A350XWB Cargo Inerting Function

Cargo Fire Protection as Combination of Halon 1301 and Nitrogen Enriched Air (NEA)

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Supported by
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- System Architecture Pre/Post
- NEA Availability
- Sizing and Performance
- Weight impact
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- Certification Approach
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Introduction

• In frame of the A350XWB development the current flow-metered Halon 1301 fire extinguishing bottle for cargo bay long term fire suppression shall be deleted.

• Nitrogen Enriched Air (NEA) produced by the Inert Gas Generating System (IGGS) as part of the Fuel Tank Inerting System (FTIS) will be used instead.

• Benefits:
  • First step to halon-free A/C
  • Greener A/C (less halon)
  • 20-45 kg weight saving
  • A/C level architecture synergy
  • Unlimited ETOPS
Why A350XWB

Current Aircraft

• Current Aircraft produced after 1992 having tanks with a flammability exposure of 7% or higher are required to have a Flammability Reduction Means fitted
  • Affected aircraft - SA, LR and WB (Note: A380 has no tanks with a flammability exposure above 7%).
  • Affected tanks – centre tank

New Aircraft – A350XWB

• Tanks outside the fuselage are required to meet 3% flammability exposure
  • Affected tanks – wing tanks
• Tanks within the fuselage wholly or partly and those normally emptied are required to meet 3% warm day requirement in addition to the 3% flammability exposure
  • Affected tanks – centre tank

😊 FTIS performance < Cargo Inerting needs
😊 FTIS performance > Cargo Inerting needs
A350XWB  FWD LDCC

- Fire Extinguishing Nozzle
- Smoke Detectors Cavity
- Pressure Equalization Valve
System Architecture Pre/Post

**Pre:**

- LH: CSAS → IGGS → IGDS
- RH: CSAS → IGGS → IGDS

**Post:**

- LH: CSAS → IGGS → IGDS
- RH: CSAS → IGGS → IGDS

- Cargo inerting valves

- Fuel Tank Boundary

- Halon 1301

- Diverter Valve

- FME

- New pipe-work

- Replace diverter valve with fwd/aft selector valve

- Delete hold-down bottle + FME

- FWD LDCC

- AFT LDCC

- FWD Selector Valve

- AFT Selector Valve
NEA Availability

• Identical parallel sides (left/right)  
  ⇒ Separated for installation reasons

• Today (FTIS only):  
  Loss of one FTIS side = both sides shut down  
  MMEL: GO (10 days)

• Tomorrow (combined system):  
  Loss of one FTIS side = one side shut down  
  MMEL: GOIF (10 days)

• One FTIS side provides enough NEA for cargo inerting, so reliability and availability targets are met
Decent rate is sizing: Higher descent rate = higher ingress of ambient air
Weight impact

The weight reduction with respect to the conventional system depends on the ETOPS configuration:

- Up to 20 kg are envisaged for 195 min diversion time.
- Up to 45 kg are envisaged for 360 min diversion time.
Combination of Halon 1301 and NEA

**Halon 1301**
- Requirement
  - Initial concentration 5% by vol.
  - Suppression concentration 3% by vol.
- Effectiveness
  - Inhibition
    (interrupt chemical reaction)

**NEA**
- Requirement
  - min. Oxygen Concentration 12% by vol.
- Effectiveness
  - Oxygen Suppression

**History:**
- FAA Tech Center MPS Aerosol Can Test Campaign
- Airbus Halon-IGGS MPS Tests Campaign
  (Bulk-, Container-, Open-Surface-Fire Engineering Tests)
- Airbus Halon-NEA Small-Scale “Cold” Tests
  (A320 AFT LDCC mock-up)
Combination of Halon 1301 and NEA

Combination of Halon 1301 and NEA (based on FAA TC Test Results)

MPS Simulated Aerosol Can Explosion

- Safe Atmosphere
- Halon and O₂ Decay
- Halon Discharge
- Unsafe Atmosphere
- Ventilation of Compartment

End of Test

Start of Test

y = 0.70x - 8.11
y = 0.63x - 7.29

As per DOT/FAA/AR-TN08/49
10% Halon 1301 Safety Margin
SA AFT LDCC Mock-Up Test Result (Test 2, Sensors O₂_4 & H11)
Additional FHA cases

- Provision of gas to the fuel tanks above 200 deg C resulting in ignition (CAT) 1.0E-9
- Inability to prevent fuel vapour back-flowing onto an ignition source resulting in ignition within FTIS and subsequent tank ignition (CAT) 1.0E-9
- Provision of gas to the fuel tank at flow rates above the tank pressure limits (CAT) 1.0E-9
- Asphyxiation of ground crew due to discharge of NEA into the fuel tanks during maintenance operations (HDA) 1.0E-7

Therefore, “undetected discharge of NEA into the cargo hold” should have a design objective of 1.0E-07
Certification Approach

- **Goal:** Certification with as much commonality to standard system as possible.
- **Proposed applicable certification requirements**

<table>
<thead>
<tr>
<th>CS-25 Req’mt</th>
<th>Paragraph Title</th>
<th>Means of Compliance</th>
<th>Remarks</th>
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<tr>
<td>25.851 (b)</td>
<td>FIRE EXTINGUISHERS - Built-in Fire Extinguishers</td>
<td>0 1 2 4 6 7</td>
<td></td>
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<tr>
<td>(b) (1) (i)</td>
<td>hazardous extinguishing agent in occupied areas</td>
<td></td>
<td></td>
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<tr>
<td>(b) (1) (ii)</td>
<td>structural damage</td>
<td></td>
<td></td>
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<tr>
<td>(b) (2)</td>
<td>adequate system capacity</td>
<td>X X</td>
<td>ref. AMC 25.851(b)</td>
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<td>25.855 (h)</td>
<td>CARGO OR BAGGAGE COMPARTMENT - Flight Tests</td>
<td>0 6</td>
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<tr>
<td>(h) (2)</td>
<td>hazardous quantities of extinguishing agent in occupied areas</td>
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<tr>
<td>(h) (3)</td>
<td>agent dissipation</td>
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<tr>
<td>25.855 (i)</td>
<td>CARGO OR BAGGAGE COMPARTMENT - Inadvertent Detector Operation</td>
<td>0 6</td>
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<tr>
<td>25.857 (c)</td>
<td>CARGO COMPARTMENT CLASSIFICATION - Class C</td>
<td>0 1 2 6 7 9</td>
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<tr>
<td>(c) (2)</td>
<td>approved system controllable from cockpit</td>
<td></td>
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<tr>
<td>(c) (3)</td>
<td>exclude hazardous quantities from occupied areas</td>
<td></td>
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<tr>
<td>(c) (4)</td>
<td>control ventilation and draughts</td>
<td></td>
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<tr>
<td>25.1309 (a)</td>
<td>EQUIPMENT, SYSTEMS AND INSTALLATION - Intended Function</td>
<td>0 1 2 5 6 7 9</td>
<td></td>
</tr>
<tr>
<td>(a) (1)</td>
<td>perform intended function under aeroplane operating and environmental conditions</td>
<td></td>
<td></td>
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<tr>
<td>(a) (2)</td>
<td>no adverse effect on proper function</td>
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- **Only for CS 25.851(b)(2) MoC changes are envisaged**
- **Compliance to CS 25.851(b)(2) via MoC 4&6 (lab & flight tests)**
## Certification Approach

<table>
<thead>
<tr>
<th>Test Objective</th>
<th>Mock Up &quot;Cold Test&quot;</th>
<th>Mock Up &quot;Hot Test&quot;</th>
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<td></td>
<td>• Provide agent distribution profile</td>
<td>• Perform testing on product regarding the MPS characteristics</td>
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<td></td>
<td>• MoC 4 justification</td>
<td>• MoC 4 justification</td>
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<td>Test Demonstration</td>
<td>• Demonstration of sufficient mixing and distribution of Halon/Oxygen (NEA)</td>
<td>Demonstration of sufficient fire suppression performance for MPS test scenarios in</td>
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<td>concentration in accordance to the diagram</td>
<td>A350 FWD LDCC configuration with four MPS fire loads (bulk-load fire, containerized</td>
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<td>• Identification of worst case loading configuration</td>
<td>fire, aerosol can explosion, surface burn fire)</td>
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<td>Test Configuration</td>
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<td></td>
<td>• A350 FWD LDCC geometry (largest volume)</td>
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<td>• Simulated NEA mixture as specified will be used</td>
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### Way forward

- Preparation of draft CRI based on Airbus working paper
- Preparation of mock-up tests at DLR in Trauen
Summary

• A350XWB will be the first Airbus A/C with cargo fire protection as combination of Halon 1301 and Nitrogen Enriched Air (NEA).

• Benefits:
  • First step to halon-free A/C
  • Greener A/C (less halon)
  • 20-45 kg weight saving
  • A/C level architecture synergy
  • Unlimited ETOPS

• NEA availability, function reliability as well as sizing and performance fulfill the needs.

• Effectiveness of a combined Halon 1301 / NEA system has been shown.

• Certification approach with as much commonality to standard system as possible.
Thank you!

Questions?
Glossary

- FTIS – Fuel Tank Inerting System (ATA47)
  - IGGS – Inert Gas Generation System (ATA47)
  - IGDS – Inert Gas Distribution System (ATA47)
  - CSAS – Conditioned Service Air System (ATA21)

- LDCC FES – Lower Deck Cargo Compartment Fire Extinguishing System (ATA26)
  - FME – Flow Metering Equipment
  - MPS – Minimum Performance Standard

- NEA – Nitrogen Enriched Air
  - sometimes called “ODA” – Oxygen Depleted Air.