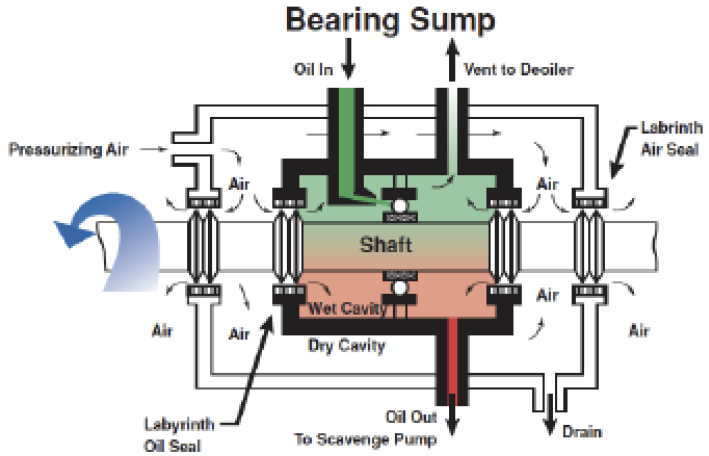
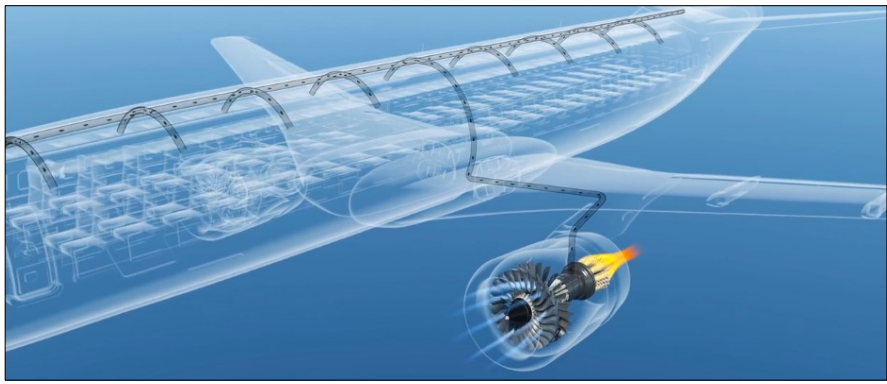
Title





1950s – 2020s

- Pressurised air used to seal oil in engine & breathing air (seals leak)
- Oil contains hazardous substances: OPs, complex heated mixture…
- People are being exposed to:
  - Continual background oil leakage +
  - Fume events
  1) Transient power/air supply changes – normal ops
  2) Operational/failure incidents- less frequent
- + Other fluids… e.g: Hydraulic/ deicing fluids

Design flaw

Flight safety impaired
Health effects-ST/LT

World Health Organization
REGIONAL OFFICE FOR Europe
PUBLIC HEALTH PANORAMA VOLUME 3 | ISSUE 2 | JUNE 2017 | 141-356

Epidemiological data - 2017

Original research

AEROTOXIC SYNDROME: A NEW OCCUPATIONAL DISEASE?

Susan Michaelis[1], Jonathan Burdon[2], C. Vyvyan Howard[3]

[1] School of Health Sciences, University of Stirling, United Kingdom
[2] Consultant Respiratory Physician, Melbourne, Australia
[3] Centre for Molecular Biosciences, University of Ulster, United Kingdom

Neurolgical
- CNS, PNS

Neurobehavioural
- Neurological, cognitive

Gastrointestinal
Respiratory
Cardiovascular
Rheumatological
Miscellaneous
Soft tissue
Irritation
Skin
Immune
Cancers

CONCLUSIONS

Aircraft air supplies contaminated by pyrolysed engine oil and other aircraft fluids can reasonably be linked to acute and chronic symptoms, findings and diagnoses, thus establishing causation. Other potential causes of symptoms have been suggested. However, these fail to recognize that:

- the design mechanism allows chronic low-level exposure to a complex mixture during both normal flight and specific incident events with confirmed leakage;
- observed effects are consistent with those of recognized hazards;
- acute effects and operational limitations reduce flight safety;
- chronic effects are common; and
- passengers occupy the same environment as crew.

World Health Organization
REGIONAL OFFICE FOR Europe

Medical findings/ diagnoses – 15 fume events

Examples

Short-term	No.	Long-term	No.
SPO2 70-80%		RADS	6
Abnormal blood results	2	Toxic encephalopathy	1
Hydrocarbon fumes	1	Neuropathy on vocal chords/limbs	3
TOCP adduct on BChE	1	Cognitive dysfunction	4
Poisoning by non medical agent	5	Aerotoxic Syndrome	1
toxic effect of gas/fumes/ smoke	2	Neurological chemical injury	1
Inhalation injury	1	Wallerian degeneration	1
Raised carboxyhemoglobin	4	Optic nerve damage	

TABLE 2. STUDY B: INDEPENDENT MEDICAL FINDINGS/DIAGNOSES BY MEDICAL STAFF

SHORT-TERM MEDICAL FINDINGS & DIAGNOSES	No.	LONG-TERM MEDICAL FINDINGS & DIAGNOSES	No.
Hydrocarbon fume inhalation/chemical injury on aircraft	1	RADS (Reactive Airways Dysfunction Syndrome) / occupational asthma	6
Adverse effect on the vocal chords and bronchial tubes	1	PTSD (Post Traumatic Stress Disorder)	3
Tricresyl phosphate (TCP) in blood	1	Neurotoxic injury	1
Raised levels of VOCs, nickel, cell degradation	1	Toxic encephalopathy	1
Double hernia due vomiting	1	Neuropathy on vocal chords/limbs	3
Poisoning by non-medical agent	5	MCS (Multiple Chemical Sensitivity)	1
SPO2 70% / 80% (peripheral capillary oxygen saturation)	2	CFS (Chronic Fatigue Syndrome)	1
Abnormal blood results: CK; CK-MB; LDH; GOT (AST); GPT (ALT)	2	Anxiety/depression	1
Traumatic muscle damage and ischemia due excessive athletic sports or contamination	2	Cognitive dysfunction	4
Toxic effect of gas, fumes or smoke	2	Dementia	1
Possible inhibition of the enzyme AChe or other neurospecific esterase caused by organophosphates	2	ADHD (Attention Deficit Hyperactivity Disorder)	1
Toxicopy	2	Seizure disorder	1
carboxyhemoglobin at or above the high normal range - exposure to burned organic chemicals	4	Depression	1
TOCP (Triortho cresyl phosphate) adduct on Bche	1	Aerotoxic syndrome	1
Inhalation injury	1	Chemical injury at work	1
Organophosphate (OP) type poisoning/internal bleeding	1	Neurological chemical injury	1
		CNS injury	1
		G4 GBM (deceased) - (Glioblastoma brain tumour)	1
		Wallerian degeneration	1
		Vocal polyps	1
		Heart attack + phosphate exposure (deceased)	1

Recent industry actions* /position

- Not flight safety issue/Contaminants lower than houses/below government limits; acute effects/irritants; nocebo?
- Aviation industry/government actions:
  - Oil pyrolysis studies –> complex mixture; neuroactive activity altered
  - Cabin air monitoring studies -> Consistent pattern of OPs, VOCs, UFPs.
  - ICAO (2015)- Fumes guidance training/education required
  - EASA/EC (2017-2020) 'FACTS'cabin air study- Failed (2 mill euros)
  - EASA/EC (2020-2024) Future cabin air research study (1.5 mill euros)- Very broad
  - FAA (2020-2024)- Cabin air studies- Follow on from 2003-2015 funding
  - ECHA (2016-2019) – TCP review
  - CEN/SAE standardisation – Cabin air-chemical agents
  - Manufacturer/airline patents….
  - Medical care pathways- e.g: CAA/NHS, IATA- Not specific/not working

* Limited examples only

Legal actions

Civil actions

Successful: Turner V East west: High court of Australia (2010) – Oil is harmful to lungs

Settled

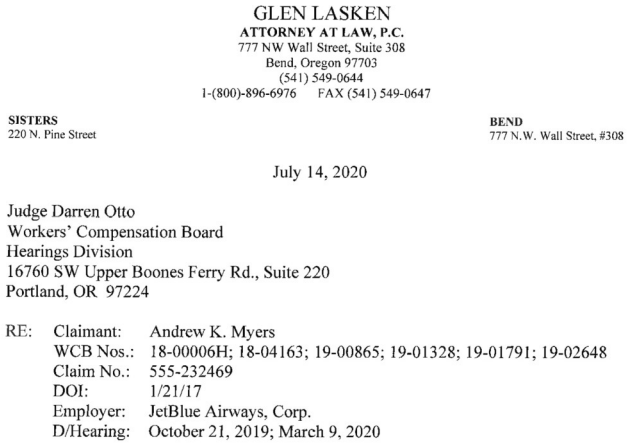
- Williams V Boeing (2011)
- Woods et al V Boeing/ Escobedo V Boeing (2020)

Workers comp (2020)

Andrew Myers/ Jet Blue (Oregon)

→ Successful

Other ongoing: E.g. Unite (UK)



GLEN LASKEN
ATTORNEY AT LAW, P.C.
777 NW Wall Street, Suite 308
Bend, Oregon 97703
(541) 549-0644
1-(800)-896-6976 FAX (541) 549-0647

SISTERS
220 N. Pine Street

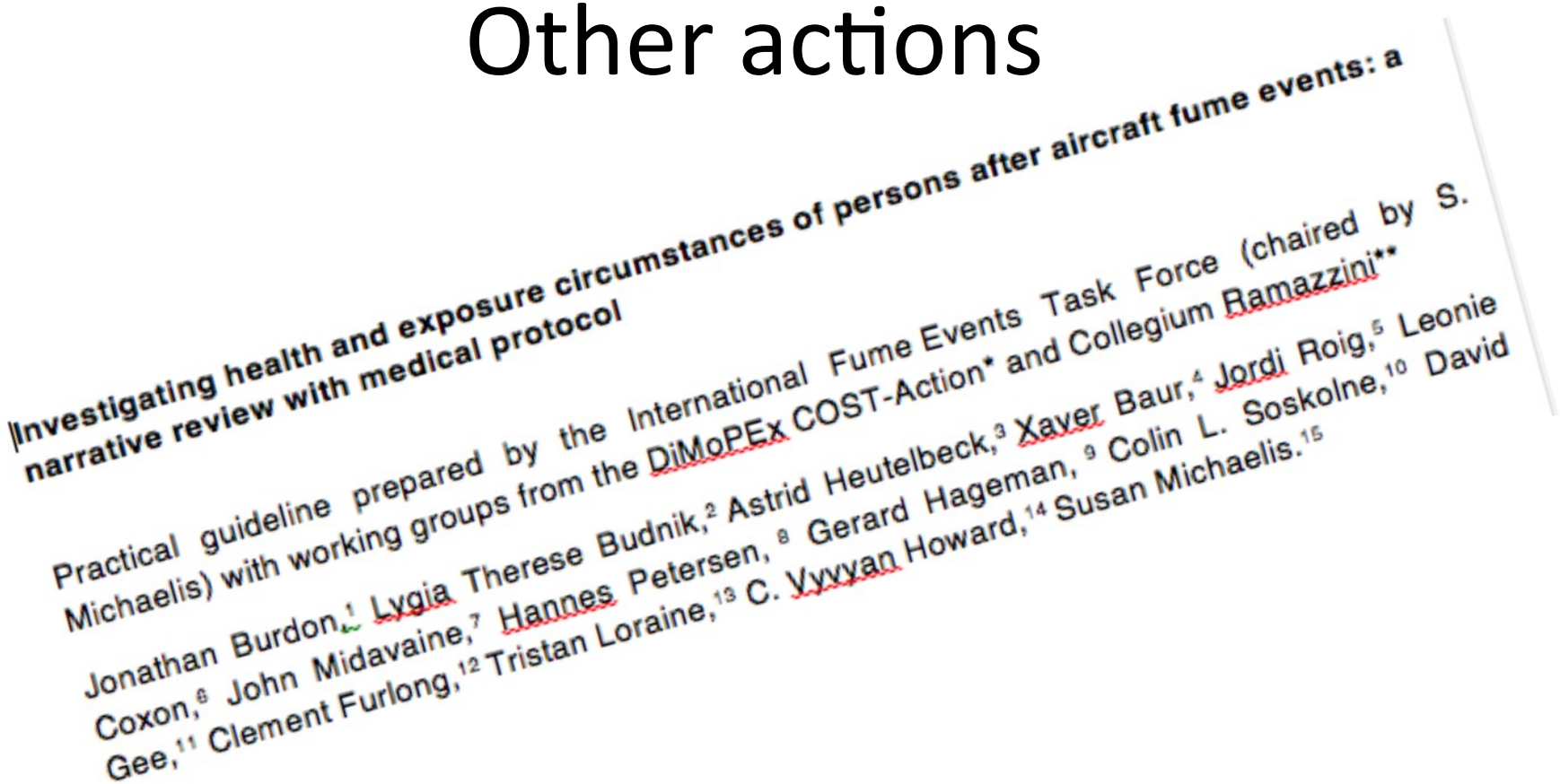
BEND
777 N.W. Wall Street, #308

July 14, 2020

Judge Darren Otto
Workers' Compensation Board
Hearings Division
16760 SW Upper Boones Ferry Rd., Suite 220
Portland, OR 97224

RE: Claimant: Andrew K. Myers
WCB Nos.: 18-00006H; 18-04163; 19-00865; 19-01328; 19-01791; 19-02648
Claim No.: 555-232469
DOI: 1/21/17
Employer: JetBlue Airways, Corp.
D/Hearing: October 21, 2019; March 9, 2020

Other actions



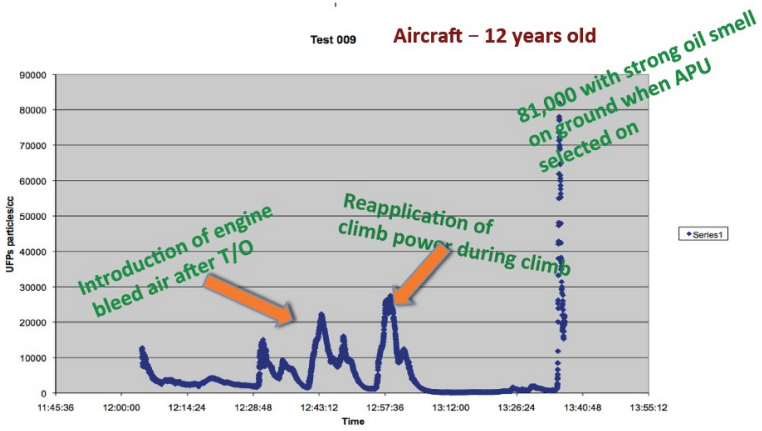
Investigating health and exposure circumstances of persons after aircraft fume events: a narrative review with medical protocol

Practical guideline prepared by the International Fume Events Task Force (chaired by S. Michaelis) with working groups from the DiMoPEx COST-Action* and Collegium Ramazzini**

Jonathan Burdon,[1] Lygia Therese Budnik,[2] Astrid Heutelbeck,[3] Xaver Baur,[4] Jordi Roig,[5] Leonie Coxon,[6] John Midavaine,[7] Hannes Petersen,[8] Gerard Hageman,[9] Colin L. Soskolne,[10] David Gee,[11] Clement Furlong,[12] Tristan Loraine,[13] C. Vyvyan Howard,[14] Susan Michaelis.[15]

University of Washington (TAP biomarkers) – C Furlong
University of Augusta – A. Terry (non cholinergic mechanisms/ LL chronic ex to OPs)
University of Kansas – B Jones - Pyrolysed oil generates UFPs- normal ops
Duke University - M Abou-Donia – Glial autoantibody neuronal research
Harvard- Breast cancer: +66% in crew/ all cancers in female crew 115%
International conferences/films, documentaries/ filter & sensor development….

UFPs- causal mechanism for AS?



The Nature of Particulates in Aircraft Bleed Air Resulting from Oil Contamination

Byron W. Jones, PhD, PE *Fellow ASHRAE*
Shahin Nayyeri Amiri, PhD
Jake W. Roth
Mohammad H. Hosni, PhD *Fellow ASHRAE*

Nanomedicine and Nanoscience Research
Review Article
Howard CV, et al. J Nanomed Nanosci: JNAN-139.
DOI: 10.29011/JNAN-139. 100039

Is a Cumulative Exposure to a Background Aerosol of Nanoparticles Part of the Causal Mechanism of Aerotoxic Syndrome?

C. Vyvyan Howard[1*], David W. Johnson[2], John Morton[3], Susan Michaelis[4], David Supplee[5], Jonathan Burdon[6]

-Predominantly carbonaceous UFPs formed in engine, 1,500 C (bearings transient temps up to 30,000 C)
-Surface chemistry will lead to attachment of cresyl phosphates, and other moieties
-UFPs have maximal deposition in the alveoli, where a proportion cross the air-blood barrier by endocytosis
-UFPs can act as 'Trojan Horses' to cross the Blood Brain Barrier, thus carrying their chemical coatings directly to the brain
Over a 20,000 hour career this represents a cumulative dose of toxicological significance

Relative toxicity of O-CP isomers[1]

Tricresyl Phosphate: Toxicity of Isomers

Isomer	Concentration		Toxicity	
	Absolute (ppm)	Relative to TOCP	Relative to TOCP	Equivalent
TOCP	0.005	1	1	1 ×
DOCP	6	1,200	5	6,000 ×
MOCP	3070	614,000	10	6,140,000 ×
			Total	**6,146,001 ×**

TCP isomers in aircraft ducting [2]

Table 1 Identity and Quantity of Phosphorous Containing Compounds in Solvent Extracts of Ducts 2, 3 and Oil Samples

Sample	Dstl Laboratory Sample Number	Concentration of TCP (μg/g Oil or Duct)		
		Ortho-isomer	Meta-isomer	Para-isomer
Exxon turbine oil		0.002	0.138	0.044
Pre-test oil from Pyestock trial		0.001	0.137	0.044
Post test oil from Pyestock trial		0.001	0.145	0.044
Engine oil from aircraft		0.002	0.149	0.047
Duct 1, hexane extract	0206846r01	<LOD	<LOD	<LOD
Duct 1, dichloromethane extract	0206846r02	<LOD	<LOD	<LOD
Duct 1, methanol extract	0206846r03	<LOD	<LOD	<LOD
Duct 2, hexane extract	0206847r01	0.6	28.1	0.8
Duct 2, dichloromethane extract	0206847r02	0.8	39.4	1.4
Duct 2, methanol extract	0206847r03	0.5	23.1	1.1
Duct 3, hexane extract	0206848r01	0.9	68.1	3.5
Duct 3, dichloromethane extract	0206848r02	0.6	55.8	7.1
Duct 3, methanol extract	0206848r03	0.6	44.7	3.1
Duct 1, ASE/dichloromethane extract	0206846r04	<LOD	<LOD	<LOD
Duct 2, ASE/dichloromethane extract	0206847r04	0.9	35.8	2.5
Duct 3, ASE/dichloromethane extract	0206848r04	1.0	67.4	8.1

<LOD concentration less than 0.001 μg/g duct

1. Winder C, Balouet JC (2001). Toxicological And Occupational Hygiene Aspects Of Aerotoxic Syndrome. In: *Conference of the Australian Institute of occupational hygienists- 19th Annual Conference: The evolving face of occupational hygiene, Novotel, Northbeach, Wollongong, 1-5 Dec, 2001*. 2001, pp. 1–5.

2. CAA (2004) Cabin air quality

Risk assessments inadequate

- Current regulatory/industry risk assessments do not acknowledge any of the literature showing irreversible changes induced by OPs.
- This has been reviewed by Terry (2012, 2018) and demonstrates a major effect of repeated low dose exposure to OPs on axonal transport
- The assumption that all effects of OPs are reversible is untenable – some toxicological damage will be both cumulative and irreversible

Terry et al. (2012) Pharmacol Ther. Functional Consequences of Repeated Organophosphate Exposure: Potential Non-Cholinergic Mechanisms.) Pharmacol Ther. 134 93) 355-365
Naughton, Terry et al. (2018) Neurotoxocity in acute and repeated OP exposure. Toxicology. 408:101-112

CR contribution

- CR clinicians have been central to the development of a Medical Protocol, giving advice on how to deal with ‘fume event’ patients
- There is a need to have Aerotoxic Syndrome officially recognized as an occupational disease. Guidance by CR in achieving this through Codex Alimentarius would help

Main points

- There is a basic design fault in nearly all commercial aircraft – the cabin breathing air comes from the engine compressor
- This air has been shown to contain a complex mixture of OPs at low levels and UFPs
- It is toxicologically plausible that chronic repeated exposure to this mixture would lead to the clinical picture seen in some aircrew.
- Current risk assessments are inadequate