EASA & FAA RESEARCH FINDINGS & ACTIONS – CABIN AIR QUALITY

Captain Maxford Thomson - GCAQE
Mr. Jordan Braystone – GCAQE/CUPE

INTERNATIONAL AIRCRAFT CABIN AIR CONFERENCE
IMPERIAL COLLEGE LONDON
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GCAQE
Global Cabin Air Quality Executive

Why are GCAQE/CUPE presenting this presentation?

- EASA agreed to present their most recent research
  - Withdrew from conference presentation or attendance, August 2017
- FAA was asked to present their activities on CAQ in February 2017
  - Advised too busy to find speaker or attend
- Therefore the GCAQE decided it was important to present their recent work on CAQ

FAA- BACKGROUND

1994: US Senate Hearings - Airliner Cabin Air Quality (CAQ)

- Studies show air generally safe but concerns remain

2001: National Research Council review of CAQ

- Oils and hydraulic fluids & decomposition products – **Moderate concern**
- Recommendations included:
  - FAA to rigorously demonstrate adequacy of FARs related to CAQ
  - Revise standards to protect health and comfort of crew & passengers if required
  - Etc.

https://archive.org/stream/airlinercabinair00unit/airlinercabinair00unit_djvu.txt

FAA (1/3)

2002: FAA response to NRC

- FAA rulemaking not kept pace with CAQ expectations & does not protect against particulate matter & 'other' chemical hazards
- ARAC: FAA Aviation Advisory Rulemaking Committee to review existing standards - FAR 25.831… (ventilation & heating) – oil hydraulic leakage… (postponed indefinitely)

FAA (2/3)

2003 – US Public Law 108-176 S 815*

- FAA to undertake studies recommended by NRC:
- Ozone, pesticides, analyze ducting filters for contamination; establish reporting system

- FAA COE: Many studies undertaken under FAA Centre of Excellence (2003-2013)
  - ACER-Airliner Cabin Environment Research
  - OHRCA - Occupational Health Research Consortium in Aviation
  - RITE – Research in the Intermodal Transport

*https://www.congress.gov/108/plaws/publ176/PLAW-108publ176.htm

FAA (3/3)

- ACER/RITE/OHRCA funded studies: 2003-2013?
- $23 million in FAA grants & $28 million in matched industry funding. Examples of studies:
  - Recirculation filters
  - Incident monitoring & reporting
  - Medical protocol for bleed air contamination
  - Cabin flow dynamic models & sensors
  - Contaminant transport in airliners
  - Sensors & prognostics to mitigate bleed air contamination
  - On board monitoring & measurement methods
  - Effects of partial pressures on passengers
  - Flame retardants…

FAA - OTHER

VIPR - Vehicle Integrated Propulsion- Parts 1-3

- 2011 onwards
- NASA/FAA/USAF…
- Example: Jones B et al. (2017) – oil contamination in the compressor will result in a fog of **very** fine droplets (<10 nm) in the bleed air under most operating conditions. Sensors should focus on UFPs.

2012 - FAA Modernization Reform Act

- H.R 658, S 320/ S 917 – Study of Air Quality in Aircraft Cabins/ R&D for cleaning & monitoring bleed air
  - **Rejected** by FAA (2013) in a report to Congress** as considered work already undertaken or not required
    - Events too infrequent
    - Potential toxicity speculative

https://www.faa.gov/about/office_org/headquarters_offices/agi/reports/media/Report_to_Congress_on_Engine_and_APU_Bleed_Air_Supplied_on_Pressurized_Aircraft.pdf

EASA- A-NPA

European Aviation Safety Agency
Certification Specifications
and
Acceptable Means of Compliance
for
Large Aeroplanes
CS-25

EASA- A-NPA

European Aviation Safety Agency

28 Sep 2009

ADVANCE NOTICE OF PROPOSED AMENDMENT (A-NPA) NO 2009-10

"Cabin Air Quality onboard Large Aeroplanes"

EASA- A-NPA 1/4

- Encourage discussion around source of CAQ degradation

- The primary issue is that a **"Vast majority** of these events are associated with an abnormal leakage of engine or APU lubrication fluid (aviation engine oil)"

EASA – A-NPA 2/4

CRD (2011)- Comment Response Document to –A-NPA – cabin air quality

- No safety case justifying general rulemaking action because:
  - There were no accidents (injuries / loss of life / major aircraft damage) with cabin air contamination as root cause.
  - No serious incidents were reported (impairment or incapacitation of crew) with a focus on toxic products sufficient to **incapacitate** crew/passengers.
  - The minor 'nuisance' of temporary bad smell events – due inappropriate maintenance or mechanical failures – were acknowledged as under-reported.

EASA – A-NPA 3/4

CRD (2011)- Comment Response Document to –A-NPA – cabin air quality

- There is no safety case that would justify an immediate and general rulemaking action.

- Causal relationship between reported adverse health effects and oil and/or hydraulic contamination was not established – Therefore there is no need to change existing designs or certification specifications.

- Health effects are not within EASA's primary scope.

- EASA will keep an eye on the topic.

EASA- ANPA 4/4

Final Decision (2012) - **DECISION No 2012/001/R OF THE EXECUTIVE DIRECTOR OF EASA:**

- Termination of rulemaking task 25.035 'Cabin air quality on board Large Aeroplanes' without amending EASA regulations – No causal link

EASA- CAQ STUDY 2017

EASA
European Aviation Safety Agency

Final Report EASA_REP_RESEA_2014_4

Research Project:

CAQ

Preliminary cabin air quality measurement campaign

EASA CAQ Study 2017 1/5

FINDINGS

- Traces of meta & para TCP isomers were found in most samples;
- TCP contamination occurs.

- 1) **PERMANENT TCP RELEASE** - in all aircraft including Boeing 787
  - Showed ubiquitous background low-level TCP from textiles, plastics, circuit boards…
  - These results were similar to buildings / environment
  - The levels were too low to cause adverse effect on CAQ

EASA CAQ Study 2017 2/5

- 2) **OIL TRIGGERED EVENTS** (Source: bleed air)
  - **Non permanent release**
    - 67% of samples – Taxi out,Take off, climb, descent and landing-
    - **Primary event**: Engine seal failures, oil overfill / Very rare
    - **Secondary event**: Deposits in bleed air system & ducting – Sourced to permanent low-level leakage of APU/engines
      - Responsible for more frequent smell event- Non toxic odours released
      - Unknown frequency
      - Inspection of the engines after an event will lead to no findings
      - Triggering events can be physico-chemical influences on deposit

EASA CAQ Study 2017 3/5

- 2) **OIL TRIGGERED EVENTS** (Source: bleed air)

  - **Permanent release**
    - There is permanent low level TCP / oil entry via bleed air (due to chronic seal failure)
    - Most engines have a certain turbine oil leak rate
    - It is not detectable / below detection limit 2ng/m3 – Some is assumed to enter cabin
    - Future testing technology must be improved
    - Amounts too low to effect CAQ

EASA CAQ Study 2017 4/5

- Ubiquitous low-level TCP leakage can be differentiated from oil triggered events (Technical cockpit/cabin air contamination)
- Permanent low-level TCP / oil is from the bleed air system
- With high air exchange rates, the cabin is less polluted than homes/offices…
- Oil triggered events present no harm to health
- Medical procedure are only undertaken once the oil source classified
-
- Bio-analytical methods are not sufficient at present

EASA CAQ Study 2017 5/5

- Aerotoxic syndrome remains completely incomprehensible.
- Oil levels too low to cause acute / chronic neurological effects- hyperventilation & other causes are under consideration
- Risk mitigation should be a reasonable cost benefit ratio
- Oil investigations using conventional methods no longer possible because of low levels and rare occurrence rates
- Future 'large scale study' should
  - **"provide data to put to end misguided discussion on CAQ 'once and for all"**

EASA Oil Pyrolysis Study 2013 Findings/Conclusions

EASA
European Aviation Safety Agency

Final Report EASA_REP_RESEA_2015_2

Research Project:

AVOIL

Characterisation of the toxicity of aviation turbine engine oils after pyrolysis

EASA Oil Pyrolysis Study 2013 Findings/Conclusions 1/3

Aim: Characterize oil toxicity including pyrolysed mixture

- If seals not performing effectively: Oil & thermally degraded products can enter bleed air
- 127 compounds identified (including Polycyclic Aromatic Hydrocarbons)
- High levels of aldehydes & CO found
- CO levels 'drastically increased' at 375 +/- 25°C
- TCP detected but not TOCP (increased TCPs at temps 375 +/- 25°C)
  - Questioned if effects related to TOCP exposure?
- Oil changes in composition over lifetime
- No were neuronal effects from neuroactive pyrolysis products (30 mins or 24 hr was the exposure for rats)
  - Toxicity may be aggravated by prolonged exposure
- Human sensitivity variability is largely unknown
- Effects of chemicals combined with other occupational stressors largely unknown
- Part of symptoms may not be caused by exposure to chemicals (due lack of specific symptoms)

EASA Oil Pyrolysis Study 2013 Findings/Conclusions 2/3

Suggested further research

- Neuronal effects of prolonged/repeated exposures;

- Establish maximum concentrations of chemical substances/ internal dose levels / molecular targets / no effect concentrations;

EASA Oil Pyrolysis Study 2013 Findings/Conclusions 3/3

Suggested further research

- Define specific symptoms reported by crew to determine if a syndrome is present – Include 'personality situational factors' together with triggering and maintaining factors;
- Explore the possibility that cabin conditions may differ from standard conditions used for determining exposure limits;
- What are the effects of mixture toxicology?

EASA / EU COMMISSION FINDINGS TO DATE

- Cabin air very good compared to other indoor environments – normal conditions (no oil fume events)
- Levels of pyrolysed engine oils released present no problems
- Causal link between exposures & health not established & considered unlikely
- Future EU Commission study will focus particularly on abnormal conditions

EU COMMISSION

- **New large scale study - DG MOVE/EASA: €2 mill (2017)**

- **'Investigation of the quality level of the air inside the cabin of large transport aeroplanes and its health implications'**

http://ted.europa.eu/TED/notice/udl?uri=TED:NOTICE:66334-2017:TEXT:EN:HTML

EU COMMISSION

- Characterize bleed air contaminants, concentration & impact on CAQ
  - In terms of exposure limits & other indoor air quality guidelines/ regulations
- Identify Short Term & Long Term health effects
- Simulate cabin air contamination events
- Complete a toxicological risk assessment
- Look for Risk Mitigation protocols

http://ted.europa.eu/TED/notice/udl?uri=TED:NOTICE:66334-2017:TEXT:EN:HTML