Presented by

R DELETAIN / C FABRE AIRBUS

ECOLOG (**E**xtinguishing **CO**ncept **L**owering **O**zone depletion and **G**reen 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

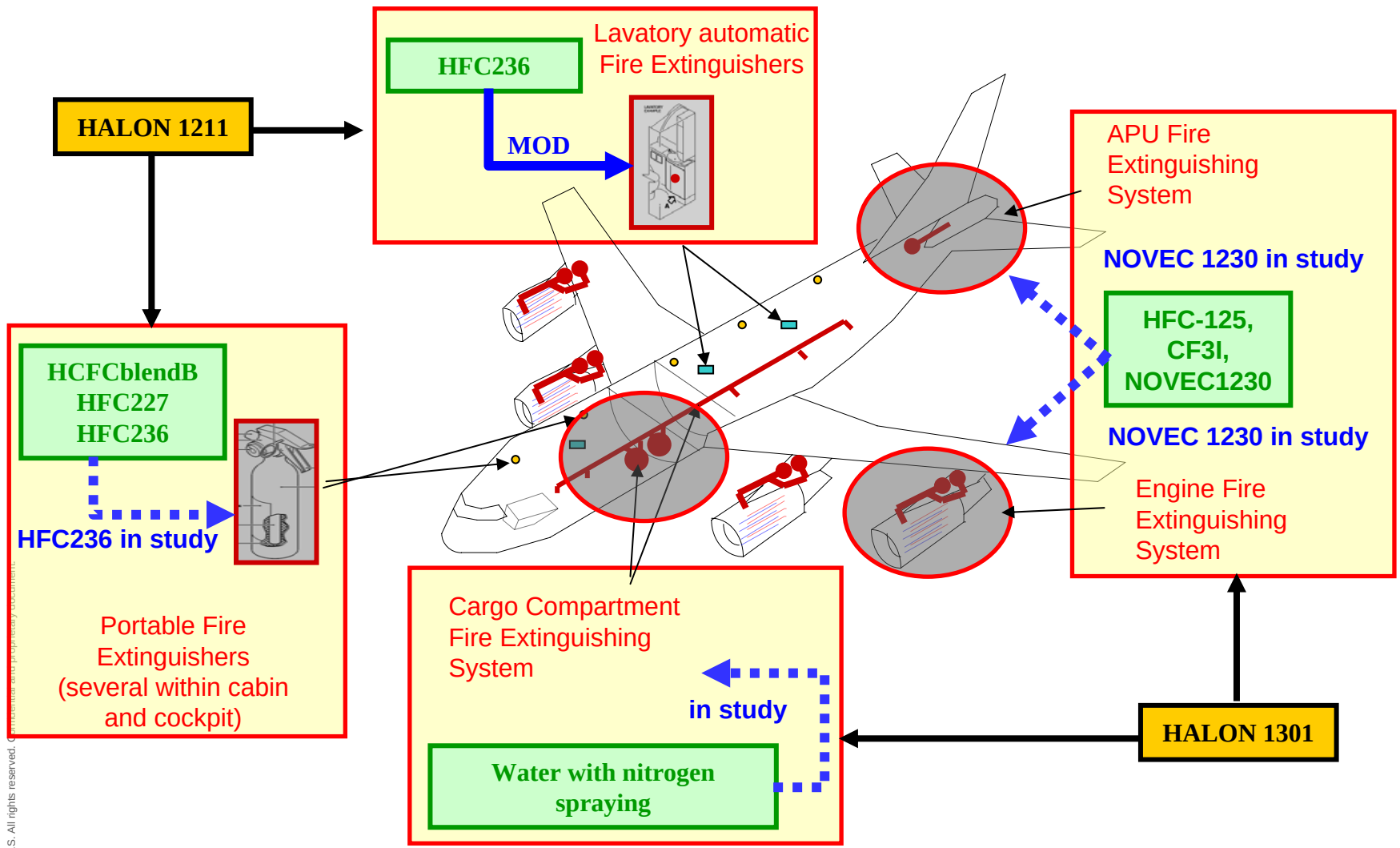
HALON REPLACEMENT PROBLEMATIC:

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



Fire zone with extinguishing system | **Forbidden Agent** | Validated Authorized Agent | AIRBUS Effort

Aircraft Fire Extinguishing Agents & Problematics

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

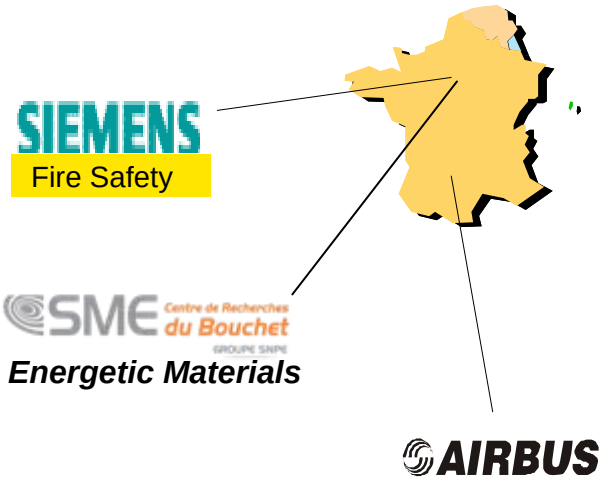
- for new A/C (starting from ***A350***)
- for existing A/C (in **production** or by **retrofit** application)

PROJECT INITIATED / COORDINATED / FOUNDED BY AIRBUS

(*) ECOLOG: "Extinguishing Concept Lowering Ozone depletion and Green house effect"

ECOLOG BACKGROUND - Research phase

ECOLOG RESEARCH PHASE



- Phase launched mid 2002 :
  - 2 industrial partners associated
    - ***SIEMENS SBT*** *(*Fire Det/Ext spécialists)
    - ***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

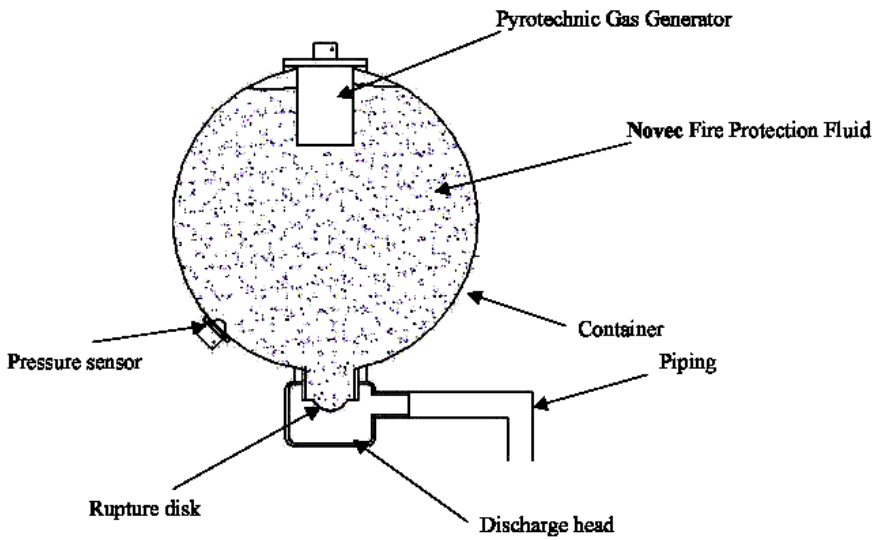
- Concept based on both:

  -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 <u>low pressure</u> 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.



ECOLOG BACKGROUND - Research phase

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)*

Agent	*Vapour Pressure*	*Boiling Point*	*Concent. Ration*	*LOAEL*	*NOAEL*	*ODP*	*GWP*	*AL*	*Weight*	*Volume*
HALON 1301	14,6 bar	-57,8°C	5%	7%	5%	10	6900	65	1	1
NOVEC 1230	0,4 bar	49°C	5-6%	>10%	10%	0	1	0,013	2,12	0,96

- ***complies with the Halon replacement criteria***

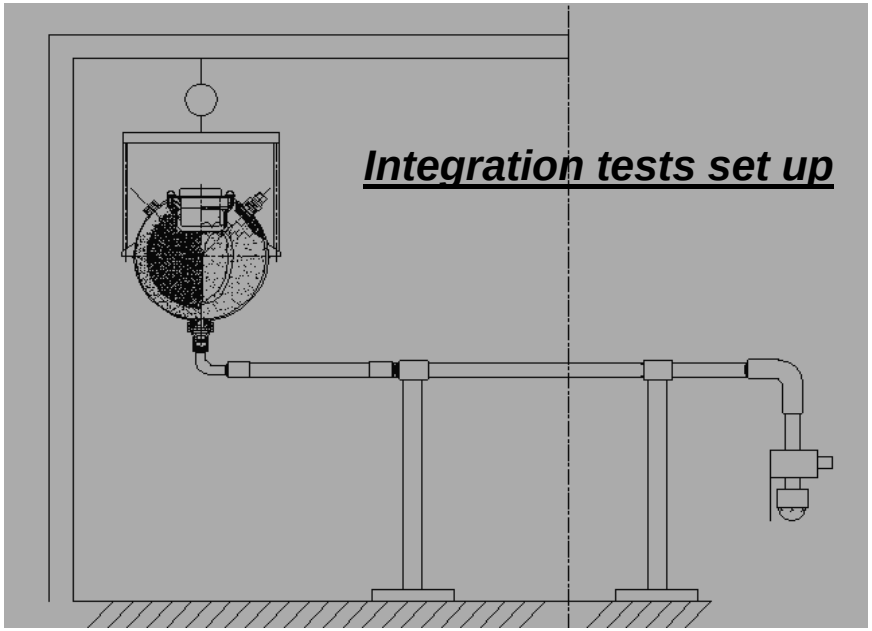
  - Ozone Depletion Potential (ODP=0)
  - Global Warming Potential (GWP=1)
  - Atmospheric Lifetime (AL=0.014)

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

ECOLOG BACKGROUND - Research phase

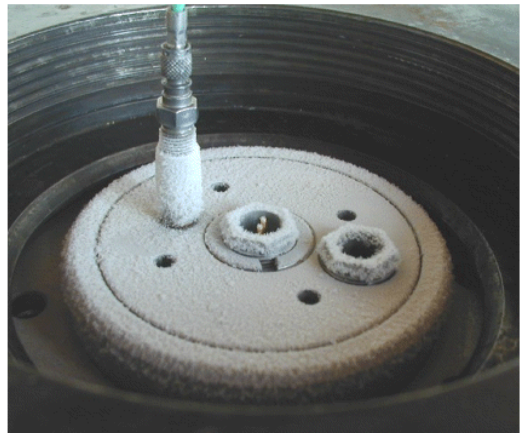
Fire extinguisher bottle design and testing

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



Integration tests set up

Full scale demonstrator



Hot and cold tests

ECOLOG BACKGROUND - Research phase

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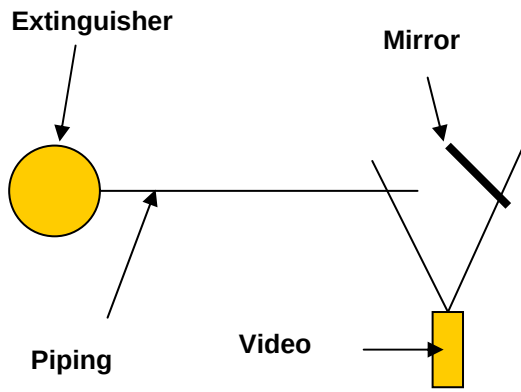
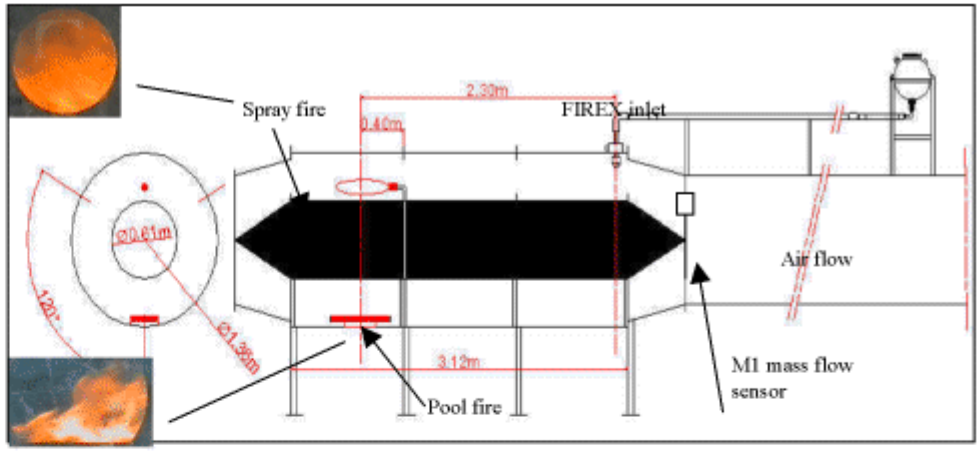


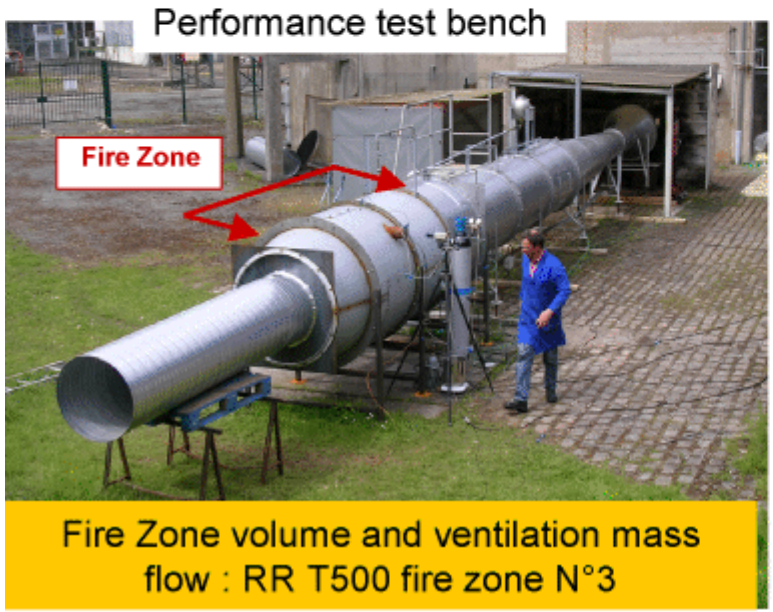
ECOLOG BACKGROUND - Research phase

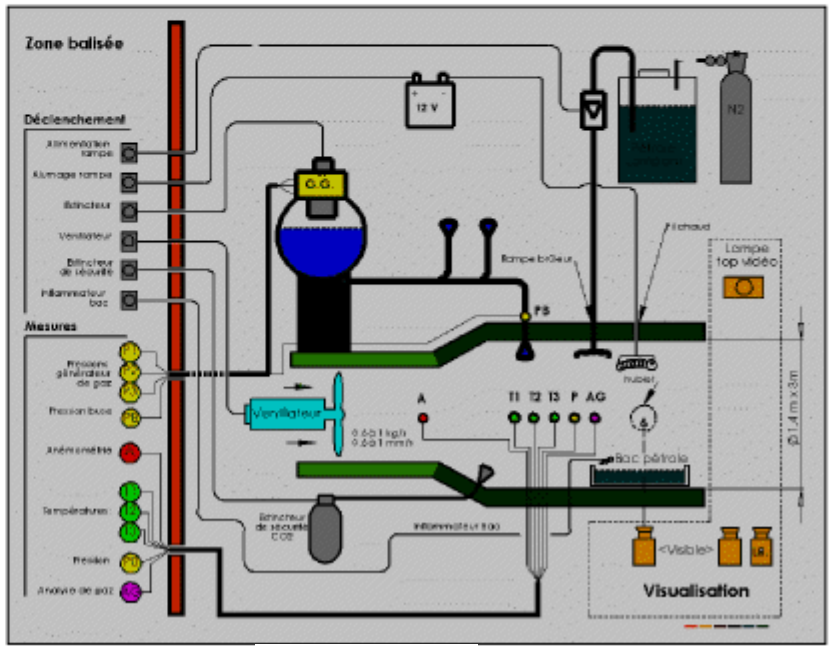
Fire extinguishing efficiency tests

- Performance test bench design and manufacturing

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





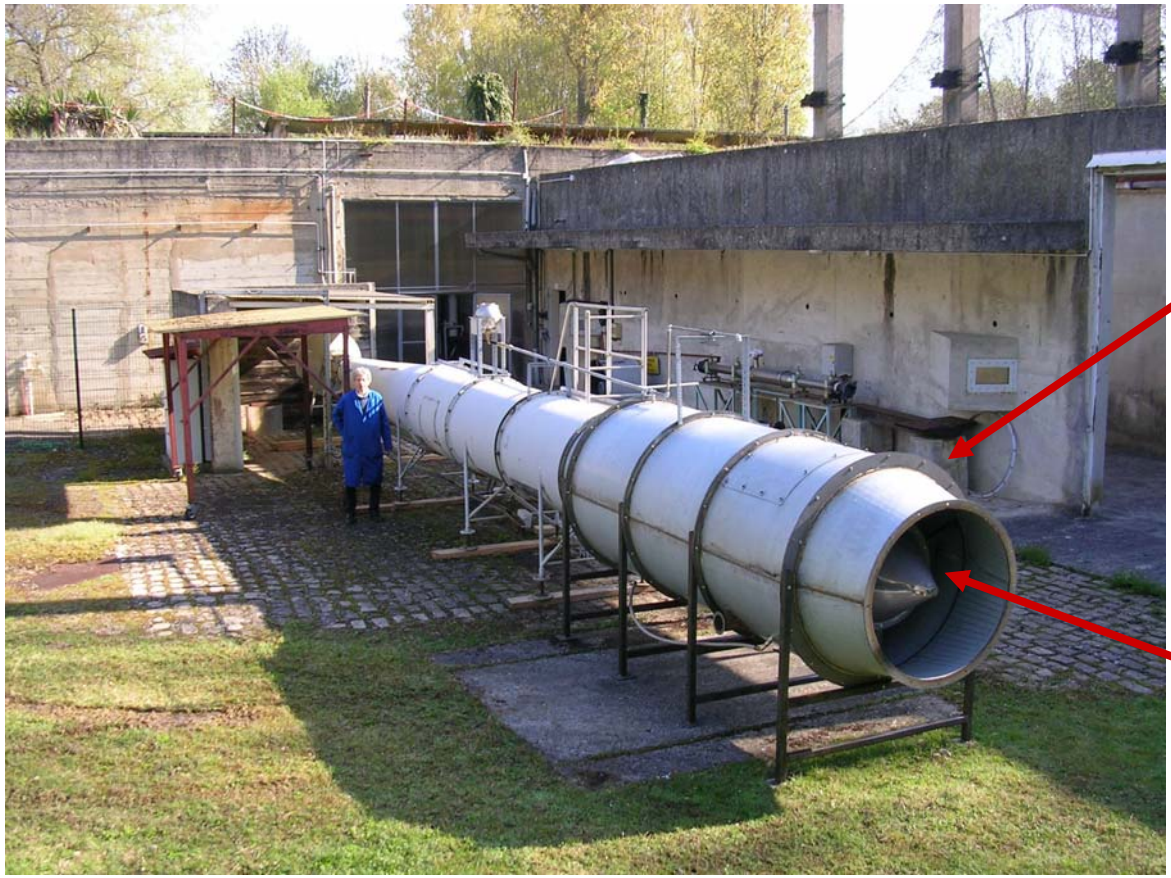


Test set up

ECOLOG BACKGROUND - Research phase

Fire extinguishing efficiency tests : Spray fire

Window view →



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Internal view →

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.

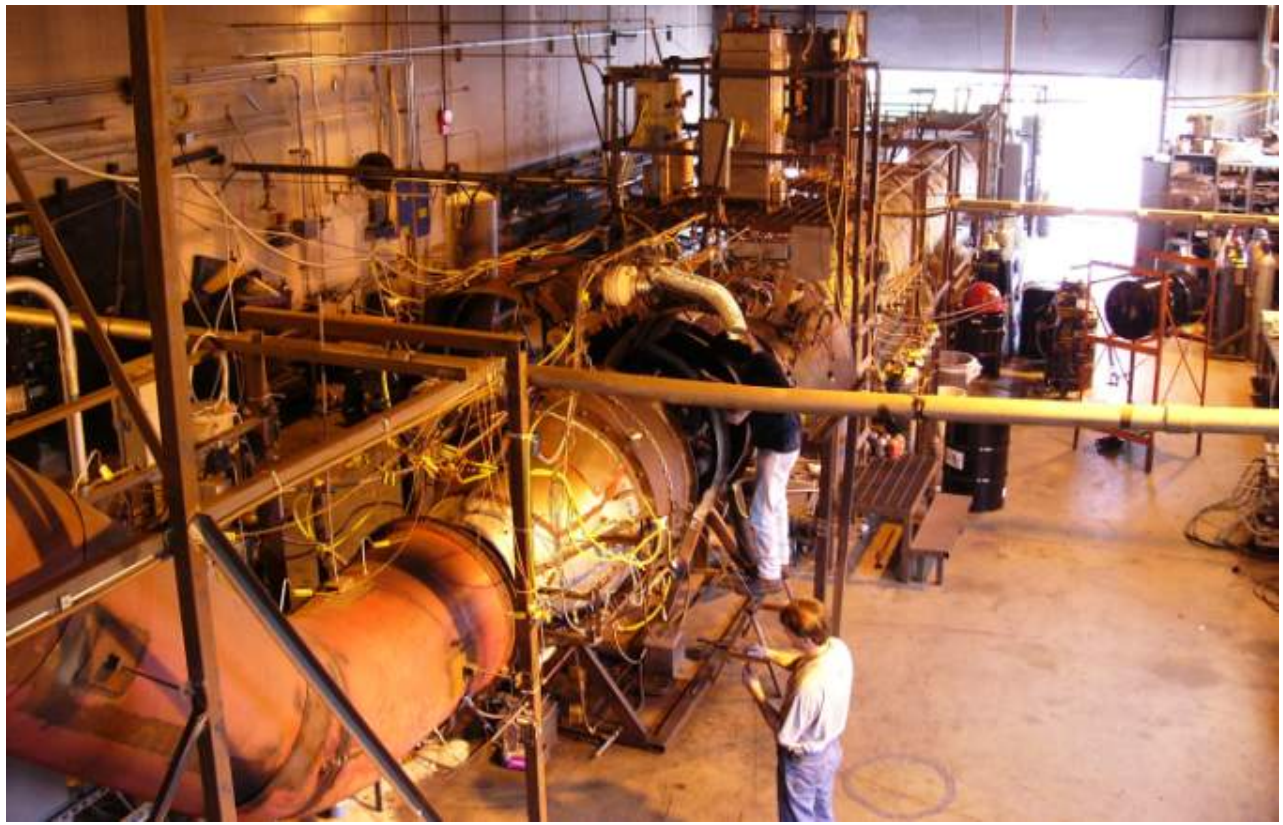
- This value 6,1 % by volume has been released by the FAA –TC during the last IAFPWG meeting (International Aircraft system Fire Protection Working Group) in November 2006.

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



ECOLOG/MPP - Feasibility Study phase

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

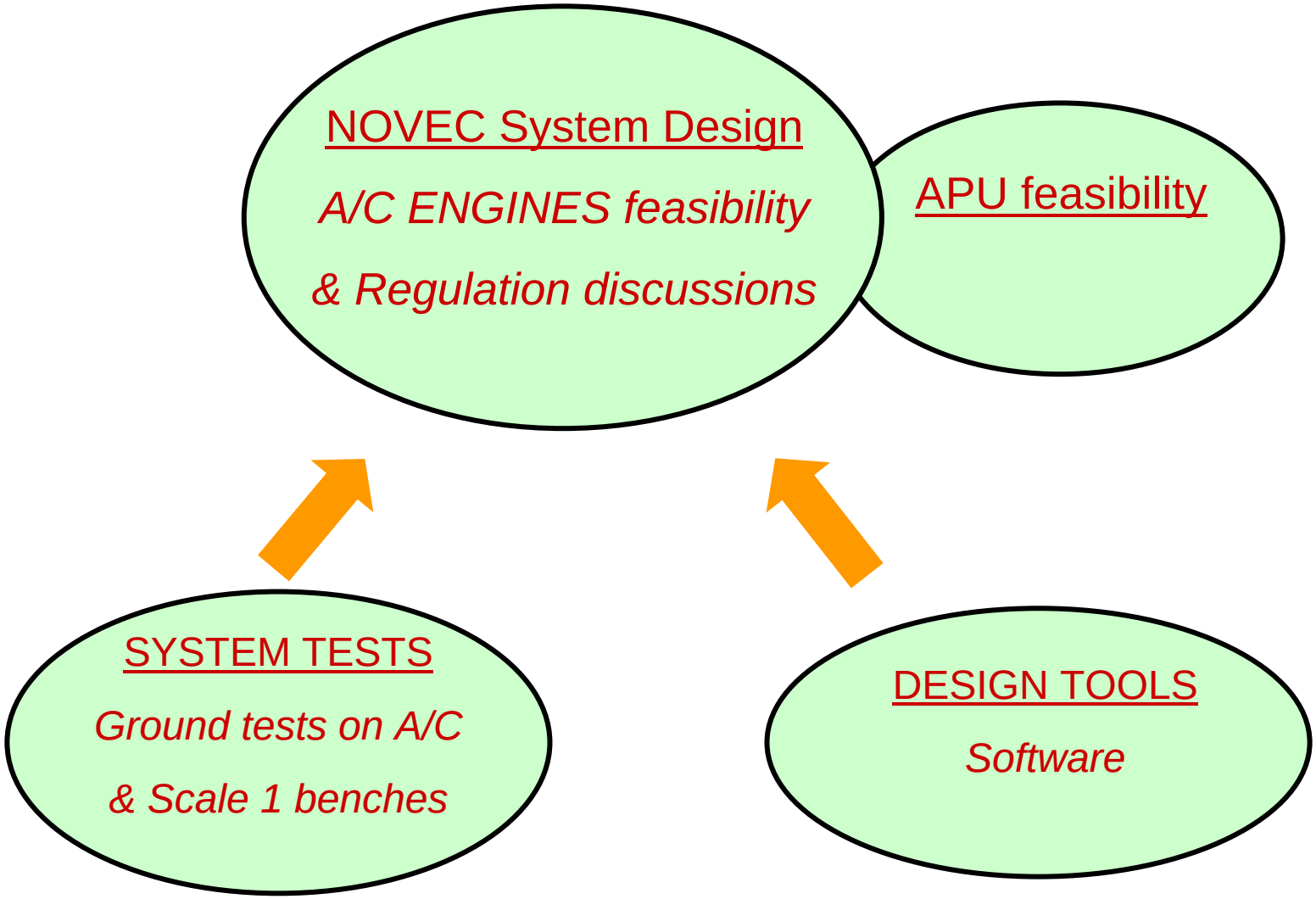
ECOLOG/MPP - Feasibility Study phase

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)



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

ECOLOG/MPP - Feasibility Study phase

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*

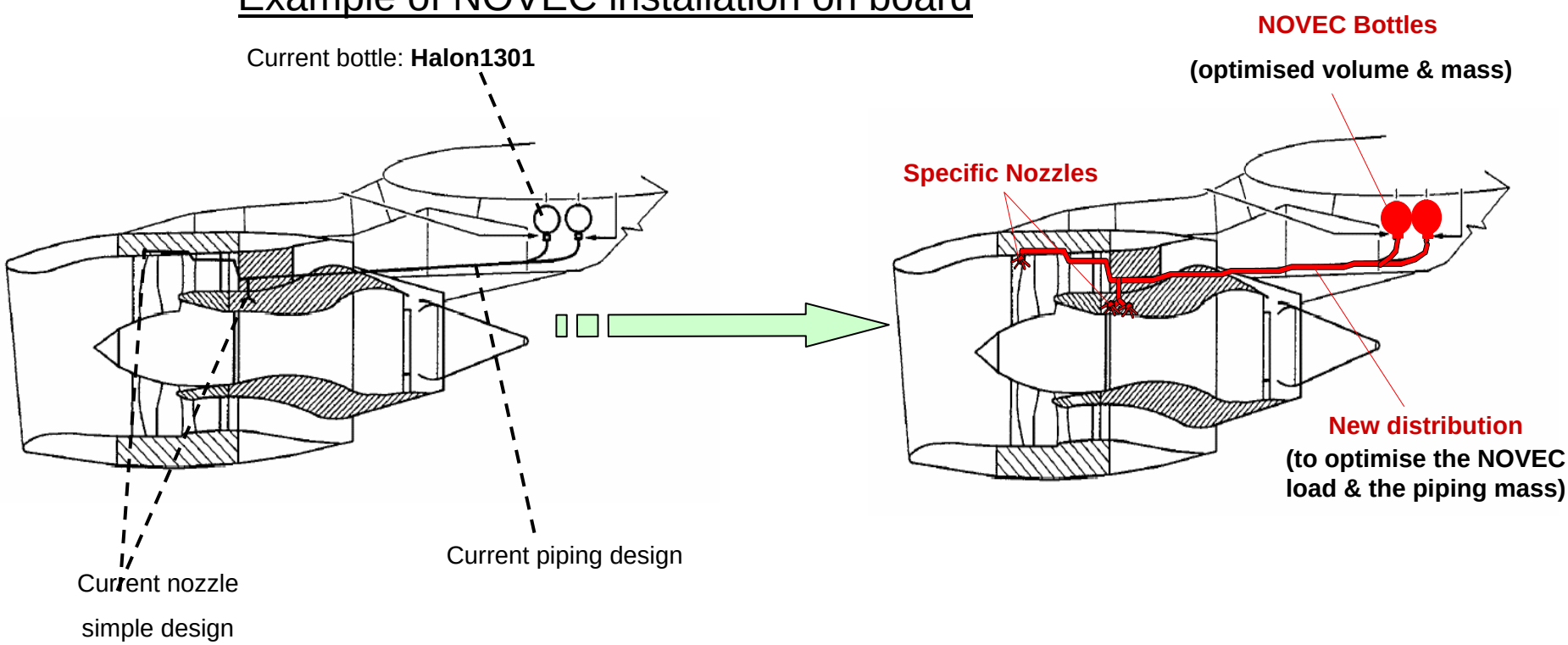
- Tests have shown a **satisfactory behaviour of NOVEC** – Certification criteria reach.

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

ECOLOG/MPP - Feasibility Study phase

SYSTEM DESIGN

Example of NOVEC installation on board



HALON Bottle

NOVEC Bottle

ECOLOG/MPP - Feasibility Study phase

SIMULATION TOOLS

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

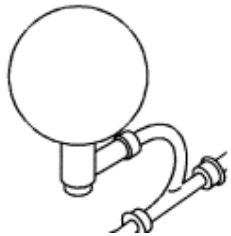
- Several applications:
  - Development of new systems
  - Certification support
  - In Service events
  - Analysis of given scenario

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

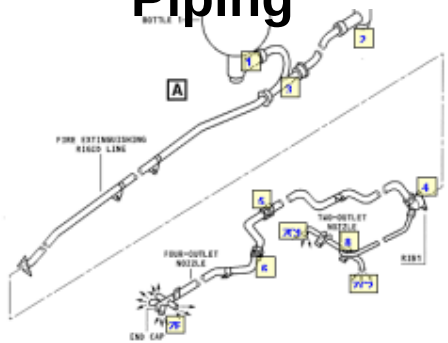
ECOLOG/MPP - Feasibility Study phase

SIMULATION TOOLS

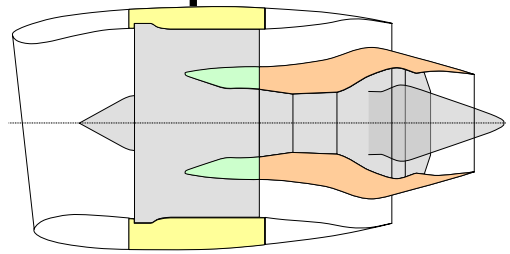
Bottle discharge:



Piping



Agent Dispersion

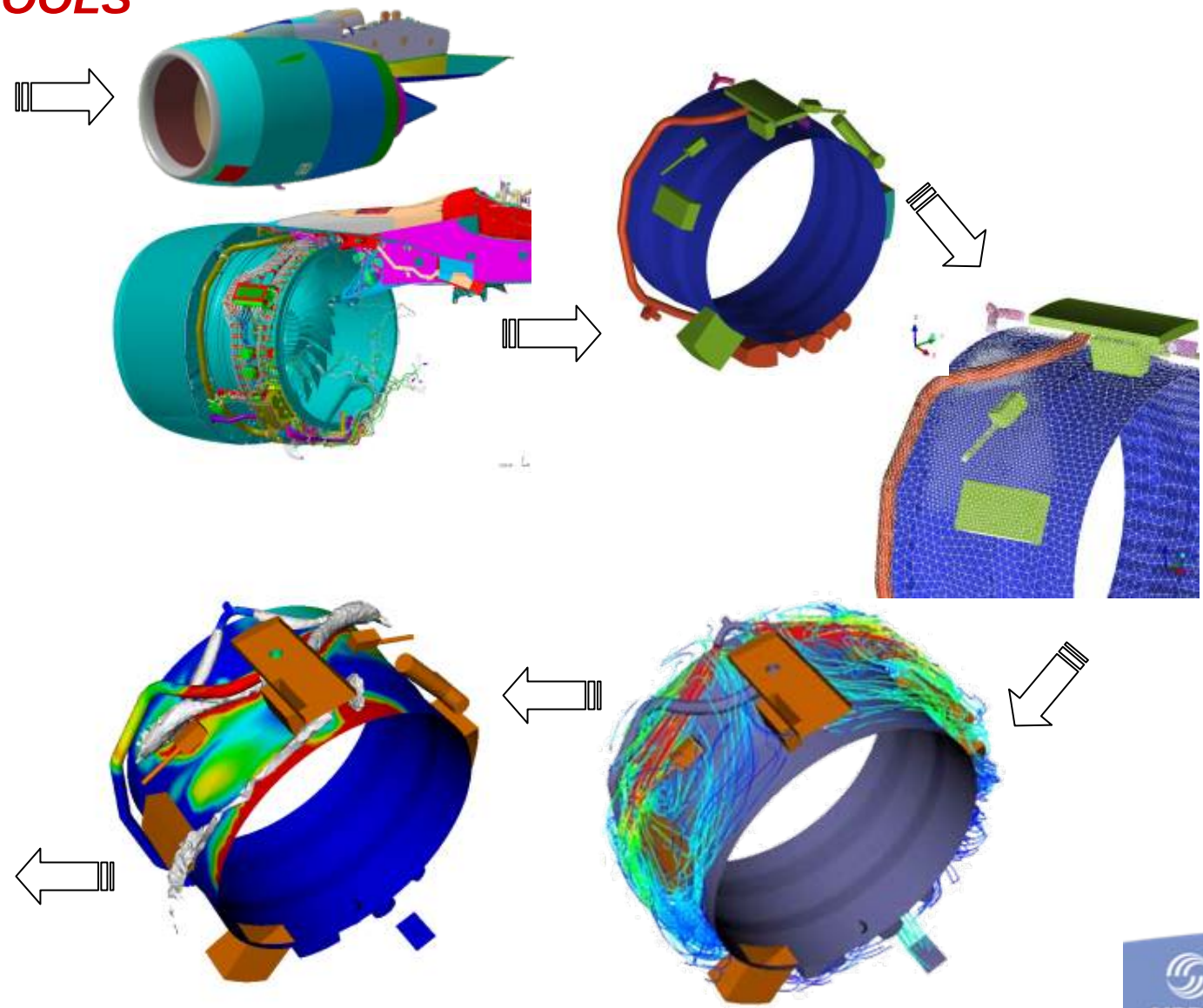


Available Tools	Legacy F77 code =>HFLOW (Halon only)	Single Element Reduction Method	Global Mass Budget
Integrated Tool	**New bottle Characteristics**	**Real network computation** ⇒Precise pressure loss prediction ⇒Precise mass distribution	**High precision Dispersion models:** ⇒ **CFD solutions**

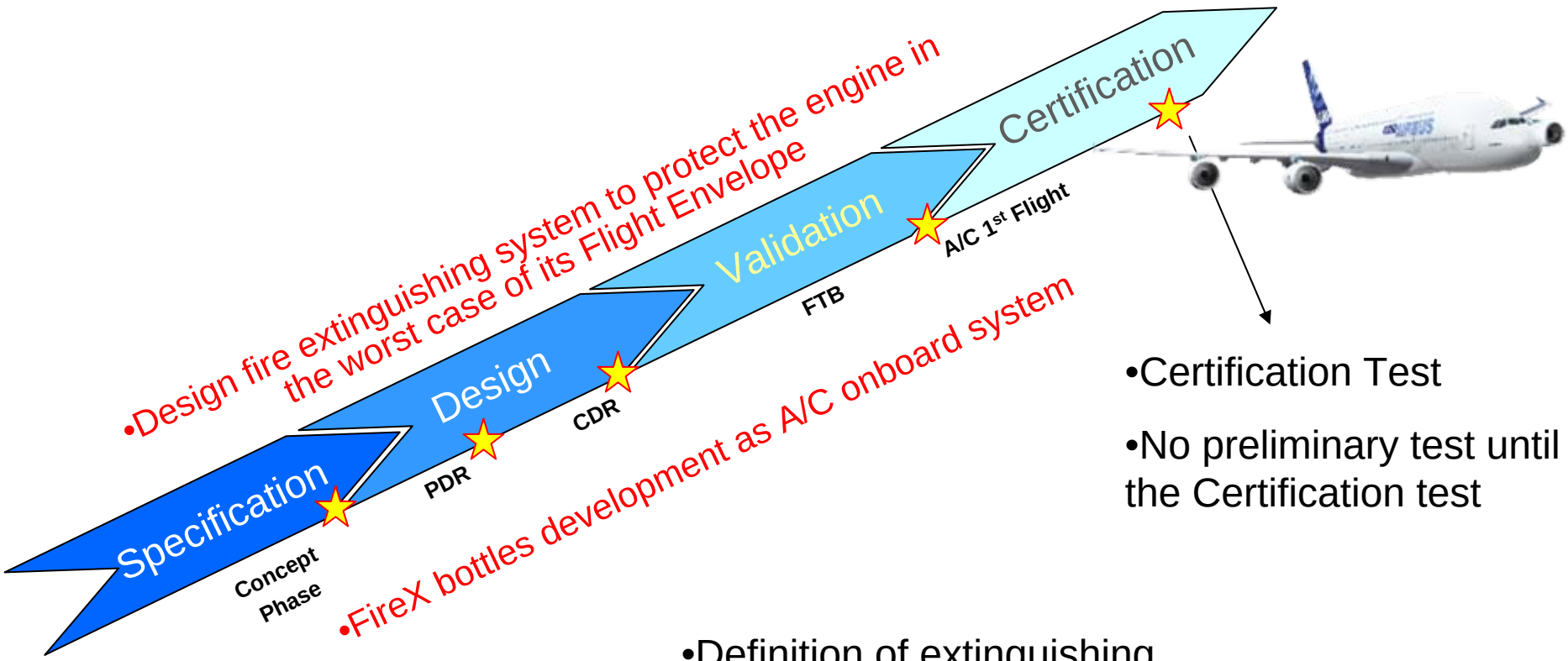
ECOLOG/MPP - Feasibility Study phase

SIMULATION TOOLS

- CAD extraction
- CAD simplification
- Meshing
- Ventilation Simulation
- Agent Discharge Simulation
- Post-processing Analysis



ECOLOG – Development For Identified A/C



•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

AN EADS JOINT COMPANY
WITH BAE SYSTEMS