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Review: John Hoytes, *Aerotoxic Syndrome: Aviation's Darkest Secret*, Pilot Press, London, UK, 2014

Pages: 253

Seminal Work on the Great Mile-High Crime

History truly repeats itself, especially in the corporate world with the cover up of 'harmless' VOCs in cabin air, just like tobacco smoke never caused cancer.

Some may see this as a 'fringe' health issue as they're not frequent flyers, however, as the author points out (and statistics warn), *any* flight may result in a so-called 'fume-event' (FE). during which neurotoxic engine oil byproducts are pumped into the cabin air system. In as little as *fifteen* seconds irreparable damage may be done, or worse, pilots taken out and a major incident. And for non-flyers chances are they no someone who *does* fly who could be saved by having informed consent reading this book.

Hoyte covers all aspects: disease etiology, chemistry, bleed-air design, safety systems, legal cases, and politics involved.

The worrying conclusion is, unless you're on a bleed-free air system in a Boeing 787, you may be victim to a silent but deadly FE unless armed with basic precautions like a carbon filter mask.

Caveat viator aereus!

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Foreword (pp. xv-xvi)

Lawyers can argue cause might lie elsewhere; such a 'negative' is difficult to disprove. The parallel is to the tobacco industry and damaged smokers.

I) A Pilot Walks (pp. 1-3)

Airfields are safety ranked as A, B, or C.

Commercial pilots who pull out of flights over safety concerns are punished by their bosses.

II) Flying Makes People Ill (pp. 4-14)

Pilots are expected to fly even if they know they aren't well enough.

The A340 is notorious for fume events; engine starts are notorious times for these.

Pilot 'shirt test' test positive for tricresyl phosphate (TCP) residue, an organophosphate oil and hydraulic fluid additive.

40% of people have livers which can't process TCP which for 3% is fatal.

A ketogenic diet is claimed to remyelinate damaged peripheral nerves; medium-chain triglycerides like coconut oil are recommended.

"If I mentioned that health problems were related to oil, I wouldn't get my income payments … it was safe to admit to chronic fatigue … but not to mention chemical issues." [p13]

III) Depression, Fatigue – and Cancer (pp. 15-17)

Of a 1,008-airline staff study, 23% had no sick leave and 25% long-term sickness. The top major disorders were: depression; IBS; Chron's disease; high BP; high cholesterol; [soriasis; insomnia; and migraines.

Flight attendants rank 88/100 on the contaminated job scale.

IV) A Syndrome (pp. 18-20)

V) The Aircraft Air (pp. 21-26)

To be breathable, air must be pressurised at altitude to raise O_2 concentration.

Engine air intake is passed along hot engine parts and picks up vaporised engine oil chemicals. Designers use seal to prevent this, but they often fail.

HEPA filters are integrated in the cabin air system, but these don't block VOCs from bleed air since it's too hot. Carbon filters could be used but aren't due to cost.

There are 0.86 fume vents (FE) per day in the U.S.

V) Organophosphate Poisoning: a Long History (pp. 27-30)

OP may lower cholinesterase.

Seals leak by design for cooling, wear-and-tear, and failure.

OPs were originally chemical warfare agents like Sarin gas. They cause uncontrollable muscle movement.

OPs are insecticidal.

3-5% of jet-engine oil is TCP.

Symptoms include weakness in shoulder, neck, and upper leg and influenza.

VII) Not Waving But Wading (pp. 31-35)

VIII) The Tombstone Imperative (p.36)

"The Tombstone Imperative is the day-to-day reality of working for low-cost airlines."

IX) The Size of the Problem (p. 37)

0.05% of flights have FEs.

An airline who agrees to an audit will take unusual maintenance measures which biases (understates) the problem.

X) Symptoms and Syndromes (pp. 38-40)

A psychosomatic illness is never proven.

XI) <u>All in the Mind?</u> (pp. 41-51)

Pilot Len Lawrence recorded his first FE 11/29/1991 … during its takeoff … the flight deck suddenly filled with hot acrid fumes … he and his captain … Their skin was burning and they found it difficult to breathe ...The whole fume incident lasted … 15s. Len's last recorded fume event occurred in 2004 ... Although evidence of breathing toxic fumes was made known to the psychiatrists to whom he was referred, they chose not to consider this option and instead to diagnose him with a mental illness … Len was effectively 'held captive' as a mental patient for almost 18 months, heavily medicated, during which time most of his assets were disposed of. At last, the 5th psychiatrist … referred [him] for … treatment for poisoning by … tricresyl phosphate." [pp41,42]

XII) <u>The Airline Response</u> (pp. 52-54)

XIII) <u>Red Alert</u> (pp. 55-57)

A No. 3 engine bleed air valve was brand new and engineers had forgot to remove its protective oil coat before fitting it.

XIV) <u>Incidents Across the World</u> (pp. 55-62)

The CCRU made little progress after a decade of research. A 1950 critical review found: no clear definition of the common cold (CC) existed; the CC had no objective diagnosis; CC symptoms were broad; and many factors were causative.

XV) <u>Captain's Discretion</u> (pp. 63-69)

Scheduling pressure and efficiency emphasis are relentless in the industry.

Plying on three engines Is legal but risky.
"There's a very strong ethos that you 'get the mission done' regardless." [p66]

XVI) <u>Passing the Medicals</u> (pp. 70-74)

A 'sterile cockpit' should prevail under 10K ft, i.e., all communications must be restricted to take-off or landing.

XVII) To Report or Not to Report (pp. 75-77)

Reporting is problematic since only 3.7% of FEs are reported: airliners don't have air quality sensors fitted; no one likes costs and extra work associated with declared emergencies; complainants are labelled 'troublemakers'.

XVIII) Problem? What Problem? (pp. 78-80)

XIX) The End of a Career (pp. 81-84)

XX) Evidence? What Evidence? (pp. 85-90)

XXI) Real Causes, Real Research (pp. 91-94)

XXII) Real Media Attention (p.96)

XXIII) Victims in High Places? (p.97)

BAe engineers added perfume to APU oil to try and disguise any FE smells!

XXIV) The Aerotoxic Association (pp. 98-99)

XXV) Is There a Cure? (p.100)

XXVI) How Common Is it? (pp. 101-104)

'Jamaica Ginger' was was sold as a medicine to get around prohibition; it was alcohol with TCP added. Nerve damage would cause drinks to life their legs high and avoid dragging them on the ground.

XXVII) A Cover-Up (pp. 105-107)

XXVIII) The Experiences of Relatives: a Widow and a Divorcee Tell Their Tales (pp. 108-112)

"In retirement no one wants to know you." [p112]

XXIX) Balance? (pp. 113-114)

XXX) The Deniers (pp. 115-121)

XXXI) The Deniers Denied (p. 122)

XXXII) Case Study: Julian Soddy (pp. 123-124)

Starting up the AUPs (Auxiliary Power Units) would belch out smoke into the cockpit.

“I had severe flu-like symptoms every time I flew and they just became worse … I had headaches and shortness of breath … there are more pilots around than jobs, so people are not keen to talk.” [p124]

De-icing fluid fumes also pass into jet engine intakes.

XXXIII) The Cranfield Study (pp. 125-137)

[Semi]VOCs, CO, and particles are the main hazards.

n=100 non-random flights: “no fume events ever occurred”.

Tenax TA porous polymer resin for trapping compounds is designed for apolar molecules, not polar OPs.

Peak flight particles can reach 500K particles cm^{-3}.

N-phenyl-α-napththylamine (PAN) is one oil carcinogen.

Cabin pressure is ~750-750 millibars of ~2.3K m altitude. Humidity is only 5% of normal air and dehydration makes OP poisoning (OPP) worse.

TOP has been found on 14% of flights, TCP 23% and tributyl phosphate on 73%. TBP is highest during engine startup.

XXXIV) A Safe Limit? (pp. 138-139)

OPs are lipophilic.

Pilots, farmers, and Gulf War veterans all have OPP symptoms.

XXXV) <u>Scripts and Framing</u> (pp. 140-146)

XXXVI) <u>Holidays to Hell</u> (pp. 147-150)

XXXVII) <u>What Happens in Court?</u> (pp. 151-158)

Hair loss and lethargy are also OPP symptoms.

Joanne Turner's East-West Airline flight to Brisbane, 1992: "About 20 minutes, smoke was emitted into the cabin … coughing, a burning throat, sore eyes and a headache."

B737s all tested positive for TCP (155 ngm^{-3} peak concentration).

Four common OPP themes:

1. Initial good health becomes mysteriously compromised.

2. Causal link between toxic oil fumes and symptoms.

3. Ignorant state-sponsored doctors.

4. Victims seeking tests to prove exposure.

XXXVIII) <u>Sample Sizes and Research Agreements</u> (pp. 159-168)

44% of pilots have short-term ill health, 32% long-term, and 13% lost their licence.

Autoantibodies are an OPP damage biomarker.

Chronic sinusitis, dizziness and neuro-cognitive deficits are more OPP symptoms.

TBP, tris (2-chloroethyl) phosphate (TCEP) and triphenyl phopshate (TPP) are still all absorbed even when no FEs are recorded.

The first captain Dr Julu saw was accused of malingering.

XXXIX) <u>A Lack of Conclusive Evidence?</u> (pp. 169-171)

XL) <u>An Export of Chemical Poisoning Comments</u> (pp. 172-173)

OPIDN (organophosphate-induced delay neuropathy) can take up to two weeks to manifest.

XLI) <u>Jet-Lagged, Travel Fatigued or Poisoned?</u> (pp. 174-175)

XLII) <u>What the Airlines Know</u> (pp. 176-180)

George Bates, Boeing Environmental Controls, email: 10/26/2007"GE and Rolls Royce engine specs do not mention bleed air quality … Engine Specs are the hole no one has addressed … Who knows what the by-products are in hot synthetic Turbine Oil … I think we are looking for a tombstone before anyone with any horsepower is going to take interest." [pp178,179]

XLIII) <u>Pressure on Politicians</u> (pp. 181-182)

"There are millions if not billions at stake in fixing the problem." [p181]

XLIV) <u>A Good Look at a Dissenter</u> (pp. 183-204)

CO is not usually among turbine engine products of combustion.

20-40% of student aircrew suffer hyperventilation.

TCP on most craft is 3% of oil, and ToCP 0.2% of this.

IOELV: Indicative Occupational Exposure Limit Value is 100μgm^{-3} for TCP.
Lung alveolar membrane is 0.5-1.0μ thick and 400m alveoli provide a large surface area. The body circulates are 12-15 times min^{-1} and pulmonary blood 3.5-5L.

XLV) <u>The Attitude of Doctors</u> (pp. 205-207)

XLVI) <u>Do We Need More Research?</u> (pp. 208-209)

XLVII) <u>Hot Off the Press: A Crucial Report</u> (pp. 210-212)

Industry overlooks combined effects of multiple exposures, repeated low-dose exposure, and genetic predispositions to OPP.

XLVIII) Airbus on Bleed Air, 2014 (p. 213)

Bleed air used to pressurise fuel tanks is filtered, as it is imperative oil doesn't mix with fuel. Only bleed air passed to passengers is not filtered! [p213]

XLIX) How to Stop the Problem in Future (pp. 214-217)

Catalytic filter install, and separate cabin air compressor from free stream ram air is ideal.

1. No new aircraft to be designed with bleed air systems. Like the B787, whose APU is even bleed-air free.

2. All aircraft engine bleed air fitted with filters.

3. Raise awareness: many aircrew are ignorant of bleed air contamination and FE risks.

4. Develop a safe alternative engine oil.

5. Monitor cabin air quality in real time.

6. All craft should have activated charcoal face masks available.

L) A Safety Demonstration With a Difference (pp. 218-220)

Every flight could theoretically become an FE flight.

Drop-down O_2 masks are useless since they mix in cabin air (only the cockpit has pure O_2). Supply also only lasts 20min, whereas a long-haul flight may be 17 hours!

LI) What Sufferers Should Do (pp. 221-223)

Every flight could theoretically become an FE flight.

Epilogue (pp. 224-230)

Every flight could theoretically become an FE flight.