Presented by

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ECOLOG (Extinguishing COnccept Lowering Ozone depletion and Green house effect)

An Airbus Project addressing the Halon Replacement concern for Engine/APU fire extinguishing application
AGENDA

• Halon Replacement Problematic
  ➢ Context & drivers for Halon 1301 replacement
  ➢ ATA26 Firex Problematics

• ECOLOG Background – Research Phase

• ECOLOG – Feasibility Study

• Summary
HALON REPLACEMENT PROBLEMATIC:

Halon depletes the ozone layer and is a great contributor to the green house effect

• HALON banishment status:
  ‣ MONTREAL protocol (1994) for ozone layer protection: production and use banishment
  ‣ KYOTO protocol (1998) for green house effect limitation: scheduled GWP agents reduction
  ‣ But due to the lack of alternative solution
    ➔ Derogation does exist for aeronautical field, until a new solution appears
    ➔ But deadline for derogation validity unknown but will happen due to increasing pressure coming from Governments & Airlines!

• Activities for alternate solutions for A/C applications
  ‣ International work (IASFPWG) created further to FAA request for new agent research
  ‣ MPS(*) established and some new agents tested

(*) MPS: Minimum Performance Standard for new agent validation
Aircraft Fire Extinguishing Agents & Problematics

HALON 1211

HCFCblendB
HFC227
HFC236

HFC236 in study

HCFCblendB
HFC227
HFC236

HFC236 in study

Portable Fire Extinguishers (several within cabin and cockpit)

Lavatory automatic Fire Extinguishers

APU Fire Extinguishing System

NOVEC 1230 in study

HFC-125, CF3I, NOVEC1230

NOVEC 1230 in study

Engine Fire Extinguishing System

Cargo Compartment Fire Extinguishing System

Water with nitrogen spraying

HALON 1301

FORBIDDEN AGENT

VALIDATED AUTHORIZED AGENT

AIRBUS EFFORT

4th Fire And Cabin Safety Conference - Halon Replacement for Engine/APU applications - EET1 - Ref. Y228907111411, Issue 1

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Main Considerations

• In the past 2 Agents for 5 applications

• Today:
  - Methods of compliance customized for each application (fire threat related)
  - No Unique agent identified for all applications
  - No Unique agent validated for all applications

⇒ Industrial efforts are significant
⇒ Several different New Agents and New Technologies needed
⇒ ECOLOG dedicated to offer and Engine/APU response to problematic
**ECOLOG Project Objective**

**PROJECT OBJECTIVE:**

**ECOLOG (*) = HALON\(^{1301}\) replacement for ENGINE and APU fire extinguishing systems**

- for new A/C (starting from **A350**)
- for existing A/C (in production or by retrofit application)

**PROJECT INITIATED / COORDINATED / FOUNDED BY AIRBUS**

(*) ECOLOG: “Extinguishing Concept Lowering Ozone depletion and Green house effect”
ECOLOG RESEARCH PHASE

- Phase launched mid 2002:
  - 2 industrial partners associated
    - Siemens SBT (Fire Det/Ext spécialisists)
    - SNPE- Pyroalliance (Pyrotechnic Materials design&manufacturing)
  selected to be able to propose & develop concepts and technology bricks
  leading at the end of the study to the definition of a system:
    - mature
    - industrially realisable
    - answering the certification criteria
ECOLOG BACKGROUND - Research phase

FIRE EXTINGUISHER CONCEPT

General principle

• Concept based on both:

  - a new environmental friendly “quasi liquid” extinguishing agent (Novec 1230 (3M))

  - a solid propellant gas generator permitting the pressurization of the container and the efficient spraying of the agent.

• Extinguishing agent stored at low pressure in the container

• When electrically ignited the gas generator produces inert gases, which pressurise the container, burst the rupture disc and expel the extinguishing agent.
**New Fire Extinguishing Agent**

**LOAEL**: Low Observed Adverse Effect Level  
**NOAEL**: No Observed Adverse Effect Level  
**ODP**: Ozone Depletion Potential  
**GWP**: Global Warming Potential  
**AL**: Life duration in the atmosphere (Year)

<table>
<thead>
<tr>
<th>Agent</th>
<th>Vapour Pressure</th>
<th>Boiling Point</th>
<th>Concent. Ration</th>
<th>LOAEL</th>
<th>NOAEL</th>
<th>ODP</th>
<th>GWP</th>
<th>AL</th>
<th>Weight</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>HALON 1301</td>
<td>14,6 bar</td>
<td>-57,8°C</td>
<td>5%</td>
<td>7%</td>
<td>5%</td>
<td>10</td>
<td>6900</td>
<td>65</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>NOVEC 1230</td>
<td>0,4 bar</td>
<td>49°C</td>
<td>5-6%</td>
<td>&gt;10%</td>
<td>10%</td>
<td>0</td>
<td>1</td>
<td>0,013</td>
<td>2,12</td>
<td>0,96</td>
</tr>
</tbody>
</table>

- **complies with the Halon replacement criteria**
  - Ozone Depletion Potential (ODP=0)
  - Global Warming Potential (GWP=1)
  - Atmospheric Lifetime (AL=0.014)

- is not concerned by Montreal and Kyoto Protocols (not a HFC)  
- offers a comfortable margin regarding toxicity
ECOLOG BACKGROUND - Research phase

**Fire extinguisher bottle design and testing**

- Design and Manufacturing of a full scale demonstrator
- Extinguisher integration
- Test campaign realisation (agent spraying tests) range of temperatures (-55 °C to 95 °C)

**Full scale demonstrator**

**Integration tests set up**

**Hot and cold tests**
ECOLOG BACKGROUND - Research phase

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ECOLOG BACKGROUND - Research phase

**Fire extinguishing efficiency tests**

- Performance test bench design and manufacturing

- Test campaign realisation (extinguishing tests) according several different engine fire scenarios (spray fire and pool fire tests)

**Performance test bench**

**Fire Zone volume and ventilation mass flow:** RR T500 fire zone N°3

**Test set up**
ECOLOG BACKGROUND - Research phase

Fire extinguishing efficiency tests: Spray fire

Window view ➔

Internal view ➔

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ECOLOG BACKGROUND - Research phase

AIRWORTHINESS AUTHORITIES – FAA TEST CAMPAIGN

- First contacts have been established with Airworthiness Authorities (EASA & FAA) in October 2005).

- On Airbus’s request the FAA has accepted to launch an official NOVEC 1230 agent validation test campaign (duration 4 months starting march 2006), at the FAA Technical Center.

- This campaign has permitted to officially determine the agent concentration value to use.

- This value 6,1 % by volume has been released by the FAA –TC during the last IAFPWG meeting (International Aircraft system Fire Protection Working Group) in November 2006.
ECOLOG BACKGROUND - Research phase

Test campaign at the FAA-TC

goal:
- New agent qualification
- Determination of the minimum quantity to use for same extinguishing efficiency than when using halon
R&D to Feasibility Study

In 2006, Decision to move the project from R&D activities to a feasibility study based on:

- Green characteristics of Agent
- Promising results from the technology from the R&D efforts
- Promising results from the Agent evaluation at FAA Technical Center
- Recurring A/Ls request for Airbus efforts on Halon Replacement
- Increasing threat of derogation cancellation for Halon use
SCOPE AND OBJECTIVES

- Assessment of the possibility to implement the NOVEC onboard Engines and APU: all engines and APU SA, LR & LA (Retrofit, forward fit) and new A/C (i.e A350XWB)

- Provide relevant data to make decision possible for development phase launch such as technical repercussion data

- Prepare Supplier selection

- Prepare certification hypothesis
ECOLOG/MPP - Feasibility Study phase

AI FEASIBILITY STUDIES – MPP (Multi-Program-Project)

NOVEC System Design
A/C ENGINES feasibility & Regulation discussions

APU feasibility

SYSTEM TESTS
Ground tests on A/C & Scale 1 benches

DESIGN TOOLS
Software
ECOLOG/MPP - Feasibility Study phase

**MAIN MILESTONES**

- Contacts with suppliers for new FireX based on NOVEC 1230.

- Request for information to several suppliers for NOVEC 1230 possible FireX technologies.

- Efficiency demonstration of technologies using dedicated Test benches.

- Aircraft test campaign – Full Scale demonstration (A340-600)

- Building Firex Simulation Tools

- Building Certification Referential for Halon replacement by NOVEC1230 with validated technologies.

- Request for proposal to several suppliers for NOVEC 1230 validated FireX technologies for an identified A/C.

- Decision gate for development phases.
TEST - Efficiency demonstration on Test bench

- Successful results on preliminary tests campaigns conducted within RFI frame with RR T500 Engine Fire Extinguishing piping (A340-600):

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ECOLOG/MPP - Feasibility Study phase

**TESTS - Aircraft test campaign Engine & APU on A340-600**

- **ENG3** and **APU** compartment instrumented for **HALON & NOVEC** measurement, as well as pressures, temperatures, air flows & air speed

- Tests have shown a **satisfactory behaviour** of **NOVEC** – Certification criteria reach.

- Data collection for firex simulation tool correlation
**SYSTEM DESIGN**

Example of NOVEC installation on board

- **Current bottle:** Halon 1301
- **Current piping design:** simple design
- **Specific Nozzles**
- **New distribution** (to optimise the NOVEC load & the piping mass)

**HALON Bottle**

**NOVEC Bottle**

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ECOLOG/MPP - Feasibility Study phase

**SIMULATION TOOLS**

- Development of a Simulation method to calculate and design an optimized system, until its Certification

- Several applications:
  - Development of new systems
  - Certification support
  - In Service events
  - Analysis of given scenario

- Validation / correlation with data from Ground and Aircraft Tests
  - Piping pressures and temperatures
  - Concentration levels
  - Mass balance between powerplant Designated Fire Zones
ECOLOG/MPP - Feasibility Study phase

**SIMULATION TOOLS**

**Bottle discharge:**

**Piping**

**Agent Dispersion**

- **Available Tools**
  - Legacy F77 code => HFLOW (Halon only)
  - Single Element Reduction Method
  - Global Mass Budget

- **Integrated Tool**
  - New bottle Characteristics
  - Real network computation
    - Precise pressure loss prediction
    - Precise mass distribution
  - High precision Dispersion models:
    - CFD solutions

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ECOLOG/MPP - Feasibility Study phase

**SIMULATION TOOLS**

- CAD extraction
- CAD simplification
- Meshing
- Ventilation
- Simulation
- Agent Discharge
- Simulation
- Post-processing
- Analysis
ECOLOG – Development For Identified A/C

• Design fire extinguishing system to protect the engine in the worst case of its Flight Envelope
• FireX bottles development as A/C onboard system

- Specification
- Design
- Validation
- Certification

- Concept Phase
- PDR
- CDR
- FTB
- A/C 1st Flight
- Certification Test
- No preliminary test until the Certification test

• Definition of extinguishing system needs for piping and bottles allocation
• Trade-off studies - performance against engine volumes and ventilation
SUMMARY

• R&D phase completed
• Feasibility Studies:
  ‣ Technology “bricks” validated
  ‣ Main Technical Parameters identified
  ‣ Industrial Solutions under evaluation
  ‣ Integration Problematic under evaluation
  ‣ Simulation Tools under development
  ‣ Data collection for Certification Frame Definition on-going

• Development Phase
  ‣ Process and plan under adaptation to match A/C development
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