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POSITION PAPER

CEN TC 436 'Cabin Air Quality on commercial aircraft - Chemical Agents':

ANEC's expectations about the use of the lists of chemical marker compounds including rationales

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Background

EN 4618 "*Aerospace series - Aircraft internal air quality standards, criteria and determination methods*" was published in September 2009. It was prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN). It defined maximum contamination limits for 19 selected marker compounds (safety, health and comfort limits).

Organisations representing cabin staff (such as the European Transport Workers' Federation) raised concern over this standard for several reasons. First, because it had been prepared by an industry organisation rather than using a consensus-based process allowing a broad range of stakeholders to contribute. Second, the limits were found inadequate (limits too high or missing). Third, the absence of supply air monitoring and preventative pilot or maintenance measures was criticised. ANEC concurred largely with the critical assessment, though considered that EN 4618 contained also valuable elements.

As a result, CEN decided to submit the existing standard to a five-month CEN Enquiry starting in February 2013. Finally, it was decided to withdraw EN 4618 and to establish – after some discussions - a Technical Committee (TC) with the aim to develop a new European Standard or a set of standards dealing with the quality of air on commercial aircraft concerning chemical agents. The TC went operational in April 2015. ANEC supported these decisions.

Up to now no consensus could be reached on the basic concepts to be followed and structure of the future standard. However, the TC adopted unanimously a decision on marker compounds (see first chapter below) in March 2017. In addition, there was broad support for a prioritisation approach to select appropriate markers (see below). The following considerations build upon these two (provisional) results.

1. CEN TC 436 Decision on marker compounds

By Decision 2017/02 the TC approved the following approach for its Task Group 1 (TG 1) on 'Chemical marker compounds':

<u>The goal:</u> The primary goal of our TG is to identify a subset of the chemicals that could be present in cabin air. The compounds on the list represent the potential sources of airborne contaminants onboard (e.g., oil, de-icing fluid, exhaust, hydraulic fluid, etc.) and for which measurement technology exists that can reliably detect relevant concentrations. The purpose of developing this list is to identify candidates that could be measured in some way (e.g., continuous, periodically, during a fume event, trouble-shooting post-event, etc.).

<u>The approach:</u> We envision that this list will be the basis for a practical approach to identify the presence of selected airborne contaminants that may require intervention ("intervention level"); e.g., maintenance post-flight, source isolation inflight. It is important to ensure that each "intervention level" is not too low such that the indicator would be too sensitive and, thus, be ignored in operation. The proposed "intervention levels" are lower than published health limits for these compounds. This approach is not intended to define the toxicity of chemical compounds in the cabin environment. It is simply a practical method to determine when interventions may be required.

The decision was supported by ANEC.

2. ASHRAE standards and guidelines

The "approach" adopted by CEN TC 436 is a reflection of the standard ASHRAE 161 'Air Quality within Commercial Aircraft' developed by the American Society of Heating, Refrigerating and Air-Conditioning Engineers which says the following in 7.2 (concerning bleed air contaminant monitoring): "*The trigger point is defined as a concentration that may not be high enough to be associated with a negative health impact on its own but rather indicates the presence of partly or fully pyrolyzed oils or hydraulic fluids. The trigger point shall be high enough above background levels to indicate contamination but not so high above background levels to miss events*". Unfortunately, the standard does not elaborate in detail how the trigger points are derived. Apparently, the provisions make only sense if one has an idea about the relevant health concern levels – only then the trigger point can be set in a meaningful way ensuring that these health concern levels are not exceeded.

At least one example for a trigger point is given, stating that for CO (where appropriate) "*the trigger point for data recording and display shall be set at 9 ppm, and an exceedance shall be defined as either (1) a ten-minute time-weighted average* *concentration at or above 9 ppm or (2) a 60-second peak value at or above 50 ppm*". In fact, this approach means to have 3 different trigger values (involving low public health thresholds as well as relatively high occupational limits) rather than just one.

Some additional information is given in table 8.2.5 of the complementary guidelines ASHRAE 28. It advises among others that 9 ppm/8h have been defined by WHO for the general population which means that the first (lower) CO exceedance value in the previous paragraph is significantly below the WHO threshold as the latter applies to a much higher time span). The ASHRAE 28 guidelines also mention some occupational limits up to 50 ppm - the regulatory peak limit for aircrafts (which WHO finds acceptable for a maximum period of 30 minutes).

The ASHRAE 161 standard remains vague as regards to action to be taken as a result of exceeding the trigger point: "*The response to an exceedance will vary depending on the number, magnitude, and frequency of triggered events*". This is followed by some generic statements leaving a large room for interpretation by the users of the standard.

The approach taken by ASHRAE (including online monitoring; setting various trigger levels, starting with levels well below health limits for the general population up to occupational thresholds, etc.) seems valid and can be supported in principle but needs much more detail about the choice of substances to be included, the determination of trigger levels and the resulting pilot or maintenance actions. It could be a major benefit of a future European standard to provide additional guidance on these aspects.

3. Priority substances

TG1 of TC 436 dealing with chemical marker compounds identified a list of 53 chemicals to be covered, based on input of its members. In October 2017 a three tiers priority list was compiled. The tier 1 list included 11 substances which received broad (but not unanimous) support from the TG1 membership. It includes:

1. Acrolein
2. Benzene
3. Carbon dioxide
4. Carbon monoxide
5. Formaldehyde
6. Ozone
7. (Ultrafine) Particles
8. Tributyl phosphate (TBP)

9. Tricresyl phosphates (TCP)
10. Toluene
11. TVOC

The tier 2 list contains (at present) additional 7 (groups of) compounds for further discussion. Finally, the tier 3 list includes all remaining substances identified (with a possibility to add more substances).

ANEC supported the first-tier list (including the rationales for the selection of the substances). It does not seem to be useful to extend this list considerably for the first edition of the standard (in order to complete the standard in an acceptable timeframe). At the same time, it is also not acceptable to disregard the achievements of the very lengthy and laborious process of consensus building and eliminate a large part of the substances listed. A definitive list for the first edition of the standard should be preferably adopted at the next meeting of CEN TC 436 in March 2018.

Only some of the substances are suitable for an online cabin monitoring system using sensors at present, i.e. CO_2, CO, O_3, (T)VOC and (ultrafine) particles. The kinds and performance requirements for sensors for these substances should be determined during the course of the year. Hence, it is recommended to use CO_2, CO, O_3, (T)VOC and (ultrafine) particles for an online monitoring system.

For the other substances an offline measurement is necessary. The kind, sampling procedures and frequency of the measurements needs to be also determined. The final decisions on these issues for the public enquiry draft of first edition of the standard should be taken at the CEN TC 436 plenary meeting in spring 2019.

4. The "use" of the marker list, trigger points and purpose of measurements

4.1 Use several trigger points for online monitoring

As indicated above the approach taken by ASHRAE seems a suitable departure point for the development of an approach to determine trigger levels for online measurement, recording and pilot/maintenance actions. In particular, it seems useful to follow a tiered approach and to define several intervention levels for a particular substance with increasing concentrations for triggering various activities (not just 1 trigger point).

It is recommended, therefore to generally aim to determine several trigger points ranging from low levels below conservative health thresholds, up to high levels where the safety of the aircraft operation is at risk requiring immediate intervention.

In the course of the deliberations in TG1, it was suggested to use data measured in cabin air studies and to determine a cut-off point to distinguish between normal and elevated concentrations by using a certain percentile of the measurements as a trigger point. This could be a useful first tier level for indicating to the pilot that attention should be paid to the further development of the concentrations unless any health-based threshold suggests a lower value.

4.2 Pragmatic approach for determining trigger points for online monitoring

It is not necessary to determine precisely a percentile from one or a number of studies (and also impossible without having access to all measured values).

A pragmatic approach for setting a first trigger value for online monitoring could just determine a level – depending on the substance - from the upper range of published measured data under normal operating conditions (unless health thresholds suggest a lower value). The purpose of this trigger is just to draw the attention of the relevant parties to the need to keep attention to the further concentration development and, perhaps, to record data. Further trigger points would be based on various health thresholds, ranging from very conservative for the general population up to conservative for the occupational environment.

4.3 The example of carbon monoxide

Using CO as an example, one could determine 3 - 5 ppm as a first trigger point, given that e.g. the recent EASA study "CAQ Preliminary cabin air quality measurement campaign" published 2017 reported maximum values measured under normal operating conditions of 4.8 ppm and the maximum 95th percentile of 1.06 ppm. This would be the contamination level which should normally not be exceeded.

A second trigger point for CO could be based on a very conservative (!) health threshold for the general public (or somewhat below) or a comfort limit. The first "exceedance level" defined by ASHRAE for CO - a ten-minute time-weighted average concentration at or above 9 ppm – is a good example for this. In fact, the WHO would allow an exposure of 9 ppm CO for 8h. This trigger would form the basis for a first action tier requiring some kind of inspection/maintenance (to be further defined).

A third trigger could be a health threshold for the general public. In case of CO it would be prolonged exceedance of 9 ppm (beyond the first trigger value). In such case a second action tier requiring to take the aircraft out of operation and additional provisions concerning inspection/maintenance (to be further defined). The second and third trigger point could be, of course, also combined.

A fourth trigger could be a suitable occupational health threshold. In the ASHRAE CO example it is a 60-second peak value at or above 50 ppm (in fact, the regulatory limit). Under those circumstances a safe operation of the aircraft cannot be ensured any longer. This could require immediate action e.g. the provision of oxygen masks and a discontinuation of the flight (to be further defined).

The consequences of exceeding trigger points ("intervention levels") may be worded differently. The language may be vaguer (as in the ASHRAE standard) or more precise (preferred option). It may be more informal or more normative. However, at least the basic ideas behind the trigger approach should be communicated to the audience of the standard.

In fact, also the withdrawn EN 4618 used a tiered approach by defining comfort, health and safety levels. Whilst not explicitly talking about "intervention levels", it seems pretty obvious that e.g. exceedance of safety levels would (as the standard stated) "prevent the safe operation of the aircraft" and would, therefore, need to be followed by immediate action (e.g. the deployment of oxygen masks).

4.4 Variations of the online monitoring approach

This general scheme needs, of course, substance specific modifications. For instance, for some of the substances thresholds do not exist (e.g. TVOC or ultrafine particles). In such case only some more or less orientational values can be given, e.g. to distinguish between normal and abnormal operation.

4.5 Example TVOC

For instance, one could base the first trigger point for TVOC on a threshold used by the German (AgBB) scheme for indoor emissions from construction products, i.e. 1 mg/m^3 measured in a test chamber after 28 days. In the EASA study mentioned before online VOC measurement using a photo ionization detector (PIC) showed maximum values of 1.7 mg/m^3 and a maximum 95th percentile of about 0.55 mg/m3 (the different measurement methods are disregarded here). A second trigger point for TVOC could be defined to characterise a malfunction, e.g. by using a value of 10 mg/m^3 (which corresponds to the German indoor emission limit measured after 3 days) requiring some kind of action. In fact, there could be even a third trigger indicating the need for more immediate action (this is to be further discussed).

4.6 Offline measurements

In case of offline measurements results are, of course, available only with a time delay. Hence, any measured value cannot instruct immediate action. Nevertheless, it is still useful to set trigger points for offline measurements for (delayed) action, though in this case, the system may be simplified (e.g. using only one trigger point).

For some substances online sensors may be available in the future.

4.7 The Example of benzene

In some cases, the departure point (i.e. the first trigger point) cannot be taken from the upper range of measured data under normal operating conditions simply because these values are too high. Here one cannot build on "good practice". For offline measurements a first trigger point intended to alert the pilot as stated above does not exist anyway.

For instance, the EASA study measured for benzene (main study) a maximum concentration of 53.4 µg/m^3, a 95th percentile of 32.2 µg/m^3, a mean concentration of 8.2 µg/m^3, a median concentration of 4.3 µg/m^3. All (!) benzene concentrations measured by EASA – even the minimum levels - were above concentrations associated with a cancer risk of 1/1 Mio calculated by WHO, i.e. above 0.17 µg/m^3 (0,05 ppb). However, this is a very low threshold which could not be kept by most flights at present. In Europe an ambient air quality limit of 5 µg/m^3 (annual average) applies which might be a suitable first (still conservative) trigger point. In the EASA main study half of the measured data would have been in conformity with this limit.

It should be borne in mind that the highest values for aromatics were measured during the taxi-out phase reflecting ground contamination. Hence, this limit could be met by a higher proportion of flights excluding the taxi-out phase. It does not seem necessary to establish additional trigger points. As stated above no immediate action by the pilot can be informed as the data are not at hand during the flight.

5. Final Remark

The above considerations are intended to demonstrate an approach in principle and need further refinement as well as additional substances.

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About ANEC

ANEC is the European consumer voice in standardisation, defending consumer interests in the processes of technical standardisation and conformity assessment, as well as related legislation and public policies.

ANEC was established in 1995 as an international non-profit association under Belgian law and is open to the representation of national consumer organisations in 33 countries.

ANEC is funded by the European Union and EFTA, with national consumer organisations contributing in kind. Its Secretariat is based in Brussels.

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