

## **ETUC comments and input to the work in CEN TC 436 'Cabin Air Quality on civil aircraft - Chemical Agents'**

Cabin air can contain toxic fumes, putting flight staff and passengers' health at risk. Therefore, CEN TC 436 is developing a European standard on the quality of cabin air in civil airplanes. With this paper, we would like to give our consideration to the work of CEN TC 436.

This paper by Howard, Michaelis and Watterson (2017) [1] addressing the aetiology of aerotoxic syndrome forms the basis of our considerations in this matter.

In addition to the points highlighted by Howard et al. we wish to raise a further technical matter which was not specifically addressed but which is closely related. There is evidence that, in addition to the complex mixture of fugitive chemical emissions continually present in cabin air, there is also an aerosol of ultrafine particles (UFPs). The size range of UFPs is, by definition, the same for nano-particles, namely 1- 100 nm. This has been confirmed by Jones et al. (2017) [2] who made measurements of appreciable levels of UFPs in bleed air from gas turbine engines. This should come as no surprise because high temperature 'hot spots' in the lubrication oil pathway have been reported by Dr. David Johnson. Oil in circulation can contact some points of the engine which are at 1500 C. Measurements of extremely high transient temperatures have been made in engine bearings. It has been reported that temperatures up to 30,000 C may exist for time periods in the nano-second range [3]. This is a very short time interval but is repeated frequently as the engine rotates at high revolutions/min. Both these temperatures exceed the smoke point for lubrication oils. The higher temperature is approaching plasma arc temperatures. At these temperatures several sequelae are assured. UFPs will be formed. Organic molecules, such as the triaryl phosphates present in the vapour phase will condense on the very high specific surface of the UFP aerosol and will remain there.

What are the health consequences of being chronically exposed to an aerosol of UFPs for hundreds or thousands of hours during the professional lifetime of the cabin crew and pilots? We draw attention to a review of the toxicology of nanoparticles by Elsaesser and Howard (2012) [4], which forms an integral part of this submission. The main points of relevance are:

- When particles in the nano-scale are made, they become chemically much more reactive, it is how heterogeneous catalysts are made. This works even for materials that are chemically inert in bulk, such as gold and platinum. These very small particles develop a surface chemistry, Fenton chemistry, which is a function of their small size. A common factor between UFPs in biological matrices is that they induce inflammation, largely irrespective of what they are made of – it is a small size related property.
- Particles in the UFP size range are preferentially deposited to the deepest alveolar regions of the lungs, where gas exchanges between air and blood are conducted
- UFPs cross the alveolar membranes into the blood stream by endocytosis (in the same way that viruses do) and have been measured travelling to most organs in the body.
- UFPs act a Trojan Horses as they can cross the blood brain barrier (BBB), which has evolved to keep unwanted chemicals at bay. Pharmaceutical companies are already exploiting this aspect to increase drug penetration into the brain. They coat nano-particles with the drug of interest and this then 'piggybacks' across the BBB, again by endocytosis. Thus the drug, in this case, avoids the metabolic defence mechanisms of the BBB on the surface of the nano-particle.

- The effect of having a continual aerosol of UFPs within a complex mixture of fugitive engine vapours in cabin air will be to increase exposure of the brain to neurotoxic chemical influences leading to target organ toxicity. This will be because some of the vapour-phase volatile organic compounds will have condensed onto the surface of UFPs which can act as Trojan Horses and cross the BBB.

What are the implications of these toxicological mechanisms for the deliberations of CEN TC 436? We call upon the TC to acknowledge the existence of the scientific literature on the toxicological consequences of repeated low dose OP exposure. These have been reviewed by Terry [5]. We believe it is wrong to not mention the toxicology of complex mixtures but wanting to maintain a 'one chemical at a time' approach. The current approach of the TC to consider candidate chemicals, for which trigger limits can be set, is a standard approach in classical toxicology. However, it should be stated explicitly that, on the current evidence in the peer reviewed scientific literature, the proposed 'one chemical at a time' approach will do absolutely nothing to address problems in air crew and frequent flyers from chronic low dose exposure to a complex mixture of UFPs and fugitive vapours from gas turbine engines.

This suggests a logical approach to the setting of a standard that would take meaningful steps to protecting the health of cabin crew, pilots and passengers would be:

- 1) On existing bleed air architecture aircraft, fugitive emissions from aircraft engines will be reduced to the minimum achievable using Best Available Technology (BAT). The use of BAT in the standard would imply that a degree of vigilance would have to be maintained to make sure that technological developments are incorporated.
- 2) On future generations of aircraft, the standard will stipulate a bleed-free architecture.

We would appreciate if the members of CEN TC 436 'Cabin Air Quality on civil aircraft - Chemical Agents' could take the above points into consideration in the drafting of the standard.

## References

[1] C V Howard, S Michaelis, A Watterson. The Aetiology of 'Aerotoxic Syndrome'- A Toxicopathological Viewpoint. Open Acc J of Toxicol. 2017;1(5): 555575. DOI: 10.19080/OAJT.2017.01.555575  
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