AIRCRAFT CABIN AIR
International Conference 2024

IMPERIAL COLLEGE LONDON
SOUTH KENSINGTON

INTERNATIONAL AEROSPACE CONFERENCE

AIRCRAFT CABIN AIR CONFERENCE

Flight Safety and Cabin Air Quality

2 Day Conference

17-18 SEPTEMBER 2024

aircraftcabinair.com

SPONSORS **OVERVIEW**

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Headquartered in Fort Worth, Texas, near Dallas/Fort Worth International Airport, the Allied Pilots Association (APA) serves as the certified collective bargaining agent for the 16,000 professional pilots who fly for American Airlines. APA was founded in 1963 and is the largest independent pilots' union in the world. APA provides a broad range of representation services for its members and devotes more than 20 percent of its dues income to support aviation safety.
alliedpilots.org

ANCC GROUP

The ANCC Group was setup by a group of aviation professionals who saw a need for more combined and collaborative training across aviation roles. The team have combined experience across flight operations and ATCO roles, as well as in training, aviation psychological safety, leadership coaching & development and management consulting.
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AUSTRALIAN FEDERATION OF AIR PILOTS (AFAP)

AFAP is a professional association and industrial organisation for commercial pilots in Australia. As a professional association, it provides pilots the opportunity to meet and discuss aviation-related matters. Its Technical Committee is involved in the development of Australian and international aviation safety standards. As an industrial organisation, its role is to improve employment conditions for its members, including collective bargaining, negotiating labour contracts, representing members involved in a dispute with their employer or assistance in the event of an accident or incident.
afap.org.au

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Since 1980, BASF has been the leading supplier of ozone and volatile organic compound (VOC) removal systems for Airbus, Boeing, Gulfstream, Dassault, and many other aircraft. BASF offers technologies to improve the quality of the air provided to cabin environment and improve passenger, pilot, and flight attendant comfort.
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GLOBAL CABIN AIR QUALITY EXECUTIVE (GCAQE)

A global coalition of health and safety advocates committed to raising awareness and finding solutions to poor air quality in aircraft. Established in 2006, the GCAQE is the leading organization representing air crew (pilots, cabin crew and engineers) and passengers, that deals specifically with contaminated air issues and cabin air quality. The GCAQE represents over 30 organisations, and over one hundred thousand workers around the world.

gcaqe.org

MICHAELIS AVIATION CONSULTING

Dr. Susan Michaelis (PhD) is uniquely qualified to provide concise and high quality support regarding the various aspects of exposure to aircraft contaminated air. These involve the following areas: Overview of contaminated air issue and global actions: occurrence and understanding of oil leakage and other fluids into the aircraft air supply: accident and incident investigation: applicable aviation/OHS regulations: hazardous substances and adverse effects associated with bleed air contamination: risk and hazard assessment: Aerotoxic Syndrome: fume events training and reporting requirements: available solutions: support for airlines and manufacturers: medical and legal experts: academics and scientists: unions: governments and regulators.

susanmichaelis.com

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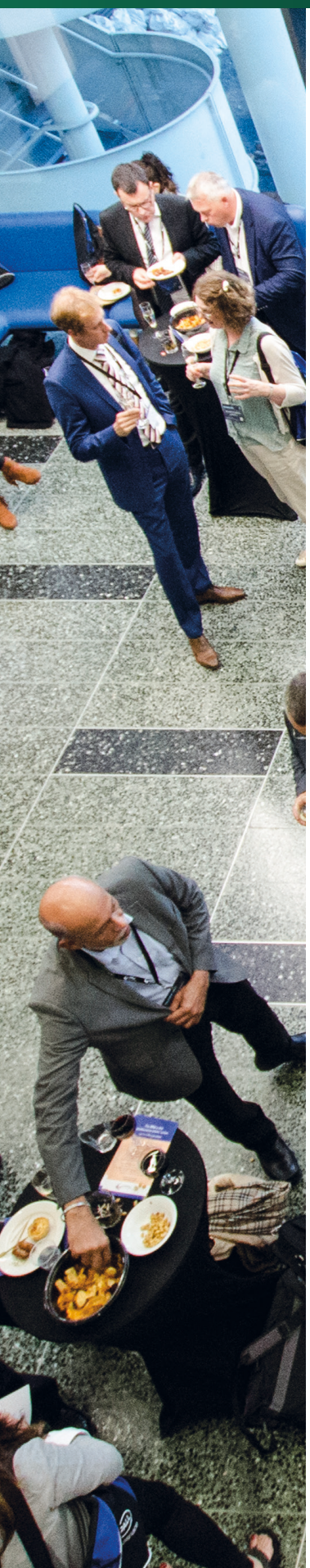
AIRCRAFT CABIN AIR **CONFERENCE 2024**



Dear Delegate

On behalf of all our sponsors and partners, welcome to the Aircraft Cabin Air Conference 2024. We are delighted to be back at Imperial College where the 2017 and 2019 conferences were held. I am certain that over the next two days, our diverse range of speakers will provide you with a unique and greater insight into the aircraft cabin environment, the issue of contaminated 'bleed air' on aircraft and in other environments and the emerging solutions available to operators.

I organised the 2017 to 2023 conferences and the 2005 conference for the British pilot union BALPA before that. Nineteen years on from the first conference, the landscape has changed. Humidification technologies and lower cabin altitudes have enhanced the flying experience. On the contaminated air issue, some of the divisions in opinion may still exist but the science and understanding of the cabin environment has vastly improved. Today, we are much closer to effective resolutions and acceptance of the need to resolve the problem of contaminated air on aircraft.

I became involved in this issue in 2001 when I was a Captain with British Airways whilst flying the Boeing 757 and Boeing 767. At the time, I was a Health & Safety representative for the UK pilot union BALPA and part of my duties involved dealing with long-term sick pilots. A fellow Captain Dave Hopkinson phoned me and informed me that he had experienced a number of exposures to contaminated air in the aircraft he flew and was being ill health retired by the company. He believed that the exposures to oil fumes we were experiencing were a serious health and flight safety issue. He mentioned the word 'organophosphate', a word I had never heard of and asked me to investigate the issue. Something I have been doing since. Dave passed away in December 2019 and sadly never saw the solutions he hoped for.

Over my twenty-three year journey, I have de-briefed more than a thousand crews and passengers over 6 continents who have experienced contaminated air exposures. I have heard their concerns about flight safety being compromised; a reluctance to report events; pilots not using emergency oxygen when the air was suspected of being contaminated, crews becoming impaired and incapacitated; their desire to have a definitive medical test to confirm exposure to one or more of the contaminated air ingredients and their collective desire that this issue be resolved for the benefit of all in aviation.

I have seen the misinformation put out by those who fear the consequences of contaminated air; I have witnessed the vested interests at work - the denial and the fear of litigation. I have sat on aerospace and Government committees; briefed regulators and safety agencies, met and discussed the issue with lubricant manufacturers, politicians, airline management, aircraft and engine manufacturers, press, doctors, scientists, the military, union leaders and countless others. I have also made five documentaries and a feature film on the issue.

I have heard all sides of the debate. I have met many people who lack the expertise and knowledge of the issue, yet are empowered to make key corporate or operational decisions in these matters. I have heard it said that contaminated air events are some form of global mass hysteria; it's all linked to the contraceptive pill, hyperventilation, a tree fungus or a food substance consumed. On the other side, I have heard an employee for an aviation regulator say it's like asbestosis and the issue will never be resolved.

Having experienced the flight safety consequences of exposure, suffered the health effects first hand and having lost my own career to repeated exposure to contaminated air at the age of 44; I know it is a very real issue and one that has to be addressed.

It took me 13 years to get my medical certificate back and I flew again, but I was lucky. Some crews and passengers have lost their health and their livelihoods from exposures and many are no longer with us.

I love aviation and I love what it has achieved. However the simple reality is that aviation has a design flaw:- in providing breathing air on aircraft as unfiltered bleed air from engines. The original passenger jet aircraft like the Boeing 707, DC-8, Convair 880/990 and VC-10 designed their aircraft not to use bleed air directly for pressurisation and air-conditioning; like many things in life – the first ideas are often the best.

The Boeing 787, with its revolutionary bleed free architecture, is without doubt the only sensible solution for future aircraft design. The crews who work on the 787 tell me it is a whole new world compared to other aircraft. I believe all current 'bleed air' aircraft should have an effective filtration system and warning systems installed to minimise as much as possible, the health and flight safety consequences of exposure. I believe less hazardous oils need to be brought to the market by engine manufacturers as a matter of priority.

In my opinion, it's not morally or ethically right to continue to debate the health and flight effects of exposure to contaminated air, whilst still allowing crews, fare-paying passengers (some pregnant) and others to be exposed to contaminated air. In my career, I have seen aviation effectively enhance flight safety with many new technologies: ADS-B, TCAS, EGPWS, CRM, the 'glass cockpit' and the advent of fly-by-wire to name a few. Aviation has the ability to resolve this problem. All it needs is the will to do so.

Most passengers I have met would pay for clean air if given a choice. Every airline shareholder I met feels that airlines should fix the problem, however the problem still exists. All it needs is airline leadership. Stop the denial, fix the problem and make air travel as safe as is reasonably possible: Minimise the risk – adapt the Precautionary Principle.

Over a dozen air accident departments globally have made over 50 recommendations and findings on the contaminated air issue. The British Air Accidents Investigation Branch (AAIB) have twice recommended to EASA and the FAA that all aircraft should have contaminated air warning systems but over 15 years later, nothing is installed on an aircraft. Is the reason why sensors are not on jet aircraft because some in the industry are terrified of the litigation or is it because the industry is not capable of designing an effective sensor? When President Kennedy outlined his plans for man to walk on the moon in 1961, the US had not yet put a man into orbit around the earth, yet within 9 years in happened. Man walked on the moon. The aerospace industry can do anything if it wants to. It just requires a will to do it.

United Airlines took a world lead many decades ago by being the first airline in the world to introduce HEPA filters in all their aircraft for the re-circulated air. DHL introduced a Pall Aerospace Cockpit Filter Unit (CFU) nearly 10 years ago. To filter the air their pilots breathe on their Rolls-Royce powered Boeing 757 aircraft and Pall Aerospace which achieved a very close solution with their MaVE filtration system. Today, the world waits for the introduction of an effective bleed air filtration system for aircraft and less hazardous engine oils and hydraulic fluids. It is just a matter of time.

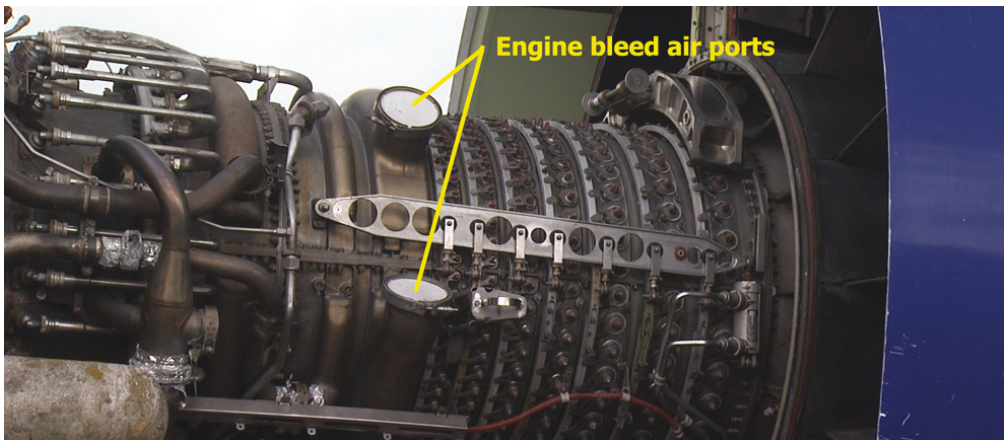
Therefore, I am glad the Aircraft Cabin Air Conference 2024 will provide an arena for delegates to better understand the challenges of the cabin environment and conduct productive discussions towards a positive solution to this issue.

Captain Tristan Loraine BCAi
Conference Director / GCAQE Spokesperson
September 2024

‘BLEED AIR’ **SIMPLIFIED**

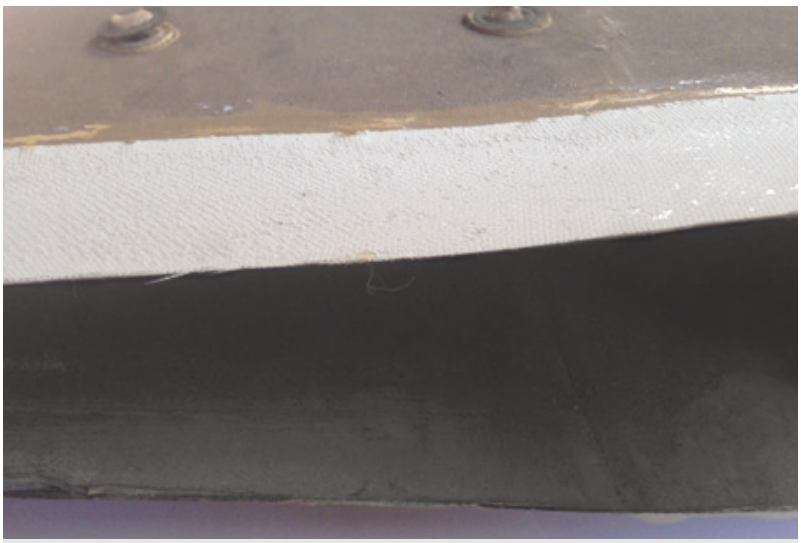
The air you breathe in-flight, onboard all currently flying commercial passenger jet aircraft (apart from the Boeing 787), originates from the compression section of the engine in a process known as ‘bleed air’ as it is bled off the engine. This air is supplied to the cabin totally unfiltered. Only the recirculated air is filtered, primarily for bacteria and viruses. Carbon media added to air filters can help reduce odors in the cabin by adsorbing volatile organic compounds (VOCs) and other odour causing substances.

Low stage air is used during high power setting operation, and high stage air (see picture right) is used during descent and other low power setting operations. Because the low stage air is a significantly lower temperature than the high stage air, the pyrolised engine oil decomposition products will differ and may provide a different smell in the cabin and cockpit due to a different chemical mixture.



The images below show the air supply ducting on a Vickers VC-10 aircraft which first flew in 1962 (the last non-bleed air aircraft before the Boeing 787 flew) removed from an aircraft at the end of its service life. Compare this to the bleed air-ducting pipe from a Boeing 737 engine, which is black from engine oil and engine oil decomposition products.

Bleed air off take port from a Boeing 737.
Interior is black from oil contamination.



Air supply ducting on a VC-10.
Interior is dirty and dusty but has no oil.

Consequently, aircraft should be designed with a ‘bleed free’ architecture, like the Boeing 787 or the ‘bleed air’ should be effectively filtered with accurate contaminated air sensors installed.
GCAQE

CONTAMINATED CABIN AIR
KEY TIMELINE 1930-2024

1930	Ortho isomers of TCP responsible for toxicity - Ginger Jake
1939	Perhaps of greater importance than the acute effects of low grade carbon monoxide poisoning are the chronic effects from repeated exposures – Harry G. Armstrong
1946	Large aerodynamic air compressor from which compressed air may be bled in quantities suitable for cabin ventilation and refrigeration - fortuitous circumstances – H. J. Wood
1946	Synthetic lubricants developed
1953	Pyrolised oil contains irritant and toxic substances. Impairment causing pilot error and hazardous situation - Aero Medical Association
1953	Toxic effect of oil contamination unknown - Boeing
1954	Inhalation toxicity of jet oils related to pyrolysis of base stock at high temps - USAF
1955	Cabin air contamination problems in crew - USAF
1955	The separate compressor as a solution – This method of eliminating contamination is considered to be the most positive - North American Aviation
1955	First civil airliner flies using direct bleed air for pressurisation and air conditioning - Sud Aviation Caravelle
1959	Other ortho isomers of TCP: MOCP and DOCP 10 and 5 x more toxic than TOCP - Henschler
1960s	TCP in lubricants replaced with other phosphate esters in all markets except aviation / military
1961	Active metabolite causing TOCP toxicity identified - Casida
1962	Oils shall have no adverse effect on human health / carcinogens prohibited - MIL Specs
1965	Other Triaryl phosphate (TAP) isomers very likely to contribute to toxicity - US Navy
1966	The high temperatures encountered within the engine compressor caused the oil vapor to decompose into extremely noxious and irritating substances - US aircraft manufacturer
1969	Oil consumption mainly linked to oil leakage past seals/loss via breather - Rolls-Royce
1970	Cockpit warning systems required - FAR 1309c - Not met as of 2024
1973	Internal engine oil leakage shall not contaminate the bleed air - MIL-E-5007D
1977	Aircrew incapacitation due inhalation exposure to aerosolized or vaporized synthetic lubricating oil - Montgomery
1981	Oils being stressed to limits due increased engine temps - Royal Dutch Shell
1981	At temps >320°C oil breaks down into toxic and carcinogenic compounds - SAE
1983	Mobil Jet Oil II assumed to be causing dirty socks odour - Cone
1985	Cabin air contamination has been experienced on acceleration from low power conditions during the Boeing 757 flight certification programme of RB211-535E4-37 engines - Rolls-Royce
1988	TOCP level in TCP is not a reliable indicator of potential TCP neurotoxicity - Mobil
1989	Recommendation to ban Exxon 2380 from US Navy and test all base stocks - US Navy
1990	Not possible to establish safe level of exposure to TOCP. TCP mixed isomers including TOCP considered major hazard to human health - WHO
1995	Air oils seals must be improved now! - Aerospace consortium – NASA / Allied Signal - ongoing (1950s - present)
1997	Reluctance of crews to report events to employer - fear of reprisals - ATSB
1998	Short term symptoms associated with odours on the BAe 146 and other types are substantiated - Ansett
1999	Oil fumes in cabin air represent a possible safety deficiency - ATSB

1999	TCP is toxic and Inhaling engine oil / TCP is hazardous - UK House of Commons
1999	Employee 'Suffered injury arising out of and in the course of her employment.' - Compensation Court - NSW
1999	TOCP exposure standards not adequately protective for products containing TCP / TOCP - Mobil
1999-2000	Australian Senate Inquiry
1999-2012	ASHRAE studies
2000	UK HOL Inquiry
2001	10 nanogrammes of TOCP found in pilot's blood after a reported contaminated air event
2001	Oil fumes seen as a nuisance / should be seen as flight safety hazard (SB/AD) - BAe Systems
2001	Recommendation that crew use oxygen at 100 %, International database established, Oil effects research – SHK
2001-2002	US NRC inquiry
2001-2004	UK CAA cabin air quality report
2002	Charge of reprehensible conduct appropriate if necessary precautions and measures not taken by airlines - Abeyratne (ICAO)
2002	Oil leaks and cabin / flight deck odours must be regarded as a potential threat to flight safety - CAA
2002	No aircraft airworthy as no contaminated air detection systems fitted - FAA
2003	Airline cannot guarantee a safe working environment free of oil fumes - NJS
2003	Leaking oil is hazardous - Rolls Royce
2003	Survey of British Airways Boeing 757 pilots shows 96% of all contaminated air events not reported - Michaelis
2004	ExxonMobil oil MSDS citation issued by OSHA / cancelled 2005 - OSHA
2004	Airworthiness Directives - Oil contamination - Unsafe condition / design problem - FAA
2004-2012	ASD-STAN - air quality standards - withdrawn (2013)
2005	International conference in London - acknowledges workplace problem - BALPA
2005-2007	UK COT inquiry
2006	TOCP found in pilot's blood after a reported contaminated air event / ill health retired 6 months later.
2006	Under-reporting is occurring - FAA
2007	Oil fumes reported in 1% of UK flights - COT
2006	Global Cabin Air Quality Executive (GCAQE) established
2007	Cabin air quality standard - ASHRAE SPC-161
2007	Senator O'Brian reveals in Australian Senate 'cash for silence' - BAe Systems, Allied Signal, Garrett
2007	Safety Recommendations - Recommended FAA / EASA consider system to enable flight crew to identify rapidly the source of smoke by providing a flight deck warning of smoke or oil mist in the air - AAIB
2007	'Welcome Aboard Toxic Airlines' documentary film released - Fact Not Fiction Films
2007	Public Enquiry into oil fumes called for in the UK - Conservative Party, Liberal Democrats and Green Party
2007	By-products of hot synthetic turbine oil unknown - Boeing
2007	All oil chemical ingredients must abide by regulations - SAE / FAA
2007-2014	Bleed air monitoring required - APH, NRC, US Senate and Congress, CASA EPAAQ, Bundestag, ASHRAE, AAIB, BFU
2007-2014	Bleed air filtration / cleaning required - APH, SAE, US Senate and Congress, CASA EPAAQ, Bundestag, ASHRAE, BFU

CONTAMINATED CABIN AIR
KEY TIMELINE 1930-2024 CONTINUED

2008	FAA funded medical protocol for fume exposures - OHRCA
2008-2012	Australian CASA EPAAQ
2009	Is Inhaling oil fumes safe? No - Bundestag
2009	Toxicity of oils raised with EASA and upgraded MSDS risk phrases - NYCO
2009	Investigate possibility of installing smoke warning system in bleed air ducting of B757 – IPFS Iceland
2010	1st successful civil litigation - J Turner, Australia: Oil harmful to lungs
2010	Documentaries 'Angel Without Wings' and 'Broken Wings – The BAe 146 Story' released - Fact Not Fiction Films
2010	Boeing 757 DHL aircraft - introduce PALL cockpit bleed air filters
2011	Identification of increased TCP / TAP toxicity: Durad 125, TpCP - Furlong
2011	Fumes mostly related to oil / under-reported - EASA
2011	The Agency agrees it is possible that they are underreported (fume events) - EASA CRD 2009-10 Cabin Air Quality onboard Large Aeroplanes
2011	First ever awarded PhD on contaminated air - Dr. Susan Michaelis
2011	German Parliamentary hearings
2011	Pressurized aircraft cabin air comes from air bled off from the gas turbine engines of the aircraft. However, the engine bleed air can sometimes become slightly contaminated with oil or other fluids, which may result inan objectionable oil or smoke smell in the cabin of the aircraft – P&W patent
2011	Boeing settles legal case (Williams / USA)
2011	Blood test for TOCP exposure developed - Lockridge
2011	Boeing 787 with bleed free architecture enters commercial airline service
2012	Cabin air position statement - ECA
2012	Toxic cabin air 6th biggest engine problem - RR
2012	Air accident report - TOCP in pilots blood after incapacitation - BFU
2012-2013	All future aircraft to be bleed free - CASA EPAAQ, Bundestag, ASHRAE
2012-2024	US Senate / Congress CAQ bills
2013	OSHA and ACGIH have not set exposure limits for decomposition product of synthetic jet engine oils - ExxonMobil
2013	Decomposition reactions of engine oils and toxicity largely unknown - FAA
2015	Cabin fume event guidance published - Cir 344 - ICAO
2014	Certification does not cover all contaminated air substances or crew impairment (only Incapacitation) - BFU
2014	Pall Aerospace A320 A-CAF filter launched
2015	Feature film 'A Dark Reflection' exploring contaminated air is released - Fact Not Fiction Films
2015	Documentary 'Unfiltered Breathed in: The Truth About Aerotoxic Syndrome' released - TVBMedia
2016	Do not breathe mist or vapor from heated material / avoid eye and skin contact - Eastman Turbo Oil 2197
2016	TCP inhalation toxicity for engine oils to be undertaken by 2018 - ECHA
2016	Engineering design and operational problem - explains frequency (unairworthy system) - Michaelis

2016 ICAO monitor international actions to determine impact on health and take safety actions - Spanish CIAIAC

2016 Pall Aerospace launch MaVE project

2017 Permanent low-level oil leakage in aircraft / >120 contaminants released from heated oils - EASA

2017 Aerotoxic Syndrome - new occupational disease? - Panorama WHO Journal

2017 1st Aircraft Cabin Air Conference, London

2017 GCAQE introduces Global Cabin Air Reporting System – GCARS starts evaluation

2017-2018 Increased Ultra Fine Particle levels measured on aircraft show correlation with engine & APU operation

2018 FAA issues a Safety Alert for Operators (SAFO 18003) calling for enhanced procedures for contaminated air events

2019 UK union Unite the Union calls for a Public Inquiry into contaminated air

2019 2nd Aircraft Cabin Air Conference, London

2020 Captain Andrew Myers wins Workers' Compensation Case - State of Oregon

2021 US Patent Application published for an oil that does not include tricresyl phosphate and includes as an anti-wear additive at least one diphosphorus compound for the prophylaxis of aerotoxic syndrome, especially in case of fume event

2021 During normal operations, engines have a defined, permissible low-level oil consumption, some of which is consumed through the deoiler, oil seals, and oil leaks - SAE

2021 Exposure to engine oil and hydraulic fluid fumes can induce considerable lung toxicity, clearly reflecting the potential health risks of contaminated aircraft cabin air - In vitro hazard characterization of simulated aircraft cabin bleed-air contamination in lung models using an air-liquid interface (ALI) exposure system – (Journal of Environment International)

2021 Ultrafine particle levels measured on board short-haul commercial passenger jet aircraft (Journal of Environmental Health)

2021 3rd Aircraft Cabin Air Conference, on-line due to COVID

2021 Documentary 'American 965' released - Fact Not Fiction Films

2022 Endocrine disrupting toxicity of aryl organophosphate esters and mode of action (Journal of Critical Reviews in Environmental Science and Technology)

2023 Consideration of aerotoxic syndrome in aircrew members with unusual or episodic symptoms of neuro/cognitive dysfunction is essential for further characterizing this occupational illness - Prolonged Disability following Re-Exposure after Complete Recovery from Aerotoxic Syndrome: A Case Report (International Journal of Environmental Research and Public Health)

2023 Engine oil- derived fume extracts persistently reduced neuronal activity - In vitro neurotoxicity screening of engine oil- and hydraulic fluid-derived aircraft cabin bleed-air contamination (Journal of Neurotoxicology)

2023 4th Aircraft Cabin Air Conference, on-line due to COVID

2023 Health consequences of exposure to aircraft contaminated air and fume events: a narrative review and medical protocol for the investigation of exposed aircrew and passengers (Journal of Environmental Health)

2024 The role of nanoparticles in bleed air in the etiology of Aerotoxic Syndrome: A review of cabin air-quality studies of 2003–2023 (Journal of Occupational and Environmental Hygiene)

2024 Organophosphate toxicity patterns - A new approach for assessing organophosphate neurotoxicity (Journal of Hazardous Materials)

2024 UK Civil Aviation Authority mandates carbon monoxide detectors in piston engine aircraft

1954-2024 > 100 Published papers to date on contaminated air

> 50 Air accident recommendations and findings

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AGENDA
DAY 1

Subject to change

07:45-08:50 REGISTRATION AND REFRESHMENTS

SESSION **ONE:**

08:50-08:59 CONFERENCE INTRODUCTION

Baroness Bennett of Manor
Castle Green peer - UK House of Lords

09:00-09:25 OPENING KEYNOTE SPEECH

Captain Tristan Loraine BCAi
Conference Director

09:26-09:36 OUR FIRST 18 YEARS

GCAQE Board

09:37-10:11 RECENT RESEARCH IN BLEED AIR CONTAMINATION DETECTION

Professor Byron Jones
Professor of Mechanical Engineering, Kansas State University

10:12-10:36 THE UNKNOWN HEALTH THREAT OFFSHORE: CHEMICAL EXPOSURE FROM AERODERIVATIVE TURBINES. THE OIL AND GAS INDUSTRY MUST LEARN FROM AVIATION!

Halvor Erikstein
Organizational Secretary
Certified Occupational Hygienist
SAFE - Norwegian Union of Energy Workers

10:37-10:59 Q&A

11:00-11:29 REFRESHMENTS AND NETWORKING

SESSION **TWO:**

11:30-12:00 DEALING WITH CABIN ODOUR EVENTS

Ricardo Pavia
TAP Engineer

12:01-12:39 ORGANOPHOSPHATE TOXICITY PATTERNS: A NEW APPROACH FOR ASSESSING ORGANOPHOSPHATE NEUROTOXICITY AND RELEVANCE FOR AVIATION LUBRICANTS

Grégoire Herve
Scientific & Technical Director NYCO

12:40-12:59 Q&A

13:00-13:59 LUNCH AND NETWORKING

SESSION **THREE:**

14:00-14:09 THE ITF PERSPECTIVE

Gabriel Mocho Rodríguez
Civil Aviation Secretary International transport workers' federation (ITF)

14:10-14:30 CONTAMINATED AIR LITIGATION

Judy Cullinane
Aviation Legal Consultant

14:31-14:56 WHY DO WE NEED A PROTOCOL FOR AEROTOXIC SYNDROME?

Dr Jonathan Burdon
Consultant Respiratory Physician

14:57-14:17 AVIATION MEDICINE - AEROTOXIC SYNDROME: FACT OR MYTH?

Dr. med. Denis Bron
Chef Flugmedizin, Head of AeMC Eidgenössisches Departement für Verteidigung, Bevölkerungsschutz und Sport VBS Luftwaffe Fliegerärztliches Institut FAI / AMC Schweiz

15:18-15:34 Q&A

15:35-15:59 REFRESHMENTS AND NETWORKING

SESSION **FOUR:**

16:00-16:20 INDOOR AIR QUALITY IN AIRCRAFT THE IMPACT OF INCREASED MOBILITY ON HEALTH EFFECTS AND THE INFLUENCE OF BLEED AIR

Assistant Professor Seunghon
Gachon University Gil Medical Center, Department of Occupational and Environmental Medicine Graduate School of Public Health, Occupational and Environmental Health, Gachon University, Republic of Korea

16:21-16:40 AN AIRBUS PILOT'S PERSPECTIVE

Thorsten Busch
Airbus A320

16:41-16:59 CLEARING THE AIR, SAFETY MANAGEMENT RESPONSIBILITIES RELATED TO CAQ

Captain Rudy Pont
Belgian Cockpit Association (BeCA)

17:00-19:00 **CONFERENCE NETWORKING EVENT WITH MUSIC**

AGENDA
DAY 2

07:45-08:45 REGISTRATION AND REFRESHMENTS

SESSION **FIVE:**

08:45-08:46 CONFERENCE INTRODUCTION

Captain Philippe Amman
AEROPERS

08:47-09:07 AIR QUALITY ON DASSAULT FALCON AIRCRAFT

Bernard Baldini
Dassault Aviation

09:08-09:33 BENEFITS OF A HUMIDIFICATION SYSTEM WITH ACTIVE CARBON FILTER

Ola Häggfeldt
Chief Commercial Officer (CCO)
CTT Systems AB, Sweden

09:34-09:59 LEAVE CATALYSIS TO THE EXPERTS – FLY WITH VOZC!

Ms Olivia Cromwell
Global Business Manager, Aerospace BASF

10:00-10:25 LESSONS LEARNED FROM FOUR MORE YEARS OF FUME EVENTS REPORTED TO THE FAA

Judith Anderson, MSc CIH
Industrial Hygienist, Association of Flight Attendants - CWA

10:26-10:40 Q&A

10:41-11:09 REFRESHMENTS AND NETWORKING

SESSION **SIX:**

11:10-11:35 OPERATIONAL ASPECTS OF CONTAMINATED AIR EVENTS AND THE BENEFITS OF USING PEER-SUPPORT PROGRAMS FOR FLIGHT CREWS: AN AEROMEDICAL PERSPECTIVE.

Captain Rondeau Flynn
Aeromedical Chairman for Allied Pilots Association

11:36-12:01 ORGANOPHOSPHATE DOSE AND AIRCRAFT CABIN AIR

Emeritus Professor C. V. Howard.
MB. ChB. PhD. FRCPath.
Professor of Pathology (toxicology) - University of Ulster

12:02-12:32 NEUROPSYCHOLOGICAL ASSESSMENT:
THE MOST SENSITIVE MEANS OF EXAMINING THE EFFECTS OF TOXIC EXPOSURE

Professor Sarah Mackenzie Ross
Chartered Clinical Psychologist & Clinical Neuropsychologist
and Dr Leonie Coxon
Clinical Psychologist and Forensic Psychologist

12:33-12:59 Q&A

13:00-13:59 LUNCH AND NETWORKING

SESSION **SEVEN:**

14:00-14:25 CONTROLLED VOC OZONE CONVERTER TESTING

Robert C. Gleason, PMP
Vice President, Engineering and Programs
PTI Technologies Inc.

14:26-14:51 CONTROLLED VOC OZONE CONVERTER TESTING

Richard Fox, PhD,
ASHRAE Fellow Environmental Control Solutions Manager AeroParts Manufacturing and Repair, Inc.

14:52-15:17 Collins Bleed-Free ECS

Lance R. Bartosz
Advanced Technology Manager
Power and Controls – Environmental & Airframe Control Systems Collins Aerospace

15:18-15:34 Q&A

15:35-15:34 REFRESHMENTS AND NETWORKING

SESSION **EIGHT:**

16:05-16:40 DEVELOPMENT OF A BIOMARKER OF EXPOSURE

Professor Clem Furlong &
Associate Professor Dale Whittington
University of Washington. Seattle, WA

16:41-17:01 30 YEARS LATER

Marcus Diamond
Australian Federation of Air Pilots

17:02-17:29 A PERSONAL JOURNEY

Dr. Susan Michaelis
BCA(hon) PhD, ATPL

17:30-17:45 Q&A

DELEGATES DINNER

AIMS AND OBJECTIVES
GCAQE 2024/2025

BACKGROUND

The Global Cabin Air Quality Executive (GCAQE) is a global coalition of health and safety advocates committed to raising awareness and finding solutions to poor air quality in aircraft. Established in 2006, the GCAQE is the leading organisation representing air crew (pilots, cabin crew and engineers) and passengers, that deals specifically with contaminated air issues and cabin air quality. We represent over thirty organisations, and over one hundred thousand workers around the world.

The primary aim of the GCAQE is to effect the changes in the aviation industry that are necessary to prevent exposure to heated synthetic jet engine oils, hydraulic and de-icing fluids; that are known to contaminate ventilation air supplied to the cabin and flight deck.

In all modern commercial jet aircraft with the notable exception of the Boeing 787, the cabin air supply is taken unfiltered directly from compressors in the engine or the Auxiliary Power Unit (APU), using a process known as 'bleed air'. Current jet engine oil systems, by design, will enable oil to contaminate the 'bleed air' at low levels in all conditions. As the oil contamination levels increase, a smell can often be noticed, often described as a dirty sock, acrid, chemical or oily smell. This is often referred to as a 'fume event'. 'Fume events' can range from transitory exposure as part of normal operations, to more continued exposure due to abnormal conditions such as engine seal wear, engine oil over fill or seal failure. In extreme levels of contamination, a visible smoke or mist may become apparent. Contaminated air exposures are acknowledged to occur by regulatory authorities, aircraft manufacturers, safety agencies, scientists, airlines, occupational doctors, oil manufacturers, and crew unions. Some reports dating back as far as the 1950s. Contaminated air may result in crew impairment or less frequently, in crew incapacitation and jeopardise flight safety. Both short and long term health effects have been reported as a consequence of these exposures.

GCAQE OBJECTIVES

CLEAN AIRCRAFT AIR SUPPLY

We recommend that aircraft manufacturers incorporate bleed-free technology on future aircraft types and that regulators (EASA, FAA, CASA, TC, etc.) require that all aircraft certificated to use 'bleed air', be equipped with an effective and suitably maintained air cleaning technology in the shortest time frame possible.

AIR SUPPLY MONITORING

We recognise the need to define appropriate chemical markers or particulates of air supply contamination, to implement continuous monitoring onboard, and to develop procedures for crew to respond to elevated levels at the earliest possible time. We wish to remind our industry colleagues that air accident investigation departments have been also calling for this for over a decade. The failure to install such technology contravenes the regulatory requirements.

EXISTING REGULATIONS/STANDARDS TO BE MET

We call on regulators to ensure compliance with existing regulations, certification standards and compliance guidance material, including an air supply without harmful or hazardous concentrations of gases or vapors that can cause impairment or degraded crew performance, and reporting of smoke/fume events, and proper maintenance follow-up. We also call on regulatory bodies with expertise in occupational health and safety to work with aviation regulators to ensure that crewmembers' health and safety is best protected.

PREVENTIVE MEASURES TO REDUCE THE RISK OF AIR SUPPLY CONTAMINATION

We call on aircraft and component manufacturers to develop design and operational features that are proven to reduce the frequency of oil and hydraulic fluid contaminating the air supply system (e.g. improved seal design, etc.) and for regulators to require airlines to implement them.

EDUCATION AND TRAINING PROCEDURES

We call on manufacturers and airlines to acknowledge the potential for air supply contamination and to provide crewmembers with information on chemical contaminants to which crews may be exposed, symptoms, and standardised checklists, procedures suitable for fume events, and oxygen usage. We wish to remind our industry colleagues that ICAO introduced Fumes, Education and Training guidance material in 2015 and the FAA issued a Safety Alert for Operators (SAFO) in 2018 calling for enhanced procedures in this regard, yet no airline has to date adequately implemented these.

MAINTENANCE

We call on the regulators to require manufacturers and airlines to improve their investigative procedures following report fumes events; and to provide access to relevant aircraft maintenance records to enable affected crewmembers and passengers to determine if the air supply was contaminated, and if so, with what.

HEALTH IMPACT OF EXPOSURE TO BE PROPERLY ASSESSED

We urge the industry to adapt a more precautionary approach to this problem as opposed to an entrenched position of denial by looking at all the currently available data. If further research is undertaken to further clarify the toxicological mechanism, we recognise the need for truly independent and relevant inhalation toxicity research to be funded, and to be carried out by independent researchers, to properly investigate the health impact of inhalation exposure to pyrolised engine oils with an emphasis on the chronic neurotoxic effects (e.g. difficulty concentrating, memory and communication problems, difficulty multitasking, etc.) reported by crews. The toxicity of oils should not be defined according to dermal and ingestion toxicity studies that assess peripheral neuropathy and paralysis when, by definition, aircraft occupants are exposed via inhalation and report chronic neurotoxic symptoms. We also call for an epidemiological survey of crew members to properly assess the health impact of exposure to contaminated cabin air.

READY ACCESS TO INFORMATION ON MEDICAL EVALUATION AND TREATMENT

We recognise the need for a comprehensive medical protocol to be readily available to passengers, crew members and their physicians, and for physicians to have access to any onboard air sampling data to assist in diagnosis and treatment.

REPORTING

Under reporting of contaminated air events has been acknowledged globally for nearly two decades. We urge the industry to encourage the reporting of all contaminated air events. This will ensure all events are fully reported and help all stake holders better understand the frequency, nature and operational factors related to contaminated air events, and their effects on crew, passengers and maintenance practices.

In addition, we recognise that aviation maintenance workers are also impacted by these exposures, and that turbine engines maintained with the same oils have additional applications such as oil and gas production, marine, and military vehicles. The spirit of the aims and objectives described above apply equally in these other fields.

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- Providing our customers and partners with technical expertise to accompany them in their projects;
- Create innovative product combining performance and safety.

OUR VISION

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CONFERENCE **SPEAKERS**

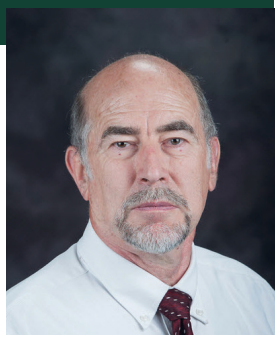
BARONESS BENNETT OF MANOR CASTLE - GREEN PEER - UK HOUSE OF LORDS

Natalie Louise Bennett, Baroness Bennett of Manor Castle, is an Australian-British politician and journalist who served as Leader of the Green Party of England and Wales from 2012 to 2016. Bennett was given a peerage in Theresa May's 2019 resignation honours.

Born and raised in Australia, she began her career as a journalist with regional newspapers in New South Wales before leaving in 1995 for Thailand, where she worked for Australian Volunteers International and the Bangkok Post newspaper over the next four years. Since settling in Britain in 1999 she has contributed to The Guardian, The Independent, and The Times. Her election as leader of the Greens came six years after she joined the party in January 2006.

CAPTAIN TRISTAN LORAINE - BCAi GCAQE SPOKESPERSON

Captain Tristan Loraine BCAi is a former British Airways Captain and was ill health retired in 2006, due to the health effects of repeated exposure to contaminated air in the cockpits of the aircraft he flew. He regained his medical to certificate to fly in 2019 but chose not to return to flying commercially. He was Co-Chairman of the Global Cabin Air Quality Executive (GCAQE) from its inception in 2006 until 2016 when he became the GCAQE Spokesperson. Previously a Health and Safety representative and National Executive Council member of the UK pilot union BALPA, he was a recipient in 2015 of a British Citizen Award for services to Industry (BCAi) for his work on the contaminated air issue since 2001. He is also an independent film maker. His latest film on the issue of contaminated air, 'American 965' was a 2022 Academy Award contender.



PROFESSOR BYRON JONES - PROFESSOR OF MECHANICAL ENGINEERING, KANSAS STATE UNIVERSITY

Dr. Byron Jones is a Professor Emeritus in the Mechanical and Nuclear Engineering Department at Kansas State University (KSU) and a Professional Licensed Engineer with 50 years of experience. He is a Fellow and Life member of the American Society of Heating Refrigerating and Air-Conditioning Engineers, a Life Member of the American Society of Mechanical Engineers, and a Member of SAE International. Dr. Jones has conducted extensive experimental research on aircraft cabin environments and aircraft environmental control systems. This research includes a series of research projects using on-wing aircraft engines and test stand engines to evaluate the characteristics of contaminants that have been introduced into engine bleed air and to evaluate the ability of sensors to detect this contamination.

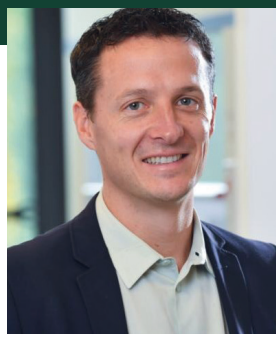
RICARDO PAVIA - TAP ENGINEER

Ricardo Pavia has a Mechanical Engineering master degree and has been working at TAP since 2014 on aircraft maintenance as Systems Engineer on air conditioning (ATA 21) and pneumatic systems (ATA 36), as well as landing gears, flight controls and hydraulics systems (ATA 32, 27 and 29 respectively) for Single Aisle and Wide body Airbus aircrafts. Ricardo is responsible to support and issue work orders and troubleshooting instructions to base and operational maintenance production teams, and also the analysis and technical dispatch of Airworthiness Directives (ADs) issued by the aeronautical authorities (EASA and FAA) and technical documentation provided by manufacturers and airframers, in accordance with Part M/ CAMO regulations.

Over the last years, Ricardo worked also as a project manager of TAP aircrafts on third-party MROs across Europe and Brazil, during maintenance layovers performed by outsourced service providers.

HALVOR ERIKSTEIN - ORGANIZATIONAL SECRETARY, CERTIFIED OCCUPATIONAL HYGIENIST, SAFE - NORWEGIAN UNION OF ENERGY WORKERS

Halvor Erikstein has worked as an occupational hygienist in the Norwegian offshore oil industry since 1988. He has been employed in occupational health services for diving companies and oil service companies, and later by the American oil company Amoco. As a chemist, he has a particular interest in the toxicity of fire smoke and the thermal degradation of polymeric materials. Since 2001, he has been employed at SAFE and became aware that a group of offshore workers who worked near the aeroderivative gas turbines had been affected by neurological health outcomes. The case was referred to as the multiple sclerosis case on the Statfjord field. He was involved in the establishment of GCAQE and served as a board member for many years. Since 2015, he has represented Norway in the work on the CEN/TC 436 standard. He is a member of the Norwegian oil industry's Safety Forum and a board member of the Petroleum Standardization Sector Board. In 2021, he was appointed by the Norwegian government as a member of the 'Compensation Commission for Oil Pioneers,' which issued NOU 2022:19.



GRÉGOIRE HERVE - SCIENTIFIC & TECHNICAL DIRECTOR NYCO

Graduated with a PhD in Organic Chemistry from Aix-Marseille University along with a Master degree at the High Chemical Engineering School of Marseille with over 15 years of experience in leading research in the chemicals industry. Started in the space and military research on propellants and energetic materials, and then, in the chemical industry at Total and Arkema. In 2012, my research area was orientated to the aeronautic industry as a new interest, with a 3-year experience in chemical surface treatment & protective coatings. In 2015, I finally joined the lubricant business becoming the Scientific & Technical Director at Nyco in charge of the global industry and aviation R&D activities.

GABRIEL MOCHO RODRÍGUEZ - CIVIL AVIATION SECRETARY - INTERNATIONAL TRANSPORT WORKERS' FEDERATION (ITF)

Gabriel Mocho Rodriguez is the Civil Aviation and Tourism Services Secretary of the International Transport Workers' Federation (ITF) supporting the General Secretary Stephen Cotton and Section Chairs in leading the sections.

Gabriel started his career in the aviation industry as a Cabin Crew member in 1988 and had served as leader of the National Cabin Crew union of Argentina (AAA) for 12 years before joining the ITF.

He was appointed by the Executive Board of the ITF in 2009 to take responsibility of leading the secretariat of the Civil Aviation and Tourism Services Sections of the organisation with headquarters in London, UK.

He has represented the ITF aviation unions in several international fora and UN agencies (e.g. International Civil Aviation Organization –ICAO- and International Labour Organization –ILO-) leading delegations of union leaders into the discussions of the present and future of the aviation industry.

JUDY CULLINANE - AVIATION LEGAL CONSULTANT

Former Ansett Australia Flight Attendant from 1984, flying the BAe-146 aircraft.

I became incapacitated 6-8 November 1997, while flying 3 days on the same British Aerospace BAe-146 (JJW) aircraft during flights between Cairns, Alice Springs, Ayers Rock and Perth. I was being exposed to fumes, (toxic vapours) through the cabin air, becoming totally incapacitated, semi-paralysed and barely able to speak, during flights. The aircraft maintenance report stated, "Number 2 bleed inlet duct and both sleeves on air cycle machine replaced. Duct cracked and leaking hoses".

I reported the incidents to the Australian Bureau of Air Safety Investigations (BASI), raised safety concerns and health problems with the Australian Government, through Question Time - questions on notice, that led to the year-long 1999 / 2000 Senate Transport References Committee Investigation into Contaminated Air on Aircraft. In August 2002, I settled at the pre-trial conference with Ansett's Insurer, nearly 6 years after becoming ill and suffering injuries that ended my career through no fault of my own.

I then retrained as a lawyer, graduating the same day as my son also a lawyer in 2016.

DR JONATHAN BURDON - CONSULTANT RESPIRATORY PHYSICIAN

Dr Burdon graduated in 1971 from the University of Melbourne and was trained at the Royal Melbourne Hospital and subsequently as a post-doctoral Fellow at McMaster University, Hamilton, Ontario.

Returning to Melbourne, he was appointed as Respiratory Physician at St. Vincent's Hospital in 1983 assuming the Directorship in 1990 stepping down ten years later. He has held senior position in a number of medical organisations and continues in private practice in East Melbourne with a particular interest in occupational lung disorders.

He first encountered the problem of the medical effects of aircraft cabin fume events about 25 years ago and his involvement has continued in assisting aircrew suffering from Aerotoxic Syndrome and in researching and publishing papers on this subject.

Dr. med. Denis Bron - Chef Flugmedizin, Head of AeMC, Eidgenössisches Departement für Verteidigung, Bevölkerungsschutz und Sport VBS, Luftwaffe, Fliegerärztliches Institut FAI / AMC Schweiz

DR. DENIS BRON - CHEF FLUGMEDIZIN, HEAD OF AEMC EIDGENÖSSISCHES DEPARTEMENT FÜR VERTEIDIGUNG, BEVÖLKERUNGSSCHUTZ UND SPORT VBS LUFTWAFFE FLIEGERÄRZTLICHES INSTITUT FAI /AMC SCHWEIZ

Dr. Denis Bron is a seasoned aviation medicine specialist with over 17 years of experience at the Aeromedical Institute in Dübendorf, Switzerland. Since January 2012, he has served as Chief of Aviation Medicine, overseeing medical evaluations and health standards for pilots. Prior to this role, he worked as an AME from 2007 to 2011. His educational background includes a specialization in General Internal Medicine (FMH) and certification as an FAA Medical Examiner from Oklahoma. He is also a certified Human Factor Specialist through the EAAP (European Association for Aviation Psychology) and an aviation medical expert with the Swiss Federal Office of Civil Aviation (BAZL).

ASSISTANT PROFESSOR SEUNGHON - GACHON UNIVERSITY GIL MEDICAL CENTER, DEPARTMENT OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE, GRADUATE SCHOOL OF PUBLIC HEALTH, OCCUPATIONAL AND ENVIRONMENTAL HEALTH, GACHON UNIVERSITY, REPUBLIC OF KOREA

Prof. Dr. Seunghon Ham is an Associate Professor in the Department of Occupational and Environmental Medicine at Gil Medical Center, Gachon University, Republic of Korea. He holds a Ph.D. and M.P.H. in Occupational Hygiene and Environmental Health from Seoul National University. His undergraduate education includes a B.Eng. in Mechanical Design and Automation Engineering from Seoul National University of Science and Technology and a BSc First Class Honours in Manufacturing System and Design Engineering from the University of Northumbria at Newcastle, UK.

Dr. Ham's research focuses on nanoparticle exposure assessment in workplaces. He has extensive experience in industrial hygiene, asbestos inspection, environmental health, and remote sensing. His diverse educational background and research expertise contribute significantly to the field of occupational and environmental health.

THORSTEN BUSCH - AIRBUS A320

Spanning a 23 year career as an airline pilot, Thorsten has earned type ratings for multiple aircraft (including Airbus 320), holds a degree in Aviation Management, and has had his Certified Flight Instructor designation for 20+ years. Throughout his aviation career, he has flown aircraft to 100+ countries and completed 400+ Atlantic crossings and 20+ polar crossings. He was put on medical leave indefinitely after he was severely impacted by two fume events (2019 and 2022). Thorsten's challenging journey of navigating the ambiguous and disjointed aerotoxicity process inspired him to become an Airline Pilot Association (ALPA) AeroMedical Committee Member. He is motivated to influence change in the airline industry to ensure that current and future generations of flight crew are able to remain safe as they do their job.

CAPTAIN RUDY PONT - BELGIAN COCKPIT ASSOCIATION (BECA)

Rudy Pont is a 47-year-old Airbus 320 captain with MSc degrees in Electro-mechanical Engineering, Air Safety Management, and Safety Sciences. With over 15 years of experience in (flight) safety, his credo is "people are safety!" Rudy chairs the Air Safety Committee of the Belgian Cockpit Association (BeCA) and is a part-time lecturer at the University of Antwerp faculty of Applied Engineering. A strong advocate of Just Culture, Safety-II, and Organizational Learning, he is an active member of the EUROCONTROL Just Culture Task Force and the vice-chair of the Belgian Just Culture Platform.

CAPTAIN PHILIPPE AMMAN – AEROPERS

With over three decades as a pilot, including more than 15 years as a Captain at SWISS Air Lines, Philippe Ammann brings extensive expertise in leadership, human factors, and team performance. He led leadership seminars for aspiring flight captains and developed several human factors trainings. As a keynote speaker, he focuses on Safety 1 & 2 as well as leadership topics, emphasizing a culture that views errors as learning opportunities.

Since 2020, he serves as a Cabin Air Quality Specialist for AEROPERS and as a Board Director of GCAQE, contributing to international expert groups on clean cabin air issues. His work includes supporting crew members after technical incidents and promoting the advancement of medical expertise nationally.

BERNARD BALDINI - DASSAULT AVIATION

Bernard Baldini has been with Dassault Aviation engineering for more than 35 years. Senior fellow, as well in charge of the air quality topic for more than 10 years.

OLA HÄGGFELDT - CHIEF COMMERCIAL OFFICER (CCO) CTT SYSTEMS AB, SWEDEN

- CCO at CTT
- Been with CTT for 4 years
- Based in Nykoping Sweden
- Responsible for both Sales, Marketing as well as Customer Support, MRO
- Previous
- Master in Science Materials Technology, Royal Institute of Technology, Stockholm Sweden
- +10 years of experience from Automotive industry
- +10 years of experience from Tele/ Datacom Industry
- Been resident and worked in both Dubai and Kuala Lumpur over the years
- Responsible for EU, MENA and Asia regions.

MS OLIVIA CROMWELL - GLOBAL BUSINESS MANAGER, AEROSPACE, BASF

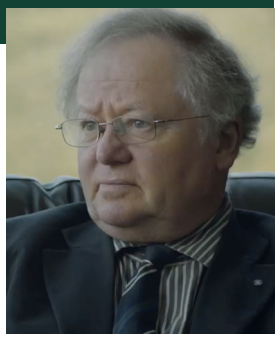
Dr. Olivia Cromwell is the Global Business Manager, Aerospace, for BASF Environmental Catalyst and Metal Solutions. Currently, she is responsible for leading the Aerospace business's legacy portfolio as well as cutting-edge technology product launches across the commercial and general aviation industries. She started her career with BASF more than nine years ago with experiences in product management, product development, technology scouting, and new business development across multiple market segments. Olivia graduated from Gettysburg College with a BS in Chemistry. She also holds PhD in Chemistry from the University of California, Irvine. She currently lives in the greater New York City area and in her free time enjoys barre and gardening.

JUDITH ANDERSON, MSC CIH – INDUSTRIAL HYGIENIST, ASSOCIATION OF FLIGHT ATTENDANTS – CWA

Judith Anderson is an Industrial Hygienist with the Association of Flight Attendants labor union, representing cabin crew at 20 airlines in the US. She has 25 years of experience working to address fume events and other crew health and flight safety hazards. She will be sharing her insights into the big picture of fume events – with examples – that US airlines reported to the FAA before and after the COVID pandemic.

CAPTAIN RONDEAU FLYNN - AEROMEDICAL CHAIRMAN FOR ALLIED PILOTS ASSOCIATION

Serving as the APA Aeromedical Committee Chairman, he specializes in occupational health and resiliency through Pilot Human Performance. He provides operational background and technical insight into issues concerning peer support to include pilot mental fitness, occupational health, and prevention measures for the airline industry. He previously served as the Deputy Chairman of the Pilot Occupational Health Committee for the Allied Pilots Association (APA). In this capacity he coordinated, staffed, and developed threat mitigation strategies for the reduction of occupational health exposures. Interfacing with industry scientists in the fields of Space Weather Radiation, and Cabin Air Quality the APA-Pilot Occupational Health Committee is dedicated to prevention-based health measures for the members of APA. CA Flynn is also the Aeromedical Chairman for the Coalition of Airline Pilots Association (CAPA) and a Board of Director for the GCAQE.



EMERITUS PROFESSOR C. V. HOWARD. MB. CHB. PHD. FRCPATH. - PROFESSOR OF PATHOLOGY (TOXICOLOGY) - UNIVERSITY OF ULSTER

Professor C. Vyvyan Howard MB. ChB. PhD. FRCPath.is a medically qualified toxico-pathologist specialising in the problems associated with the action of toxic substances on the fetus during development. In particular, and of relevance to cabin air quality, he has investigated the toxic properties of mixtures of organo-phosphates and the effects of chronic low dose exposure. He is Emeritus Professor of Bioimaging at the University of Ulster.

Professor Howard's work has emphasized the research reporting very low dose effects from endocrine disrupting chemicals on the fetus, their potential to lead to subtle functional deficits and cancer in adult life and the inadequacy of current regulatory risk assessment to address these hazards.

He is a Fellow of the Royal College of Pathologists, Fellow of the Collegium Ramazzini, Past President of the Royal Microscopical Society, Member of the British Society of Toxicogical-Pathologists andPast President of the International Society of Doctors for the Environment. He was a toxicologist on the UK Government DEFRA Advisory Committee on Pesticides from 2002-2008

PROFESSOR SARAH MACKENZIE ROSS - CHARTERED CLINICAL PSYCHOLOGIST & CLINICAL NEUROPSYCHOLOGIST

Professor Sarah Mackenzie Ross is a Consultant Clinical Psychologist & Neuropsychologist, and Honorary Professor on the Doctoral Programme in Clinical Psychology at University College London. Her career history includes several clinical appointments within the National Health Service. She now runs her own private practice. Sarah is also an Aviation Psychologist and has written book chapters on the importance of assessing mental health and cognitive function in pilots throughout their careers; and she served on a working group of international aviation experts, commissioned by the British Psychological Society, to produce a position paper on Pilot mental health and wellbeing. She has a longstanding research record and in the last ten years has become an internationally recognised expert in neurotoxicology. Sarah has been researching the impact of air quality on cognitive function in aircrew for the last 15 years. In 2020, she was awarded the Distinguished Contribution to Practice Award by her professional body for work which has made an outstanding and lasting contribution in neuropsychology.

DR LEONIE COXON - CLINICAL PSYCHOLOGIST AND FORENSIC PSYCHOLOGIST

I am a registered Clinical and Forensic Psychology with the Psychologists Board of Australia. I hold a Bachelor of Arts with Honors in Psychology, a Master's in Applied Psychology, completed PhD units in Forensic Psychology, and a Doctorate in Clinical Psychology. I am a Fellow of the Australian Psychological Society.

Over 39 years, I have worked in Perth Rehabilitation and Psychiatric Hospitals, a Head Injury Unit, and in private practice, focusing on neuropsychological and clinical assessments of head-injured and traumatised clients. I served as Director of the Psychologists' Registration Board of WA and the Psychologists Board of Australia for three years

My research interests include; brain dysfunction related to: alcohol exposure; toxic chemicals in mining, agricultural and medical settings; the effects of toxic sealants on air force engineers; and effects of jet engine oil emissions on pilots, and flight crew.

ROBERT C GLEASON, PMP - VICE PRESIDENT, ENGINEERING AND PROGRAMS, PTI TECHNOLOGIES INC.

Robert Gleason is a high energy, results oriented leader with over 28 years of industry experience that understands the unique relationships between project execution and the product life cycle in the aerospace and defense industry. He has a diverse background with demonstrated experience in product development, engineering, configuration management, business development, operations, and project/program/portfolio management as well as proven strengths in strategic planning and Lean Six Sigma enterprise implementation for organizations on rapid growth trajectories.

Currently, Robert leads engineering and program management execution excellence for PTI Technologies based in Oxnard, California. In this role, he is responsible for leading engineering, program, and configuration management teams to deliver exceptional products to the market while managing the life cycle of PTI's core products. Robert works closely with all functional areas of the business and play's a critical role in the driving PTI's engineering strategy, managing aerospace programs, and fostering technical excellence within the organization.

Prior to joining PTI Technologies, Robert has been in several key engineering and program management leadership positions for major organizations including Moog Aircraft, Parker Aerospace, Capstone Turbine and ITT for major military, commercial, rotorcraft, and business jet applications. Throughout his career, he has successfully led and grown cross-functional teams supporting a diverse array of programs, projects, and products ranging from micro-turbines, electronic controllers, servos, fluid controls & conditioning, fluid power generation, and actuation for a wide variety of mission critical applications and systems. He carries diverse experiences across all stages of the product lifecycle, and is well-versed in managing large, cross-functional organizations. Additionally, he has a wealth of global experiences, having lived in Russia, Canada, France, the US, and Brazil and managing teams in Mexico and India.

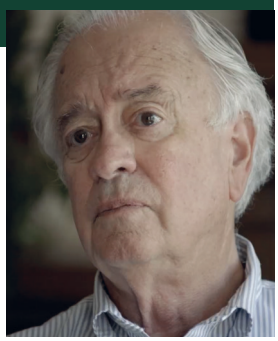
Robert is an active industry leader and has participated in in several associations including AIA, SAE, PMI, and Manufacturers Alliance for Productivity and Innovation (MAPI). He has served on the Engineering Management Committee of Aerospace Industries Association (AIA) in Washington D.C. and was a founding council member and Chair of the Santa Clarita Valley Chapter of The Aerospace and Defense Forum. He is currently an active board member of the Ventura County Chapter of The Aerospace and Defense Forum and SAE's A-6 Aerospace Actuation, Control and Fluid Power Systems Committee. Robert is consistently requested to participate in councils as a leader in his field including History Channel's Modern Marvels and the Santa Clarita Valley Economic Development Corporation where he did a podcast interview about the future of aerospace with its CEO.

RICHARD FOX, PHD, - ASHRAE FELLOW ENVIRONMENTAL CONTROL SOLUTIONS MANAGER, AEROPARTS MANUFACTURING AND REPAIR, INC.

Dr. Richard Fox, based in Queen Creek, Arizona, is AeroParts Environmental Control Solutions Manager and FAA DER. Richard brings nearly 4 decades of experience to the aerospace industry and is a Fellow of the American Society of Heating, Refrigeration, and Airconditioning Engineers (ASHRAE). Richard has a PhD with Dual Specialization in Engineering Technology Management and Marketing. Dr. Fox chairs the ASHRAE SSPC161 Committee on Aircraft Cabin Air Quality and serves as vice-chair of the SAE AC-9 Aircraft Environmental Systems Committee. Dr. Fox co-authored the Aircraft Cabin Air Chapter of the 2022 Indoor Air Handbook. He served as the technical lead to Kansas State University for Congressionally mandated FAA research to identify suitable sensors to monitor bleed air contaminants. He is also an Advisor for the currently ongoing European Aviation Safety Agency Cabin Air Quality Research III project in Europe.

LANCE R. BARTOSZ - ADVANCED TECHNOLOGY MANAGER, POWER AND CONTROLS – ENVIRONMENTAL & AIRFRAME CONTROL SYSTEMS, COLLINS AEROSPACE

Lance Bartosz is currently leading the Advanced Technology initiatives within Collins' Environmental and Airframe Control Systems business unit. Lance is also an Aircraft Cabin Air Quality expert researching innovative technologies to improve the aircraft environment. Lance has extensive engineering experience in the design, development and certification of air management and engine control systems, including: air cycle machines, jet fuel controls, electromechanical devices, hydraulic systems, heat exchangers, fuel / oil valves and many other aircraft accessories. Lance has also led factory Operations teams in the manufacture of hydromechanical engine control systems for aerospace turbine engines. Outside of work Lance enjoys spending time with his family on their boats. Cruising the ocean to various destinations is a passion of his, and Lance has captained boats on many lakes, rivers and offshore waters from Florida to Maine.



PROFESSOR CLEM FURLONG - ASSOCIATE PROFESSOR DALE WHITTINGTON UNIVERSITY OF WASHINGTON. SEATTLE, WA

Dr. Furlong received a B.A. in Chemistry from San Jose State College in 1963. He received a Ph.D. in Biochemistry from the University of California, Davis in 1968 where he studied the allosteric regulation of glycogen synthesis in bacteria. He then spent two postdoctoral years at Cornell University, Ithaca, N.Y. with Dr. Leon Heppel working on bacterial ABC nutrient transport proteins. He continued this research as a faculty member in the Biochemistry Department at the University of California, Riverside. In 1976 he spent a sabbatical at Stanford University working with Drs. Harden McConnell and Hugh McDevitt studying immunology. In 1977, Dr. Furlong joined the Departments of Medicine (Division of Medical Genetics) and Genetics (now Genome Sciences) at the University of Washington. Recent research has focused on identifying and characterizing biomarkers of exposure to organophosphates including insecticides and tricresyl phosphate, a component of jet engine lubricants.

MARCUS DIAMOND - AUSTRALIAN FEDERATION OF AIR PILOTS

With an aviation career spanning 28 years, Marcus has been a Training Captain, Fleet Captain, Flight Operations Manager, Deputy Chief Pilot and CEO of a small Part 121 regional airline. He holds Airline transport licences and has been a high capacity Airline Captain in Australia, New Zealand and Papua New Guinea.

He has also been instrumental in writing and obtaining approval for Air Operator's Certificates and has extensive experience in dealing with regulatory bodies and corporate safety departments.

As manager of the Safety & Technical (S&T) function, Marcus provides training, guidance and specialist advice to the AFAP's executive, staff and members. He has a continuing professional interest in pilot fatigue; cabin air quality; pilot training and advancement; and airport and building standards.

He liaises with industry stakeholders on S&T matters; works with our IFALPA partners and AusALPA to coordinate responses to S&T matters; and attends S&T related meetings on behalf of the AFAP and AusALPA. He has been a member of the AFAP since the 1990s and was a negotiating representative and served on the AFAP executive.

DR. SUSAN MICHAELIS BCA(HON) PHD, ATPL

Dr. Susan Michaelis, a former Australian ATPL airline pilot holds a PhD in Safety Science, specifically addressing the health and fight safety implications of exposure to aircraft contaminated air. She holds an MSc in Air Safety and Accident Investigation and is a qualified air accident investigator. In 1987 she was awarded the Australian Civil Aviation Authority's award for academic merit, while in 2017 she was awarded the Cranfeld University MSc Course Director's best overall student for her MSc, which included a thesis reviewing how oil leaks in turbine engines. Susan received a British Citizens Award (BCAhon) in 2023 in the House of Lords, for her 25+ years of work on the contaminated air issue. For over 25 years, she has led much of the global research on the aircraft contaminated air issue and has widely published on this topic. She is also qualified in hazardous substances and general occupational health and safety. She is the founder of Michaelis Aviation Consulting.

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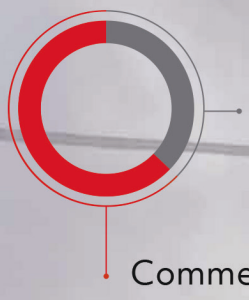

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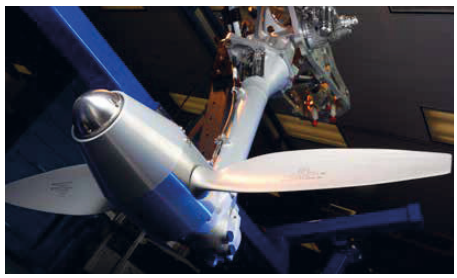

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WE ARE REDEFINING AEROSPACE.

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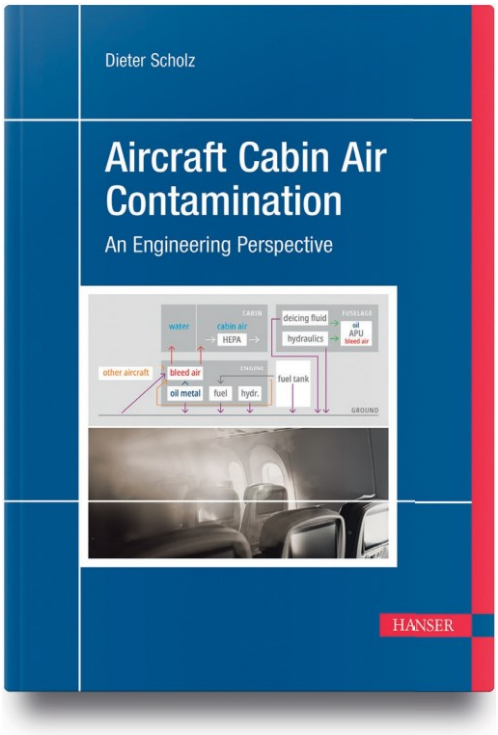

Abstract

Purpose – This text is written to bring the engineering explanations of aircraft cabin air contamination together in one place and on another level of detail. Explanations go into technical detail, but all interested parties and people from all disciplines should benefit. --- **Methodology** – It is a review of the evidence combined with own contributions to the field. --- **Findings** – At a closer look, the aircraft is anything else but a glamorous polished machine. For technical reasons, dangerous chemicals are in use. These substances leave their intended places and get distributed everywhere. As such they just follow the law of nature: entropy. Unfortunately, while spreading, the substances also arrive in the human body with health and flight safety consequences. All occupants are potentially affected, but predominantly the crew, who spend much more time in an airplane than even a frequent flyer. In this way low dose exposures accumulate and are potentially topped by a high dose exposure in a failure case. --- **Research Limitations** – Focus is on cabin air contamination from engine oil in transport category airplanes. Contamination due to hydraulic fluid, deicing fluid, and even ozone is also considered. --- **Practical Implications** – People who suffer from consequences of aircraft cabin air contamination may find answers to the main question: Why? Others may find hints on how to get protected. --- **Social Implications** – This text can prove evidence of the engineering fundamentals in court. **Originality** – No comparable text seems to be published.

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About the Author

Dieter SCHOLZ is a professor at Hamburg University of Applied Sciences. He teaches Aircraft Systems (among other subjects) and was engaged in research with Airbus on simulation and design of the Environmental Control System (among other topics). He uses two official Airbus A320 Aircraft System Simulators (MTD) with real hardware in his laboratory for teaching. Dr. Scholz has contributed a chapter on aircraft systems to three aerospace standard handbooks and has contributed to the topic at various meetings, conferences, and hearings. Chapter 8.5 and Chapter 9.1 – which are central to this text – have been partially published Open Access with peer review. Scholz holds a Private Pilot License (PPL-A and PPL-B), CVFR-Rating, Night-Rating, AZF, more than 700 Flight Hours (PIC), experience in Educational Flight Testing, ICAO Language-Proficiency in English: Level 6 ("near native"). Homepage: http://ProfScholz.de. Full CV: http://CV.ProfScholz.de. info@ProfScholz.de.

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