- During that testing “There was no ignition of the contents of the simulator in four of the five tests. There was a very brief ignition of some of the contents during one test (test 28), but no overpressure was recorded.”

- Recent testing by the FAA at the William J Hughes FAA Technical Center has reproduced these results

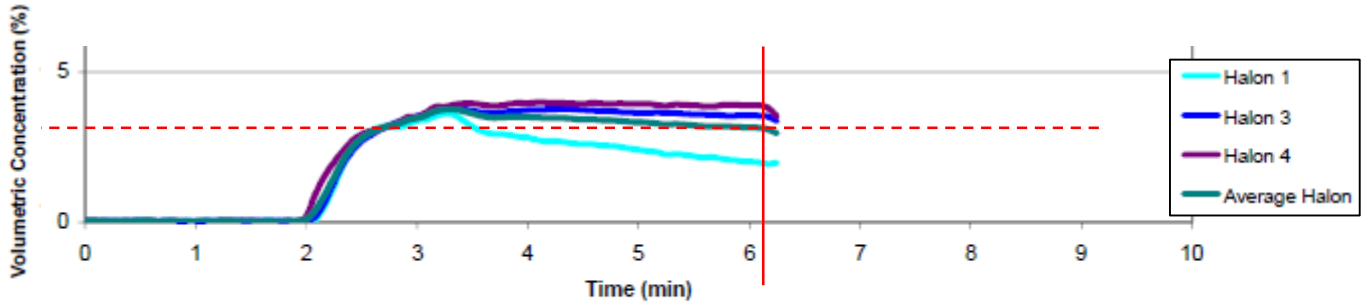
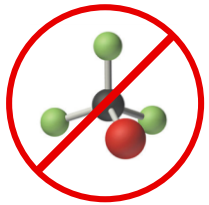


FIGURE 72. AEROSOL EXPLOSION TEST 28 (122299T2) GAS CONCENTRATION PLOT

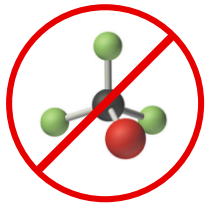
Data from DOT/FAA/AR-00/28, “Development of a Minimum Performance Standard for Aircraft Cargo Compartment Gaseous Fire Suppression Systems”, John W. Reinhardt, David Blake, Timothy Marker September, 2000.



Proposed Solution to Agent Settling

- The current Cargo MPS document requires that the concentration *at the igniter* is at the minimum value (e.g. 3% for halon)
- If the agent is allowed to settle to achieve this result, this will create an average concentration that is unrealistically low
- The goal of this test is to create a concentration that is as nearly uniform as possible, and at the minimum concentration at the igniter height
- This condition has been accomplished in recent tests by adding fans to mix the air in the compartment

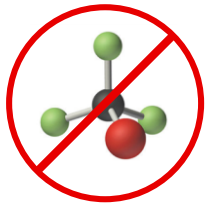
- Precedents for use of mixing fans:
  - FAA 2018 Proof of Concept Testing
  - https://www.nist.gov/sites/default/files/documents/el/fire_research/R0301158.pdf
  - https://www.nist.gov/sites/default/files/documents/el/fire_research/R0301009.pdf
  - https://www.nist.gov/sites/default/files/documents/el/fire_research/R9401596.pdf



Proposed Solution to Agent Settling

"In the short version, the aerosol can explosion simulator device is placed inside the empty standard compartment (see figure 10). The simulator device is prepared as specified in the section titled Aerosol Can Explosion Simulation. This test starts when the fire suppression agent is discharged. It is acceptable to use mixing fans in the compartment to prevent stratification of the agent during this test. The mixing fans should be turned off prior to activation of the simulator. The simulator device is activated at least 2 minutes after agent discharge. The activation time is dictated by the measured volumetric concentration, within ±0.1% of the minimum protection concentration. The minimum concentration is measured 2 feet (60.9 cm) above the floor, near the sparking electrodes. The agent concentration must be measured during the test, and calculation of agent concentration based on the leakage rate is not permitted. The gas-sampling probe is 36 inches (91.4 cm) from the exit of the simulator device and 18 inches (45.7 cm) to the side of the spark igniters (starboard or portside). The applicant must demonstrate that the system is capable of providing sufficient agent, at least to maintain the minimum inert concentration..."

This proposed revision to the MPS document will add a clarifying note to explain the use of mixing fans



Aerosol Can Test Pass/Fail Criteria

- Current Pass/Fail Criteria

"The criterion for the aerosol can explosion simulation scenario is that there is no evidence of an explosion or reaction. Evidence of an explosion or reaction includes deflagrations, flashes, and overpressures, etc. There shall be no overpressures (zero pressure rise)…"

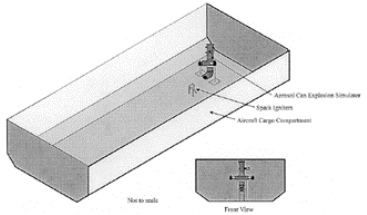
Reactions occur at the electrode in every case. DOT/FAA/AR-00/28 noted that with halon "There was a very brief ignition of some of the contents during one test (test 28), but no overpressure was recorded."

Deflagrations and flashes can range from very benign events to severe events.

The pressure rise needs to be non-threatening to a cargo hold. The ability to measure and verify "zero pressure rise" might be a challenge, especially if a more sensitive pressure transducer is used.

"etc" is not necessary and is open-ended

Criteria Proposal



"The criterion for the aerosol can explosion simulation scenario is that there is no evidence of an explosion or reaction that would be a threat to the integrity of the cargo compartment. ~~Evidence of an explosion or reaction includes deflagrations, flashes, and overpressures, etc. There shall be no overpressures (zero pressure rise).~~ …"

This proposal explains the intent of the requirement and allows for judgment in assessing small flames that are not self propagating, such as have been seen in FAA testing of both halon 1301 and alternate agents