GCAQE

Global Cabin Air Quality Executive

31/1/18

RATIONALE AS TO WHY A CHEMICAL LIST SHOULD NOT BE UTILISED AS PART OF THE STANDARDS DEVELOPMENT FOR TC 436.

Summary:
The GCAQE does not agree with the use of a chemical list (chemical marker compounds) as part of the standard 'TC 436 – Cabin air quality on civil aircraft- chemical agents', for the reasons below:

Standardisation under TC 436 must not be used to:

- Allow the use of chemical limits and thresholds / OELs, IAQ limits….;
- Derive a performance based standard that uses thresholds to define acceptable engine/APU or aircraft air quality;
- Define chemical marker compounds that could be used by an end-user to define acceptable air quality, health or toxicity limits or performance outcomes;
- Compromise/achieve consensus that degrades the air quality below the levels outlined under the currently available regulations & standards – CS 25.831, CS E 510, CS APU 210, CS E 690 etc. and related acceptable means of compliance;
- Measuring individual chemical substances will not address the toxicity of the very complex mixtures related to the oils and other aircraft fluids that enter via the bleed air supply. Therefore markers cannot advise the 'acceptability' of the air quality;
- Advise acceptability of the air based on currently available technology used to measure individual chemical substances, which will be very unlikely to detect the very low-levels of emissions in normal operations or lower-level fume events.

Standardisation under TC 436 can only be used to:

- Provide practical early warning marker substances to be used in flight and on the ground. This may help crew take operational action in relation to higher dose fume events as well as some lower-dose fume events, using the best available technology. It could also assist maintenance/ engineering as to when to take action on the ground.
- Markers to be considered should be: particulates (PM2.5 and ultrafine particles), CO, CO_2, total carbon.

While the title of this proposed standard lists chemical agents, this does not imply that markers need to be individual substances. Markers must be logical. The chemical list approach is not.

Justification:
The GCAQE does not agree with the use of a chemical list to meet the scope of TC 436 Cabin Air Quality on civil aircraft - Chemical Agents.

At present the scope says it will *'focus on the presence of and means to prevent exposure to chemical agents, including those that could cause adverse effects, taking into account the precautionary principle.'* Clearly this addresses identification and prevention of those substances possibly related to adverse effects.

While standardisation involves consensus building and compromise, this is not at all suitable for such a safety critical environment. The aviation airworthiness standards require that the ventilation system does not cause harmful effects. This cannot be compromised by use of a consensus standard.

The development of a list using priority chemicals and currently available detection technology will not be able to protect against adverse health effects or define when actions should be taken. At best it may define acute higher level events relevant to those who fly infrequently, but it will not be able to identify exposure to the lower-levels of oil lubricants and other fluids that are known to be present at background levels in all flights.

A chemical list should not be utilised for the following reasons:

a) It leaves open the likelihood for end users to use such markers as defining adequacy of the air quality. This cannot be done using Occupational Exposure Limits (OEL) and similar limits which are not designed to deal with the chronic continual exposure pattern to a complex low dose mixture. [1]

b) The reference to published health limits is inappropriate as end users will be <u>able</u> to interpret levels detected in light of these & use of such limits should NOT be applied in the aviation environment or to complex pyrolysed mixtures…. [1–3] OELs represent high concentrations of single chemicals as monitoring endpoints. OELs are designed to cope with short-term exposures which are rare events. [4] Classical regulatory toxicology cannot address cabin air quality questions. *'Safe'* limits always come down…….with very few exceptions.[5] OELs do not apply to the public, are not available for all substances and do not protect all workers.

c) Detection equipment is likely unable to detect 'relevant concentrations' due to the Limit of detection (LOD) limits being often too high to detect background fugitive emissions that are very relevant to those frequently in the aircraft environment.

d) A chemical list selection based on toxicity concerns or frequency of detection ignores actual exposures occurring in aircraft setting: Low-level repeat exposures and adverse effects documented.

e) Classical toxicology cannot address cabin air quality, one chemical at a time when the cabin air supply involves chronic low-level exposures to a complex mixture of UFPs and fugitive vapours from gas turbine engines. [6,7]

There is considerable published literature supporting:

- Low-level exposure to bleed air contaminants in normal flight. [8–10]
- Adverse effects following chronic low level exposure to oils/fluids exacerbated by acute events.[11–13]
- Low level repeat exposure to OPs causing non cholinesterase effects.[14,15]
- Repeat low-level exposure to OPs causing increased susceptibility to neurotoxic damage. [16]
- Exposure to UFPs allowing increased adverse effects of organic compounds including OPs. [7,9,17]
- UFPs (Less than 10nm -150nm): "oil contamination in the compressor will result in a

fog of very fine droplets in the bleed air under most operating conditions. This research shows that development of sensors for detecting oil contamination in aircraft bleed air should focus on ultrafine particle detection and sensing of low contamination levels may require sensitivity to extreme ultrafine particles 10 nanometers and smaller." [18]

- Individual susceptibility to OPs. [19],[20]

Given that it is simply not possible to identify the toxicity or adequacy of the individual substances when applied as part of this complex mixture, the only option is prevention and identification using best available technology (BAT) when intervention actions should be taken.

Therefore a practical approach to identify exposure to oils, hydraulic and other fluids is the only sensible solution. This method will identify the increase in contaminants, such that action can be taken. It is a preventative method, rather than a liability based system.

The suggested practical means using best available technology to detect when action should be taken, either in flight or on the ground should include a rise in:

- Ultrafine particles
- PM 2.5
- Carbon differential
- Identification of fluids such as specific oils, hydraulic fluids….. using electronically trained sensors
- Carbon monoxide – to satisfy CS 25.831 b, however CO may not be an accurate indicator of contamination in all cases.
- Carbon dioxide

Early warning marker: It is not logical to set the sensor to go off at a level high enough so that it is not too sensitive and therefore going off too frequently, but below health limits. This rationale will ensure people continue to be exposed to background levels of air supply contaminants, which are documented to be causing adverse effects and health limits cannot be applied to the aircraft environment. Exposure to fugitive emissions and transient bleed air contaminants occur as a design factor with the use of the bleed air system, thereby guaranteeing exposure in normal flight operation. The use of best available technology will ensure exposure is reduced well beyond warning systems set to identify higher level exposures.

If the aim is to identify the presence of and means to prevent exposure to contaminants, including those that can cause adverse effects, then the only option is to use methodology that will identify that exposure is occurring at the earliest time possible using BAT. To measure individual substances will not be protective, or prevent adverse effects.

The aviation environment is a safety critical environment. This is well accepted. ICAO recognizes symptoms related to bleed air contaminants, subtly may downgrade crew performance in flight. The oil MSDSs and warning labels warn not to breathe mist or vapour from heated material & wording such as *'product may decompose at elevated temperatures or under fire conditions and give off irritating and/or harmful (carbon monoxide) gases /vapors/fumes. Symptoms from acute exposure to these decomposition products in confined spaces may include headache, nausea, eye, nose, and throat irritation'*. These are being regularly reported and are not compatible with safe flight. This is not something that can be bargained with on a consensus basis. The use of the bleed air system is a fail dangerous

system, by way of exposure being guaranteed. Therefore there is a duty to utilize prevention techniques as per the best available technology available.

The GCAQE cannot support the use of individual chemical markers, which will do little if anything to prevent exposures in the aircraft environment setting being reported. Such markers must not be used as part of a performance based standard. There is a practical way forward to identify when actions should be taken. Industry consensus cannot be applied here when aircraft safety relies in part of crew not being subjected to substances causing impairment. The best available technology using a practical methodology is the only way forward to ensure the air supply remains as free as possible of adverse effects.

The only options suitable for the GCAQE are to either:

A. Produce a standard that describes the quality of the air in generic terms, with the focus on practical identification (as listed above) as to when action should be undertaken using best available technology to keep exposures to an absolute minimum. It must be noted that adequacy of the air and toxicity cannot be addressed at this time.
B. No standard
and
C. The CEN work program must not start until the rationale of what we are trying to do has been resolved as the issues raised above are fundamental to the way forward.

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