EASA Comment Response Tool

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Title	Cabin Air Quality onboard Large Aeroplanes
NPA Number	A-NPA 2009-10

ETF (f.ballestero@etf-europe.org) has placed **15** unique comments on this NPA:

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21	A. Explanatory Note - I. General	3	"Today, based on European Aviation Safety Agency (EASA) knowledge, the cabin air contamination events by engine or Auxiliary Power Unit (APU) remain relatively rare, and among these events the proportion for which there was an impact on flight safety (e.g. flight crew performance degradation) is very low. However, as explained in the following chapter IV, there is an on-going debate among stakeholders about the reporting of these events and also about the associated possible health effects. In addition, the number of reports appears to be very variable from one country to another one, and it is not possible to determine a reliable rate of occurrence." Comment: It cannot be stated with certainty that Cabin air contamination events by engine or APU are “relatively rare” and the impact on flight safety “is very low” as there is not enough research or reporting on these events. Reporting events is not done very often because of ignorance as to the signs of oil leakage and subsequent cabin air contamination (pervading smell like that of “old socks” or “smelly feet”, blue mists in the cabin, etc…) or because of fear of reporting an incident. Further explanation can be found in *ACARM (2007b) “Chapter 12: Frequency of Events and Underreporting” “Aviation Contaminated Air Reference Manual,”* Michaelis, S., ed. ISBN 9780955567209, London, England, pp. 211-248. We support the intention of the EASA to collect detailed information on this issue in order to evaluate the threat for the health of aeroplane occupants & create new airworthiness standards.	
22	A. Explanatory Note - IV. Content of the A-NPA - 8. Background	5	"Most of the modern Large Aeroplanes use a fine High Efficiency Particulate Air (HEPA) filtration." Comment: We don't agree with this statement and ask the EASA to question	

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	and description of the issue		European Airlines on their use of HEPA filters on aircraft in their fleet.	
23	A. Explanatory Note - IV. Content of the A-NPA - 8. Background and description of the issue	5	"The majority of cabin air recirculation filters take out particulate, bacteria and viruses contamination. Some recent filters also combine the HEPA filtration with an odour absorber which removes odours and Volatile Organic Compounds (VOC's)." Comment : Before such air conditioning system filters can be assessed for their performance, the nature and concentrations of all hazardous compounds to which they may be exposed, needs to be established in order that such filters are effective *and effective over long periods.* In considering this subject in response to a safety recommendation made during an investigation, Boeing concluded that the efficiency and life of such VOC converters precluded their introduction into service at this time. Another consideration with the use of filters or converters is that they could possibly mask the evidence of an oil leak by the removal of the odour normally associated with such events, but fail to remove any contamination which could affect flight crews. ETF feels that filtration should only ever be used in conjunction with good maintenance practices/design & less toxic oils in reducing the likelihood of the oil leakage in the first place, and not as a substitute.	
24	A. Explanatory Note - IV. Content of the A-NPA - 8. Background and description of the issue	5	"Under certain fault conditions (e.g. engine or APU oil seal or bearing failure, engine or APU maintenance error/irregularities, or design deficiency), engine or APU oil, hydraulic fluid, fuel, de-icing fluid and the corresponding pyrolysis products may contaminate the bleed air, which then enters the cabin air supply and can be inhaled by the aeroplane occupants. In such a situation, the following questions therefore need to be answered: **What contaminants are released to the cabin and in which quantity?** **What is the effect on flight safety?** **Can it induce a health concern?** **What is the frequency of this kind of event?"**	

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			Comment: There has been and is still great difficulty in collecting and interpreting the mounting data and identifying toxic/irritant products in oil substances used in the airline industry. The physiological effects of gases and vapours in cabin air are now becoming clear and the defining of maximum acceptable quantities or concentrations must become a subject for legislation and standards.	
25	A. Explanatory Note - IV. Content of the A-NPA - 8. Background and description of the issue	5	"What contaminants are released to the cabin and in which quantity?" Comment: We refer to statements published by Dr. Mackerer in 1999 and to the Henschler report published in 1958 "Engine oils contain a mixture of tricresylphosphates, of which TOCP in not the most toxic". TOCP is NOT the only ortho isomer in TCP - the more toxic MOCP& DOCP are in the oil in far higher quantities. **Mobil** advised the Australian Senate Inquiry that the ortho isomers were in the TCP in it's oil at >0.3%. The more toxic MOCP & DOCP were not mentioned. **ORTHO** isomers divide into: **TOCP**, **DOCP** and **MOCP**. Focus has been on TOCP with UK House of Lords and CAA reports of 2000 and 2004. These reports fail to ever mention DOCP or MOCP. **TOCP 0.006 ppm Toxicity factor x 1** **DOCP 6 ppm Toxicity factor x 5** **MOCP 3070 ppm Toxicity factor x 10** In ignoring DOCP and MOCP the total ORTHO toxicity is underestimated by a factor of **6.14 million** which has been known since 1958 (Henschler). It has been known for years that when aviation engine oils are heated, a potent neurotoxic chemical called TMPP (trimethylolpropane phosphate) can be formed. TMPP is even worse than TCPs and exposure is associated with epileptic type seizures, convulsion, tremors, and changes to social/emotional behaviors. To our knowledge, it has never been found on aircraft. But to our knowledge, nobody has ever looked into this..	

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			A 1989 US Navy report stated that Exxon 2380 (now BP2380) generated high levels of TMPP when it was heated to temperatures at or above 350C. The TCPs in the oil then react with TMP chemicals in the "base stock" of the oil. **The levels of TMPP were so significant that the authors recommended that Exxon 2380 not be used on US naval vessels. But BP2380 is still widely used in commercial aviation**. **A 1996 US Air Force paper** raised concerns about the potential for being exposed to highly toxic TMPP, and stated that TMPP could be formed when oils that contain TCPs and TMP are heated to temperatures as low as 250C. This is important because these temperatures are more likely to be reached in the engine/bleed air system. Wright also stated that TMPP can NOT be formed if the engine oil base stock contains PE chemicals instead of TMP. *WRIGHT R. L. Formation of the neurotoxin TMPP from TMPE-phosphate formulations - Tribiology transactions 1996, vol. 39, no4, pp. 827-834* **Another US navy report in 1992** also expressed concern about the hazards 1) What engine oil(s) are used (e.g., Mobil Jet Oil II, BP2380, etc). 2) What APU and engine types are installed on what aircraft types (e.g. Pratt Whitney 4000, Honeywell Series 85, etc). Oils and lubricants used on the aircraft and in the engines contain not only the neurotoxins (TCPs and triphenylphosphates) but **sensitizers (N-phenyl-L-naphthylamine, PAN),** and **asphyxiants (carbon monoxide)**.. Pyrolysis studies have confirmed the presence of these toxins when commercial oils are heated (van Netten, 2000; Marshman, 2001; Fox, 2001). A Material SafetyData Sheet for engine oils acknowledge only the TCP content and the fact that “toxicfumes may be evolved on burning or exposure to heat” (BP, 2001). We ask that Studies include the potential impact of	

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			exposure to the mixture of these and other chemicals in **a reduced pressure environment**. We suggest that the EASA review all data and see if a less toxic alternative oil can be recommended that would be compatible with given aircraft engines/APUs. Ultimately, all of the engine oils should be analyzed for their base stock content (rather than relying on the analysis of the oil companies), as well as for the potential to form TMPP, and temperature range of TMPP formation.	
26	A. Explanatory Note - IV. Content of the A-NPA - 8. Background and description of the issue	5	"What is the effect on flight safety?" Comment: We refer to the following statements and documents: **2001:** "Incidents have been reported of impaired performance of flight crew…events could have been caused by inhalation of agents… leaking from oil or APU and contaminating the Environmental control system." (CAA AD 002-03-2001) **2002:** "oil leaks and cabin / flight deck odours must be regarded as a potential threat to flight safety, theyshould not be dismissed as a mere nuisance and should be addressed as soon as possible." (BAe ISB 21-150 2001 / ISB 21-156, 2002) **2003:** "Any oil leaking from an engine, entering the aircraft customer bleed offtake, is classified as HAZARDOUS" (Rolls Royce, Germany 2003, BRE air quality Conference, London) **2004:** "This amendment adopts a new airworthiness directive (AD), applicable to all BAE Systems (Operations) Limited Model BAe 146 series airplanes, that requires repetitive detailed inspections of the inside of each air conditioning sound-attenuating duct, and corrective actions as necessary. This action is necessary to prevent impairment of the operational skills and abilities of the flightcrew caused by the inhalation of agents released from	

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			oil or oil breakdown products, which could result in reduced controllability of the airplane. This action is intended to address the identified unsafe condition." (FAA AD 2004-12-05) **2006:** "The serious incident is attributable to the fact that on approach to Zurich Airport the cockpit filled with fumes which caused a toxic effect, leading to a limited capability of acting of the copilot. These fumes were caused by an oil leak as a result of a bearing damage in engine No. 1" "The medical examination of the copilot after the flight showed that during the flight toxic exposure took place." (Swiss Federal Department of Environment, Transport Energy and Communications Investigation Report No u1884 by the Aircraft Accident Investigation Bureau, 2 March 2006) We also refer the EASA to the manual written by Prof. S. Michaelis, (renowned expert on Cabin air contamination): "*Aviation Contaminated Air Reference Manual,"* Michaelis, S., ed. ISBN 9780955567209, London,	
27	A. Explanatory Note - IV. Content of the A-NPA - 8. Background and description of the issue	5	"Can it induce a health concern?" Comment: We believe that there is now sufficient available material and literature on cabin air being contaminated by toxic substances used on the aircraft. Studies are now available giving indications that the health of aircraft occupants may be severely affected by the inhalation and contact with gases and vapours of lubricants, anti-freeze agents and others. We refer the EASA to the following statements and studies : "individuals exposed to a single large toxic dose, or to small subclinical doses, of ***organophosphorus compounds*** have developed a chronic neurotoxicity that persists for years after exposure and is distinct from both cholinergic and OPIDN"(AbouDonia, 2003; *Arch. Environ. Health* **58**:484-97).	pilo Wir (15

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			· Abou-Donia MB(2004) Organophosphorus ester-induced chronic neurotoxicity. Archives of Environmental Health 58:484–497 · Organophosphate Ester Induced Chronic Neurotoxicity (OPICN)- Mohamed B Abou-Donia : Proceedings of the BALPA 'Contaminated Air Protection Air Safety and Cabin Air Quality International Aero Industry Conference'. Held at Imperial College, London, 20-21 April 2005: ISBN 0-7334-2282-9 · Journal of Occupational Health & Safety, Australia & New Zealand, Vol 21, Number 5 ,August 2005 - Special edition: New findings in aircrew exposed to airborne contaminants: Long-term health effects confirmed. - Organophosphate Ester Induced Chronic Neurotoxicity (OPICN)- Mohamed B Abou-Donia **1981:** Engine Lube Oil: "At temperatures above 320C this oil breaks down into irritating and toxic compounds." (SAE Aviation Information Report: 1539, issued 1-30-81) **1983:** "All of these toxic substances (includes engine oil) have acute and long-term effects" (Rayman R.B., McNaughton G.B. Smoke/fumes in the cockpit. Aviation, Space and Environmental Medicine, August 1983, pp 738-740. Current Director of the Aerospace Medical Association) **1998:** "Repeated low level exposure leads to cumulative toxicity." (1981 ed) "Acute and repeated exposure can produce harmful effects in man, and it has been suggested that chronic exposure at lower doses may cause long-term ill health." (1998 ed) (UKHSE: Organophosphates: HSE: MS17: Medical aspects of occupational exposures to organophosphates. Draft revision 23, November, 1998.) **1999:** "Neuropsychological outcomes - Neuropsychological abnormalities can occur as a long-term complication of acute OP poisoning" (UK COT report. Long term sequelae of acute poisoning:	

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			1999. Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment: Organophosphates: Executive Summary. Published by the Department of Health, 1999, London) **1999:** “The inhalation of mist (containing tricresylphosphate) which can be produced by high pressure systems, or direct contact with the skin, would be hazardous.” (UK Government Hansard 66599, 4 February 1999, column 737) **1999:** “TCP is toxic” (UK Government: Hansard 82322 6 May 1999 : Column: 428) **2000:** “With the weight of human evidence and suffering, which is quite clear, there must be something there” “There is absolutely no doubt in our mind that there is a general health issue here” (BAe Systems verbal evidence to Australian senate Inquiry 2000) **2001:** “Incidents have been reported of impaired performance of flight crew…events could have been caused by inhalation of agents… leaking from oil or APU and contaminating the Environmental control system.” (CAA AD 002-03-2001) **2002:** “oil leaks and cabin / flight deck odours must be regarded as a potential threat to flight safety, they should not be dismissed as a mere nuisance and should be addressed as soon as possible." (BAe ISB 21-150 2001 / ISB 21-156, 2002) **2002:** “FAA rule-making has not kept pace with public expectation and concern about air quality and does not afford explicit protection from particulate matter and other chemical and biological hazards.” “No present airplane design fulfills the intent of 25.831 because no airplane design incorporates an air Contaminant monitoring system to ensure that the air provided to the occupants is free of hazardous contaminants" **2003:** “Any oil leaking from an engine, entering the aircraft customer bleed off-take, is classified as HAZARDOUS”	

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			(Rolls Royce, Germany2003, BRE air quality Conference, London) **2003:** "It is found that the sound attenuating material used in the air-conditioning ducts can absorb oil and can become a source of persistent air contamination." (CASA AD /BAe 146/102, 23 January 2003) **2004:** "In the event of oil leakage there is the opportunity, therefore, for the pyrolysis products of engine lubricant/fuel to enter the cabin air supply and exert toxic effects on both passengers and crew." (CAA Air Quality report 2004) **2004:** "This amendment adopts a new airworthiness directive (AD), applicable to all BAE Systems (Operations) Limited Model BAe 146 series airplanes, that requires repetitive detailed inspections of the inside of each air conditioning sound-attenuating duct, and corrective actions as necessary. This action is necessary to prevent impairment of the operational skills and abilities of the flight crew caused by the inhalation of agents released from oil or oil breakdown products, which could result in reduced controllability of the airplane. This action is intended to address the identified unsafe condition." (FAA AD 2004-12-05) **2005:** "Both Flight Crew Affected By Sore Throats And Other Symptoms After Flight." "Smells and irritants from burning organic compounds from within the engines are known to produce harmful volatile organic contaminants." (UKAirline Air Safety Report, ASR G-CFAH, 4 July 2005) **2007:** "Mobil Jet Oil II- Known to be harmful" **(**CASA: AIR SAFETY & CABIN AIR QUALITY - Jim Coyne – A/g General Manager Manufacturing, Certification & New Technologies Office: 2007 presentation) **2007:** "A35-12: Protection of the health of passengers and crews and prevention of the spread of communicable disease through international travel -*Declares* that the protection of the health of passengers and crews on international flights is an integral element of safe air travel and that conditions should be in place to ensure its preservation in a timely and cost-effective manner; -*Requests* the Council to support further research on the consequences of air transport on the health of passengers	

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			and crews” (ICAO- Aviation Medicine (Med) Section Related ICAO Resolutions, 5 July 2007) http://www.icao.int/icao/en/assembl/a36/wp/wp022_en.pdf **2007:** “I call on the government to reveal whether information about defects has been withheld from the regulator, the courts or the parliament” “I am gravely concerned that crew and passengers of BAe146 aircraft have been exposed to dangerous fumes produced by engine defects" (Senate Hansard: Monday, 13 August 2007, Senator O'Brien **2009:** “Product may decompose at elevated temperatures or under fire conditions and produce harmful gases or vapours. Vapours or mist of heated product may be harmful by inhalation.” R 63.G3 Possible risk of harm to the unborn child. R 62.F3 Possible risk of impaired fertility. (NYCO MSDS 2009 , TURBONYCOIL 600) **2009:** “Product may decompose at elevated temperatures or under fire conditions and give off irritating and/or harmful (carbon monoxide) gases/vapours/fumes. Symptoms from acute exposure to these decomposition products in confined spaces may include headache, nausea, eye, nose, and throat irritation.” (Mobil MJO2 MSDS EU 2009) **2009:** Plus Minus: “Is inhaling of tricresyl phosphate (TCP) safe or dangerous?” Professor D henschler (1958 TCP researcher): “I believe it to be dangerous.” (German TV: Plus Minus, March 2009) **2009:** “Does the German Government believe that inhaling of heated engine oil fumes is harmless for the health of crew and passengers?”. Answer “No" German Ministry of Transport, Secretary of State Ulrich Kasparick. (Question to MP Winfried Hermann of Bundnis90/Greenparty in regards to contaminated cabin air on board of civil airliners, printed matter 16/12023, 3 March 2009) **2009** “Smoke from pyrolysed oil can be hazardous to the eyes, mucous membranes and lungs”	

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			(Turner V Eastwest Airlines [2009] NSWDDT 5 May 2009 , Australian Court) 2009: “Smoke or fumes in the flight deck or passenger cabin present the crew with a potentially hazardous situation” AAIB Bulletin 6/2009 G-BYAO B757, EW/C2006/10/08 Bobb, A.J. and Still, K.R. (2003) “Known Harmful Effects of Constituents of Jet Oil Smoke,” TOXDET-03-04, Naval Health Research Center Detachment (Toxicology), Wright-Patterson AFB, OH Winder, C; Fonteyn, P; Balouet, JC. (2002) “Aerotoxic syndrome: a descriptive epidemiological survey of aircrew exposed to in-cabin airborne contaminants” J Occup Health Safety – Austr New Zealand, 18(4): 321-328 Winder, C. (2006) Hazardous chemicals on jet aircraft: Case study – Jet engine oils and aerotoxic syndrome. Current Topics in Toxicology. Vol 3, 2006 2008 -- Cognitive function following exposure to contaminated air on commercial aircraft: A case series of 27 pilots seen for clinical purposes -- S Mackenzie Ross -- Journal of Nutritional &Environmental Medicine -- June 2008; 17(2): 111–126 (see attachment 1: SMR_2008_27_pilots.pdf) 2006 -- Hazardous Chemicals on Jet Aircraft: Case Study-Jet Engine Oils and Aerotoxic Syndrome, -- C.Winder -- Current Topics in Toxicology. Vol 3 2006 (see attachment 2: Winder_Hazardous_Chemicals_on_Jet_Aircraft_2006.pdf) **The neuro-toxicity of products used in lubricants and other substances in the aircraft engines seem to provoke Long-term health problems including :** – Neurological effects: CNS,PNS: Jamal 1997, Jamal, Julu… 2002, 2005 – Autonomic nervous system effects: Jamal, Julu… 2002, 2005	

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			– Working memory / cognitive problems. (neuropsychological), Coxon 2002 / Mackenzie Ross 2006 – Chronic neurotoxicity (OPICN): Abou-Donia 2004, 2005 – Neuronal brain cell death: Abou-Donia – Respiratory disorders: Burdon, Glanville 2005 – Immune system effects, fatigue, chemical sensitivity etc.. – Blood pathology disorders – Strong occupational link: Cone 1983,1999 / Harper 2005 – Individual susceptibility: Furlong • TCP Blood test: 6 of 10 TCP isomers are converted into the highly toxic metabolite – psp: that inhibits the activity of a number of important enzymes. • Gene expression: Gene expression effected by TCP at levels found in UK pilots' blood. The US Federal Aviation Administration (FAA) has acknowledged that "no present airplane design fulfils the intent of [federal aviation regulation] 25.831 because no airplane design incorporates an air contaminant monitoring system to ensure that the air provided to the occupants is free of hazardous contaminants" (FAA, 2002), **We point out that there is a sizable (and growing) body of literature on the association between exposure to oil fumes and acute and chronic symptoms reported globally by crews and passengers alike (ACARM, 2007). We believe there is ample justification for regulations that dictate bleed air cleaning and monitoring with flight deck indication to: (1) prevent exposure to oil fumes; (2) alert crew members if they are exposed in flight; and (3) enable maintenance workers to more effectively identify and remedy the contamination upon landing.**	

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28	A. Explanatory Note - IV. Content of the A-NPA - 8. Background and description of the issue	5	"What is the frequency of this kind of event?" Comment: As remarked earlier and in this EASA document (see IV. 9.), the frequency of events reported varies from country to country. Due to lack of information on the subject of contaminated air and risks, many incidents are simply not reported unless extremely serious or causing events that lead to full investigations. **Events are underreported. We ask that EASA initiate a mandatory reporting system for fume events.** **As Crews are not trained to recognize or respond to fume events, we ask EASA to legislate on the training of both pilots and cabin crew to recognize and respond to fume events.** Dr Rayman says fume events are very rare & cannot cause a problem.... but in 1983 & 2002 he said this: '***Smoke & fumes in the cockpit is not a rare event and a clear threat to flight safety due to acute toxic effects.***' *Rayman R.B., McNaughton G.B. (1983) Smoke/fumes in the cockpit. Aviation, Space and Environmental Medicine 1983; 67: 738-740.* AND exposure to VOCs used in aircraft operations can cause skin rashes, pulmonary and CNS symptoms ranging from mild to severe *RAYMAN Russell Cabin air quality: An overview . Aviation, space, and environmental medicine 2002, vol. 73, n°3, pp. 211-215*	
29	A. Explanatory Note - IV. Content of the A-NPA - 9. Events caused by engine/APU air contamination	5 - 6	"In the European Community, the majority of the reports are originated from the United Kingdom (UK), the other Member States reporting far less on this issue (refer to UK AAIB report 1/2004 published in February 2004). According to a presentation from the UK Civil Aviation Authority (CAA UK) to the Agency in March 2007, there were 104 flight deck occurrences on Large Aeroplanes between 1999 and 2006; a peak of events (26) appears in 2001, then followed by a significant decrease in 2002 and 2003. This decrease in the number of events can be explained by the measures taken in 2001-2002 towards the two aeroplane types generating the majority of the events (BAE146 and B757); these measures consisted in inspections and corrective actions	

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			to limit the risk of oil leakage from APU and engines. Then, after a very calm period, another peak of events appeared in 2006 (26 events). No official CAA UK events figures are available to EASA for 2007 and 2008, but according to them the tendency is a decrease in the number of reports." Comment: Despite claims that there is insufficient reporting **(please refer to ACARM (2007b) "Chapter 12: Frequency of Events and Underreporting" "*Aviation Contaminated Air Reference Manual,"* Michaelis, S., ed. ISBN 9780955567209, London, England, pp. 211-248)** and evidence to support casual relationship between exposure to oil contaminated air and pilot ill health the **UK COT report** concluded that it would be PRUDENT to PREVENT exposure to oil contaminated air. We fully support any study that the EASA undertakes to collect data regarding the number of events/incidents linked to oil contaminated air and request that preventative measures be taken and included in new standards. **The FAA says it has recorded 900 fume events in 10 years.** But in 2006 they said this: ***'There have been concerns raised about numerous reports of "smoke/fumes in the cockpit/cabin" events on commercial air carrier/operator aircraft. During the FAA's analysis of this data, it appears as though there are numerous air carriers/operators who may not have reported these events as required by regulation.*** **Flight Standards Information Bulletin for Airworthiness (FSAW)06-05A, Guidance for Smoke/Fumes in the Cockpit/Cabin_29 March 2006.29 March 2006 (see attachment: Smoke-Cockpit-Ballough.ppt)** Concerning the detection & reporting of oil leakage and vapours inside the aircraft cabin Professor Windsor states that "***The only technically functional way to identify the presence of poorly volatile contaminants present in aircraft environments is to place a direct reading machine on the aircraft during flight."*** The US FAA has acknowledged that "no present airplane design fulfils the intent of [federal aviation regulation] 25.831 because no airplane design incorporates an air contaminant monitoring system to ensure that the air provided to the occupants is free of hazardous contaminants"	

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30	A. Explanatory Note - IV. Content of the A-NPA - 9. Events caused by engine/APU air contamination	5 - 6	"The measures taken towards BAE146 and B757 types are summarised hereafter: In the case of the European type BAE 146, two Inspection Service Bulletins (ISB) have been mandated through Airworthiness Directives (ADs) by the UK CAA in March 2001 and November 2002. The first ISB requires the inspection for contaminants in the Environmental Control Systems (ECS), and should any be found, requires inspection of the engines and APU for any signs of oil leakage; inspection accomplishment is required every A-check or when a cabin air quality problem is reported. The second ISB, supplementing the first one, requires inspection of sound attenuating ducts within the ECS for signs of oil contamination; it also provides appropriate trouble shooting and rectification procedures, including replacement of contaminated ducts. In addition, in December 2002, CAA UK mandated the replacement of the inlet air connection to the APU by an improved design to prevent the induction of potentially contaminated air. Concerning the B757, the engine manufacturer Rolls Royce identified overhaul improvements for the engine and Boeing updated the engine oil servicing procedure in the B757 Aircraft Maintenance Manual to avoid oil tank over-servicing." Comment: It seems that there is still a UK preoccupation with continued “leaking” of oil into the cabin as there is a new device that sterilizes aircraft cabin air to eradicate contaminants and pathogens such as swine flu which has been developed by BAE Systems and UK firm Quest International. BAE Systems plans to fit 2,600 aircraft with the devices – that is about 10% of the global total of commercial aircraft. Larger commercial jets require more than one. Five airlines are trialing the device, and one has recently placed an order for it’s BAE Avro RJ fleet of regional jets. The device is also installed on BAE System’s own corporate jets. It has been certified for use on the BAE 146 and Avro	

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			RJ aircraft and has a supplemental certificate for Boeing 757s. **There still seems to be some concern over the effectiveness of this device to eliminate all toxic substances from heated oils and contaminants**.	
31	A. Explanatory Note - IV. Content of the A-NPA - 9. Events caused by engine/APU air contamination	5 - 6	"According to available reports, there is a variety of symptoms, and there is not a single symptom or type of symptoms which can be characteristic of cabin air quality event. This ranges from benign symptoms like unpleasant odour, light eye or nose irritation, light headache up to more serious symptoms like severe headache, difficulty to concentrate, nausea or muscle cramp. The most serious symptoms can substantially degrade flight crew awareness and performance of their duties. Then, the main associated safety threat would be a dual and simultaneous pilot incapacitation occurring during a critical phase of flight such as take-off or landing, which would be potentially catastrophic. However, a majority of events involves low severity symptoms (irritation, feeling unwell), and the cases where incapacitation was reached are very rare (e.g. 2 reports of single incapacitation in UK as of 2006)." Comment: We believe that there are more than 2 reports of single incapacitation in the UK – this can be checked by contacting the UK CAA.	
32	A. Explanatory Note - IV. Content of the A-NPA - 10. Research outcomes	6 - 7	Aviation lubricants main constituents and pyrolysis products are: • chemical esters (2 main families: trimethylolpropane (TMP) esters and pentaerythritol (PE) esters), • additives: organophosphates, N-phenyl-1-naphtylamine, • low molecular weight organic acids, esters and ketones Here are the possible toxicity effects, if the contaminant is present at sufficient concentration in the air: • Organic acids: known to be irritants (e.g. eyes, nose, throat) and also have characteristic odours (often described as “old socks” or “body odours”),	

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			• Organophosphates: tricresylphosphates (TCP) and in particular its ortho isomer can induce irritations (e.g. eyes, nose, throat) and in the long term "Organophosphate Induced Delayed Neuropathy" (OPIDN); the toxicity of meta and para isomers is not clearly established, • Gases: toxic gases can be produced from oil pyrolysis, such as carbon monoxide and oxides of nitrogen Comment: We refer to statements published by Dr. Mackerer in 1999 and to the Henschler report in 1958 "Engine oils contain a mixture of tricresylphosphates, of which TOCP in not the most toxic". TOCP is NOT the only ortho isomer in TCP - the more toxic MOCP& DOCP are in the oil in far higher quantities. **Mobil** advised the Australian Senate Inquiry that the ortho isomers were in the TCP in it's oil at >0.3%. The more toxic MOCP & DOCP were not mentioned. **ORTHO** isomers divide into: **TOCP**, **DOCP** and **MOCP**. Focus has been on TOCP with UK House of Lords and CAA reports of 2000 and 2004. These reports fail to ever mention DOCP or MOCP. **TOCP 0.006 ppm Toxicity factor x 1** **DOCP 6 ppm Toxicity factor x 5** **MOCP 3070 ppm Toxicity factor x 10** In ignoring DOCP and MOCP the total ORTHO toxicity is underestimated by a factor of **6.14 million** which has been known since 1958 (Henschler). It has been known for years that when aviation engine oils are heated, a potent neurotoxic chemical called TMPP (trimethylolpropane phosphate) can be formed. TMPP is even worse than TCPs and exposure is associated with epileptic type seizures, convulsion, tremors, and changes to social/emotional behaviors. To our knowledge, it has never	

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			been found on aircraft. But to our knowledge, nobody has ever looked for it. A 1989 US Navy report stating that Exxon 2380 (now BP2380) generated high levels of TMPP when it was heated to temperatures at or above 350C. The TCPs in the oil react with TMP chemicals in the "base stock" of the oil. **The levels of TMPP were so significant that the authors recommended that Exxon 2380 not be used on US naval vessels. But BP2380 is still widely used in commercial aviation**. A 1996 US Air Force paper raised concerns about the potential for being exposed to highly toxic TMPP, and stated that TMPP could be formed when oils that contain TCPs and TMP are heated to temperatures as low as 250C. This is important because these temperatures are more likely to be reached in the engine/bleed air system. Wright also stated that TMPP can NOT be formed if the engine oil base stock contains PE chemicals instead of TMP. *WRIGHT R. L. Formation of the neurotoxin TMPP from TMPE-phosphate formulations - Tribiology transactions 1996, vol. 39, no4, pp. 827-834* Another US navy report in 1992 also expressed concern about the hazards 1) What engine oil(s) are used (e.g., Mobil Jet Oil II, BP2380, etc). 2) What APU and engine types are installed on what aircraft types (e.g. Pratt Whitney 4000, Honeywell Series 85, etc). Oils and lubricants used on the aircraft and in the engines contain not only the neurotoxins (TCPs and triphenylphosphates) but **sensitizers (N-phenyl-L-naphthylamine, PAN),** and **asphyxiants (carbon monoxide**).. Pyrolysis studies have confirmed the presence of these toxins when commercial oils are heated (van Netten, 2000; Marshman, 2001; Fox, 2001). A Material SafetyData Sheet for engine oils acknowledge only the TCP content and the fact that “toxicfumes may be evolved on burning or exposure to heat” (BP, 2001).	

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			We ask that studies include the potential impact of exposure to the <u>mixture</u> of these and other chemicals in a <u>reduced pressure environment</u>. We suggests that the EASA review all data and see if a less toxic alternative oil can be recommended that would be compatible with given aircraft engines/APUs. Ultimately, all of the engine oils should be analyzed for their base stock content (rather than relying on the word of the oil companies), as well as for the potential to form TMPP, and temperature range of TMPP formation.	
33	A. Explanatory Note - IV. Content of the A-NPA - 10. Research outcomes	6 - 7	In this frame, the Agency is currently monitoring on-going research studies [Cranfield University for the Department for Transport in UK, ASHRAE (American society of Heating, Refrigerating and Air Conditioning Engineers), ACER CoE (Airliner Cabin Environment Research Center of Excellence), OHRCA (Occupational Health Research Consortium in Aviation) in the USA] which are expected to help identifying, by measurements in flight, the actually released contaminants and their quantity during a “fume event” (point B. above). Comment: Prof. C Winder (http://www.safesci.unsw.edu.au/contacts/cwinder.html), professor in applied toxicology at the University of New South Wales, Australia, says collecting air samples for later analysis (as is currently the used method) is not scientifically effective for "non-volatile mists". **He says the only effective method is active, real-time analysis of the suspended chemicals and their concentration using a "direct reading machine on the aircraft during flight".** Concerning the ASHRAE ,The RAAF expert Dr. Singh points out that judging aviation air contamination using toxicity standards (ASHRAE) that apply in normal workplaces is invalid: "Aircrew members perform complex tasks requiring high-level cognitive skills, which may be much more sensitive to insult by hazardous contaminants in the	

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			smoke/fumes, such as tri-cresyl phosphate."	
34	A. Explanatory Note - IV. Content of the A-NPA - 11. EASA Large Aeroplanes Certification Specifications	7 - 8	CS-25 provisions related to cabin air contaminants can be found in CS 25.831 and 25.832: • 25.831(a) provides for the ventilation of passenger and crew compartments, as well as for a minimum flow of fresh air (0.28 m3/min) in the crew compartment “to enable crewmembers to perform their duties without undue discomfort or fatigue”. The related AMC also provides for a minimum flow per person (0.18 kg/min) for any period exceeding 5 minutes in case of loss of one source of fresh air. • 25.831(b) provides for crew and passenger compartment air to be free from “harmful” or “hazardous” concentrations of gases and vapours. Some limits are provided for carbon monoxide and carbon dioxide. • 25.831(d) provides for smoke evacuation to be “readily accomplished”, if accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable. • 25.832 provides for ozone concentration limits during flight. Concentration limits are thus provided for carbon monoxide, carbon dioxide and ozone. Other contaminants are not addressed. The terms “hazardous” and “harmful” are not defined. It can be noticed that the situation is the same in FAA Part 25. Comment: **We point out that CS and AMC material are not *binding* rules but advisory material on the subject of clean air - there are no regulatory certification requirements directly relating to engine and APU lubricating oils, with respect to ensuring as far as possible that they are free of any constituents that, potentially, could affect the occupants of aircraft**	

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			should turbine engine oil leak into the bleed air system. We furthermore point out that **JAR 25.831** requires that the flight deck and the passenger compartment to be free from “harmful or hazardous concentrations of gases or vapours’, including after any reasonably probable failure of the air conditioning, ventilation, pressurisation and other systems. Additionally, **JAR APU-210** defines that an unacceptable level of contamination of the bleed air must be extremely remote. In respect of the engines, **JAR-E-690, JAR-E-510**and associated advisory material, also consider the subject of contamination of bleed air and specify that an unacceptable concentration of toxic products generated in the air supplied to the aircraft is regarded as being hazardous. **However, as the EASA points out, there is difficulty in interpreting the JAR dispositions as “harmful, hazardous” products have to be identified and maximum acceptable concentrations specified.**	
35	A. Explanatory Note - IV. Content of the A-NPA - 12. Objective of the A-NPA	8	"After the review of the above mentioned on-going research studies conclusions and the analysis of this A-NPA collected information, the Agency will evaluate if the situation actually reveals a safety concern and/or a threat for health of aeroplanes occupants. If deemed necessary, a rulemaking phase could be launched to create new airworthiness standards in order to limit as much as possible the occurrence of this kind of event." Comment: We hail the EASA review of studies and the collect of information as extremely positive. We support any demand on the part of the EASA for further information and data as a great step forward to create new airworthiness standards in Europe. Safety recommendations and standards exist but are not in any way binding and we feel that this issue can no longer be ignored. Bleed air comes straight off the engines/APU into the cabin/flight deck. Engines/APU sometimes leak oil.	

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			Maintenance workers sometimes spill oil. **We ask EASA to issue a directive requiring bleed air cleaning to prevent fume events.** Even though it is generally accepted that engines/APU sometimes leak oil, the air supply system is not monitored. Pilots must rely on their sense of smell and whether a smoke/fume is present to determine if the air supply system is contaminated, and if it is, with what is it contaminated and whereabouts in the air supply system. This wastes precious time inflight. **We maintain that Pilots need contaminant monitoring in the air supply system with flight deck indication (per ASHRAE aircraft air quality standard 161-2007) to enable them to troubleshoot systems quickly and accurately. Also, contaminant monitoring would assist maintenance workers after landing. Monitoring systems should reduce the costs associated with diversions and delays** **The ASHRAE Aircraft Air Quality Standard 161-2007 (Contaminant monitoring (Section 7.2):** requires that sensors be installed in the air supply system to monitor for chemicals indicative of oil or hydraulic fluid contamination. It states that "The sensors will provide immediate indication of a contaminant to the flight deck. If contaminant levels exceed an agreed upon level, then the sampling data must be entered into the aircraft technical log and made available to crewmembers who experience symptoms consistent with exposure to such fumes within 60 days after the flight. This will provide proof of exposure to affected flight attendants in order to assist their physicians in diagnosis and treatment. We also hope this proof of exposure will help to motivate airlines to prevent contamination events from occurring." **Lastly, we feel that the proposed aircraft quality standard Pr EN 4666 and Pr EN 4618 require major review and modification to include standards and legislation on contaminated cabin air :** The standard defines chemical limits based on	

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			“occupational exposure limits and regulatory limits from cognisant authorities” **We feel that the “cognisant authorities” are not relevant authorities. Rather, the limits are industrial exposure limits intended to protect the majority of healthy workers assigned to an 8-hour work day, not the general public or crews assigned to a 14 hour work day, all in an enclosed space at altitude, being supplied with air compressed in the engines that sometimes leak oil.** Both aircraft standards state that formaldehyde exposure shall not exceed 2 parts per million (ppm). **However, the US National Institute for Occupational Safety & Health sets a limit of 0.1 ppm and the German regulatory body (DFG/MAK) sets a 0.3 ppm limit. So, the proposed aircraft standard is 3-20 times higher than industrial limits.** **The proposed 4666 standard** endorses 2,438 metres (8,000 feet) as a maximum cabin altitude. *This design standard was first issued in 1957 and was applicable to the oxygen needs of fit military pilots*. Many studies since then have recommended 1,523-1,829 m (5,000-6,000 feet) based on the oxygen needs of the flying public. **The 4618 standard (as well as 4666) ignores the potential for exposure to a highly toxic family of chemicals called tricresyl phosphates (“TCPs”). They are used as anti-wear agents in engine oils which sometimes leak into the air supply. TCPs have been found in the cabin/flight deck air/surfaces/aircrew blood** Exposure to oil fumes that contain TCPs and a mixture of other chemicals can cause serious neurological and other impairment. There are many documented cases. **Neither standard addresses the oil fumes hazard, despite it being recognized in aviation since the 1950's.**	

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			As part of this, the standards ignore the health and safety hazards posed by exposure to supply air contaminated with pyrolyzed engine oils and hydraulic fluids. **On page 3 of the proposed 4666, it says: “This standard was developed for the needs of the European Aerospace Industry.” It does not seem to have been developed for the safety, health, or comfort needs of either the flying public or the crewmembers that must work in the aircraft environment.**	