EASA
European Aviation Safety Agency

Cabin air quality

Background & EASA studies

CASIA annual meeting
8 May 2017
Cologne, Germany

Your safety is our mission.

An agency of the European Union

Content

- Background
- Results from the 2 EASA studies
  - In-flight measurements
  - Turbine engine oil toxicity
- Conclusion & way forward

Background

- CAQ subject to continuing debate over the last 60 years
  - Health and safety aspects
  - CAQ in normal conditions vs. single (incident) contamination event
  - Various sources of contaminations (internal/external) => focus on engine/APU oil & hydraulic fluid

- EASA pre-rulemaking activity (task 25.035) - 2009-2012
  - **A-NPA 2009-10**: EASA opinion based on review performed; ask for stakeholders input; on-line questionnaires
  - Conclusion : no safety case; no scientifically established relationship between reported health symptoms and cabin air contamination
  - 27/01/2012: ED Decision N°2012/001/R terminating task 25.035 without amending regulations

Background

- Continuing controversy/ complaints/ press articles/ questions
- EASA actions on CAQ:
  - **Continuing airworthiness of aircraft**: Follow-Up of reported events and analysis (effects, root causes, trends); corrective actions with manufacturers if design weakness identified
  - **Research:** Contribute to scientific knowledge improvement
  - **Participation in standardisation bodies activities:**
    - CEN Project Committee “Cabin air quality on civil aircraft – Chemical agents”: EASA role: observer
    - SAE ARP4418 revision (standard on engine bleed air sampling and measurement for contaminants): EASA role: member
    - SAE Cabin air measurement committee (being created): EASA role: liaison member

Background

- **Monitor official investigations by AAIBs** and **address Safety Recommendations**
- **Communication** with stakeholders (Unions, Member States, EC, Industry, individuals, press, standardisation bodies, etc…)

EASA studies

- Two EASA studies launched in 2014 and 2015
  - First study: define a cabin air contamination measurement method usable during commercial flights, and conduct a limited number of measurements on commercial flights;
  - Second study: investigate the toxicity of aviation turbine engine oil contamination of the aeroplane bleed air system, in view of supporting the analysis of flight measurements results.
- Reports published 23 March 2017:
  - https://www.easa.europa.eu/newsroom-and-events/press-releases/easa-publishes-two-studies-cabin-air-quality

Results from the 2 EASA studies

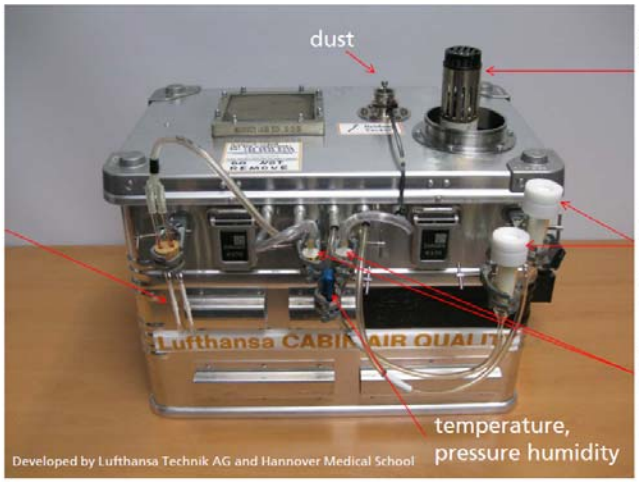
Study 1: In-flight measurements

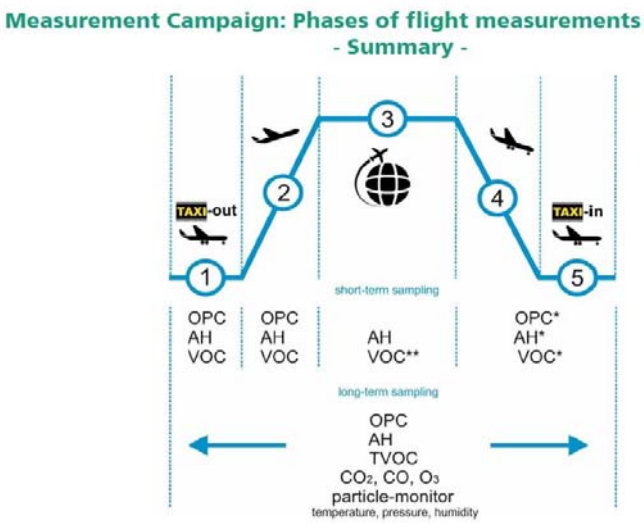
- Contractor: consortium Fraunhofer Institute for Toxicology and Experimental Medicine (ITEM) and Medical School Hannover (MHH) Institute of Occupational and Environmental Medicine

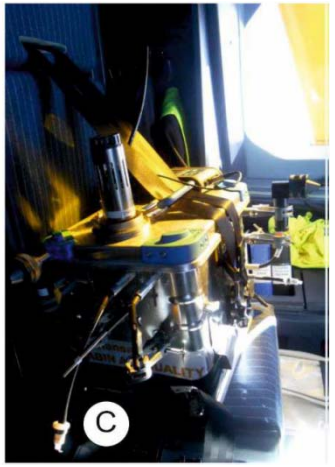
- Task 1: Development of Knowledge Basis & Inventory of Potential Contaminants and Detecting Instruments
- Task 2: Measurement Campaign
  - Preparation of Preliminary Measurement Campaign
  - Implementation of Preliminary Measurement Campaign
- Task 3: Develop Recommendations for a Large Scale Project Plan / Design

Results from the 2 EASA studies

In-flight measurements





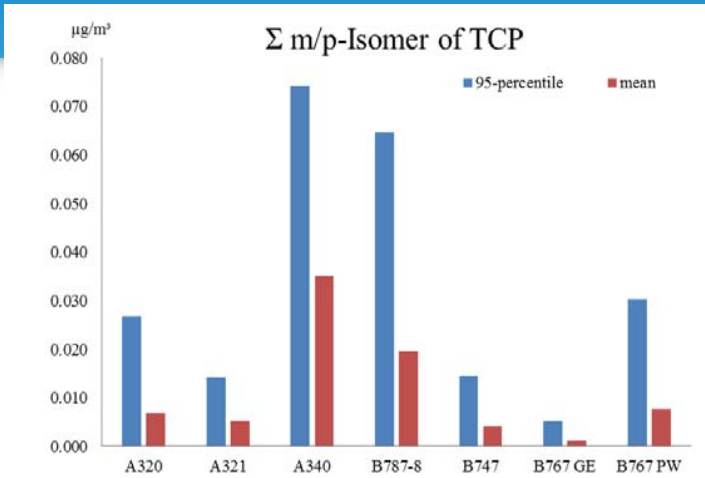


Results from the 2 EASA studies

- In-flight measurements: 69 flights
- 61 flights in total on:
  - Boeing 767-300ER / Pratt & Whitney PW4062
  - Boeing 767-300ER / General Electric CF6-80C2
  - Boeing 747-800 / General Electric GEnx-2B
  - Boeing 757-300 / Rolls-Royce RB211
  - Airbus A320-200 / CFM56-5A
  - Airbus A321-200 / CFM56-5B
  - Airbus A340-600 / Rolls-Royce Trent 556
- 8 flights on:
  - Boeing 787-8 / Rolls-Royce Trent 1000

Results from the 2 EASA studies

- In-flight measurements
- Results & conclusion:
  - Measurement methods validated
  - Air quality similar or better than normal indoor environments (offices, schools, kinder gardens or dwellings)
    - Values well below available indoor occupational exposure limits or guidelines
    - Organophosphates
      - infrequent traces
      - independent from flight phase or aircraft type
      - ortho-isomers not detected at all
  - Consistency with previous studies/measurements
  - Contaminant thinning effect forced by the high air exchange rate (typically >20 per hour)



Results from the 2 EASA studies

Oil toxicity

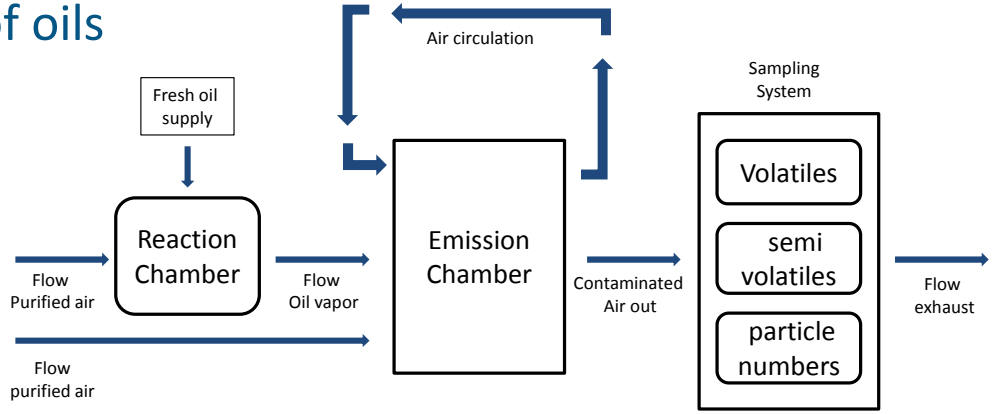
- Contractor: consortium TNO (Netherlands Organization for Applied Scientific Research) and RIVM (Netherlands National Institute for Public Health and the Environment)

- Task 1. Performance of scientific literature review and selection of applicable engine/APU oils
- Task 2. Design of a test methodology for the chemical characterisation and toxic effects of these oils after pyrolysis
- Task 3. Performance of the chemical characterisation and toxic effects of the oils after pyrolysis
- Task 4. Analysis of the human sensitivity variability factor

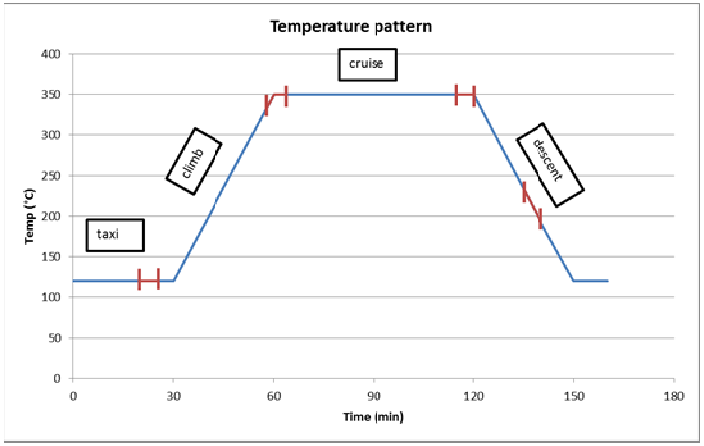
Results from the 2 EASA studies

Oil toxicity

- Selection of oils: 2 major brands / new and used oil samples
- Chemical characterisation of oils



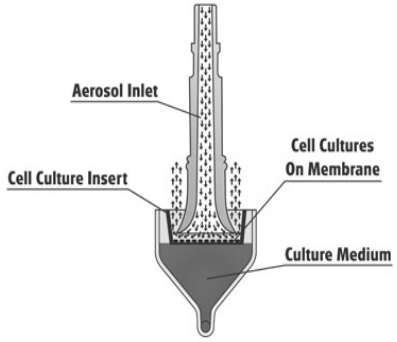
- Chemical characterisation of oils after pyrolysis

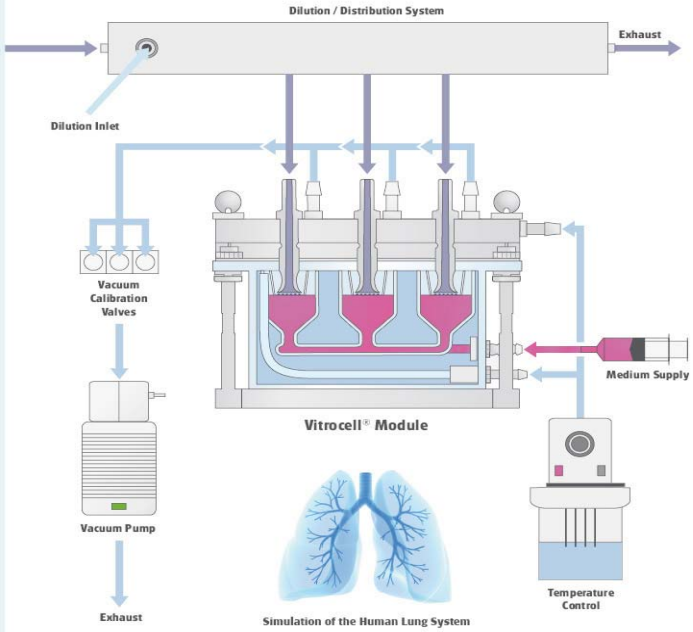


Results from the 2 EASA studies

Oil toxicity

- Toxic effects of oils after pyrolysis
  - *in vitro* model of the human lung (human bronchio-epithelial (HBE) cell line in co-culture with human endothelial cells (HUVEC)) used in an air-liquid-interface system
    - Expose lung cells to oil vapour flow and determine the maximal exposure level corresponding to minimum cytotoxicity
    - Determine transfer to the air-liquid interface: lung barrier crossing

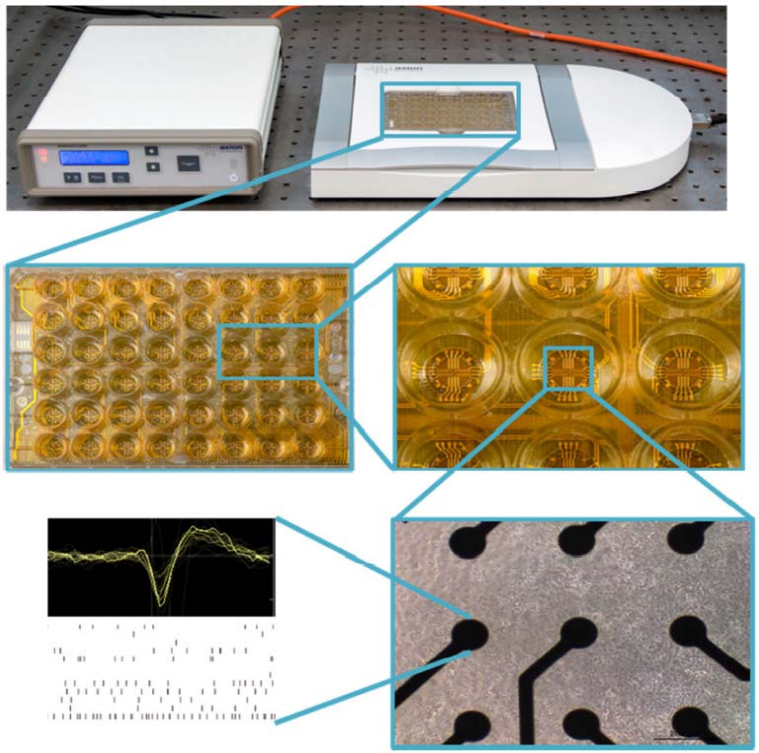




Results from the 2 EASA studies

Oil toxicity

- Toxic effects of oils after pyrolysis
  - Effects of pyrolysis on neuronal function assessed *in vitro* using primary cortical neurons (from rats) grown on microelectrode arrays (MEAs) (brain model).
    - Medium derived from lung epithelial cells exposed via the air-liquid interface model used to expose *in vitro* brain model
    - Exposure to different dilutions of oil-derived pyrolysis products following transfer to the air-liquid interface
    - acute (30min) exposure
    - sub-chronic (24h) exposure



Results from the 2 EASA studies

- Oil toxicity
  - Analysis of the human sensitivity variability factor
    - Collection and analysis of available scientific knowledge
    - Genetic differences in metabolism and detoxification
    - Influence of stress/coping strategies on underlying biological pathways leading to health complaints

Results from the 2 EASA studies

- Oil toxicity
- Results & conclusion
  - Oils chemical analysis
    - TCP found, however no ortho-isomers could be detected
    - During the lifetime of an oil, substantial changes in composition occur
      - Some compounds disappear, new compounds are found
  - Neuroactive pyrolysis products are present, but concentration in the presence of an intact lung barrier is too low to be of major concern for neuronal function
  - Analysis of the human sensitivity variability factor showed that the complete metabolic pathway and the contribution of inter-individual variability in the metabolic enzymes is still largely unknown for the majority of industrial chemicals, including cabin air contaminants

Conclusion & way forward

- The results confirm that a causal link between exposure to cabin/cockpit air contaminants and reported health symptoms is unlikely
- Some areas for future research are identified to further improve scientific knowledge
- As a follow-up activity, a European Commission (EC) study has started, with technical support from EASA. It will take into account the findings and recommendations from the two EASA studies to develop a comprehensive understanding of the cockpit and cabin air quality. The contract award notice was published on 22/02/2017 and can be found here:
  http://ted.europa.eu/udl?uri=TED:NOTICE:66334-2017:TEXT:EN:HTML&src=0
  'Investigation of the quality level of the air inside the cabin of large transport aeroplanes and its health implications'
  - Simulation of fume events on a bleed air contamination simulator (test bench simulating engine, ECS, cabin), chemical characterisation of the contaminated cabin air, and assessment of toxicity of the contaminated cabin air,
  - Tests on real aeroplane with simulated fume events, biomonitoring of personnel on board

  Website under construction to inform stakeholders on the status of the project:
  http://www.facts.aero/

EASA
European Aviation Safety Agency

Questions ?

Your safety is our mission.

An agency of the European Union