

AEROTOXIC SYNDROME: ADVERSE HEALTH EFFECTS FOLLOWING EXPOSURE TO JET OIL MIST DURING COMMERCIAL FLIGHTS

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Abstract

Materials used in the operation of aircraft may contain hazardous ingredients, some with significant toxicities, and need care in handling and use. Some maintenance or operational activities, such as leaks or poorly controlled maintenance procedures, can, through contamination of aircraft cabin air, produce unwanted exposures to personnel and passengers. Occasionally, such exposures (either short term intense or long term low level) may be of a magnitude to induce symptoms of toxicity. The symptoms reported by exposed individuals are sufficiently consistent to indicate the possibility of a discrete occupational health condition, termed aerotoxic syndrome. Features of this syndrome are that it is associated with air crew exposure at altitude to atmospheric contaminants from engine oil or other aircraft fluids, chronologically juxtaposed by the development of a consistent symptomatology of irritancy, sensitivity and neurotoxicity. This syndrome may be reversible following brief exposures, but features are emerging of a chronic syndrome following moderate to substantial exposures.

Introduction

Aircraft materials such as jet-fuel, de-icing fluids, engine oil, hydraulic fluids, and so on, contain a range of ingredients, some of which can be toxic. Although these chemicals are usually retained in engines and equipment into which they have been added, they can sometimes find their way into cabin air where crew and passengers are located, through incidents such as engine oil leaks, seal failures and fluid ingestion by APU/engines. Further, operational activities, such as APU "pack" burn outs, can give rise to significant contamination.

Dozens of in-cabin leak/smoke events are documented annually, often correlated to aircraft fluid leak events. Fume events are much more frequent, correlated to less important aircraft fluid leaks (hundreds per year), or to other independent sources. In total, aircraft fluid leak/fume/smoke events are estimated to impact over 300 flights per year worldwide, resulting in exposures to an estimated 40,000 or more crew and passengers. Some models of airplanes appear to be particularly prone to leaks.

The range of bleed air contaminants and their concentrations, which may be found during in-cabin contamination events during flight, can be extensive. Significant contaminants include: carbon monoxide, aldehydes; aromatic hydrocarbons; aliphatic hydrocarbons; chlorinated, fluorinated, methylated, phosphate, nitrogen compounds; esters; and oxides. One additional problem is the lower oxygen concentration operating in the cabins of planes flying at altitude.

Inhalation is an important route of exposure, with exposure to uncovered skin being a second, less significant route (for example, following exposure to oil mists) and ingestion improbable.

In terms of toxicity, a growing number of crew are developing symptoms following both short term and long term repeated exposures. Neurotoxicity is a major flight safety concern, especially where exposures are intense.

Symptoms

Symptoms have been collected from ten cases of pilots, first officers, pursers and flight attendants, flying in five airlines, three models of airplane and in four countries. The only common feature is that at some stage, they were involved in an incident where a leak of oil mist to the flight deck or passenger cabin occurred.

Symptoms were reported from single exposures to elevated exposures, and from long term low level exposures to low level oil leaks or residual problems from previous contamination. Combined exposures (that is, short term intense exposures combined with low level long term exposures) were also prevalent.

Symptoms from single or short term exposures are shown in Table 1 below and include: blurred or tunnel vision, disorientation, memory impairment, shaking and tremors, nausea/vomiting, parasthesias, loss of balance and vertigo, seizures, loss of consciousness, headache, lightheadedness, dizziness, confusion and feeling intoxicated, breathing difficulties (shortness of breath, tightness in chest, respiratory failure), increased heart rate and palpitations, nystagmus, irritation (eyes, nose and upper airways).

Table 1: Aerotoxic Syndrome – Symptoms, Intensity and Chronological Sequence

Symptom	Imme- diate	Post- flight	Short term	Medium term	Long term
Seizures, "gray outs", unconsciousness	✓✓	✓			
Disorientation	✓✓	✓✓	✓		
Loss of balance	✓✓	✓✓	✓	✓	
Problems with coordination	✓✓	✓✓	✓✓	✓	
Headache, lightheaded, dizziness	✓✓	✓✓	✓✓	✓✓	✓✓
Weakness, fatigue, exhaustion	✓✓	✓	✓	✓	✓
Chronic fatigue			✓	✓✓	✓✓
Cognitive problems	✓	✓	✓✓	✓✓	✓✓
Numbness, hot flashes	✓✓	✓✓	✓	✓	
Shaking/tremors, fasciculations, nystagmus	✓✓	✓✓	✓	✓	✓
Irritation of eyes, nose and throat	✓✓	✓			
Nausea, vomiting	✓✓	✓✓			
Blurred vision, tunnel vision	✓✓	✓	✓		
Respiratory problems	✓✓	✓			
Chest pain	✓✓	✓			
Increased heart rate, palpitations	✓	✓			
Joint pain, muscle weakness, salivation	✓	✓			
Rashes, blisters (uncovered body parts)	✓	✓✓	✓		
Loosing hair (2 cases of severe exposure)		✓	✓		
Immunodepression			✓	✓	
Acquired Multiple Chemical Sensitivity				✓	✓✓

Key to Exposure Intensity:
 ✓ Mild intensity and/or symptoms occur occasionally
 ✓✓ Severe intensity and/or symptoms present continuously

Key to Column headings:
Immediate: minutes to hour, during or soon after exposure
Post-flight: hours to days
Medium term: weeks to months
Short term: days to weeks
Long term: months to years

Symptoms from long term low level exposure or residual symptoms from short term exposures include: memory impairment, forgetfulness, lack of coordination, nausea/vomiting, diarrhoea, respiratory problems, chest pain, severe headaches, dizziness and feeling intoxicated, weakness and fatigue (leading to chronic fatigue), exhaustion, increased heart rate and palpitations, numbness (fingers, lips, limbs), hot flashes, joint pain, muscle weakness and pain, salivation, irritation (eyes, nose and upper airways), skin itching and rashes, skin blisters (on uncovered body parts), signs of immunosuppression, hair loss, chemical sensitivity leading to acquired or multiple chemical sensitivity (see Table 1).

It is also apparent that some symptoms occur immediately or soon after exposure, for example, many of the irritant, gastric, nervous and respiratory effects. However, others, such as nervous system impairment, immunodepression and chemical sensitivity, develop later, perhaps months after exposures may have ceased. Further, while some of these symptoms are fully reversible, others appear to persist for longer (see Table 1). Debate is also continuing about the links between exposure and some of longer term symptoms (such as chemical sensitivity).

Symptom severity depends on a number of factors, including the range of contaminants present, the intensity, duration and frequency of exposure, toxicity of compounds (expectedly influenced by cabin environment factors such as humidity, decreased oxygen concentration and contaminants such as carbon monoxide), and individual

susceptibility.

While single/long term exposure to aircraft engine lubricants and hydraulics (basically due to their chemical content and possible thermal decomposition products) is diagnosed as responsible for the aerotoxic syndrome, air crew or passengers exposed to same events or similar doses do not necessarily develop same symptom severity. The variation in symptoms severity is attributed to individual susceptibility, including anaphylactic response, may also depend on other potentiation factors, including prior exposure events.

Aerotoxic Syndrome

The symptoms reported by exposed individuals as shown in Table 1 are sufficiently consistent to indicate the development of a discrete occupational health condition, and the term aerotoxic syndrome is introduced to describe it. Features of this syndrome are that it is associated with air crew exposure at altitude to atmospheric contaminants from engine oil or other aircraft fluids, chronologically juxtaposed by the development of a consistent symptomology of irritancy, sensitivity and neurotoxicity. This syndrome may be reversible following brief exposures, but features are emerging of a chronic syndrome following significant exposures.

Management of Occupational Health and safety in the Aviation Industry

It has become apparent that the primary safety consideration of the airlines is to keep airplanes flying - the safety of workers appears to have a very low priority to operational safety. Further, the regulatory agency involved in aviation safety (the Civil Aviation Safety Authority) admitted in evidence to the Senate Aviation Inquiry that its area of responsibility is airplane safety, not occupational health and safety.

Monitoring studies conducted by aircraft manufacturers and the airlines have failed to detect any major contaminants, although to date most monitoring studies have used inappropriate sampling techniques (such as air collection of poorly volatile contaminants) or inadequate methodologies (such as sample collection time, sample volume, storage of samples, not taking account of altitude). No monitoring has been conducted during a leak incident

Attempts by airlines to address this problem through design, maintenance and operational improvements and through staff support and medical care have not been successful, and in the main, continue to be reactive and piecemeal. Obviously, in some cases, options such as improving engine design are not within the sphere of activity of the operators. The efficacy of recent modifications to the aircraft remains unknown, and leaks are still occurring, albeit at a reduced rate.

An admission was grudgingly made by one airline in 1998 that adverse exposures had been occurring, and that such exposures might cause irritation and transient effects. However, the development of long term symptoms is vigorously denied.

Civil aviation regulations clearly state that "the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crew members to perform their duties without undue discomfort or fatigue and to provide reasonable passenger comfort." The admission that irritation and transient symptoms can occur demonstrates non-compliance with the above rules.

Further, the adversarial and acrimonious manner in which some airlines have pursued workers compensation cases brought by staff with aerotoxic syndrome indicates a confrontational approach which is unlikely to be beneficial to all parties in the long term.

Conclusions

Direct exposure to hydraulics and lubricants are known to be toxic, causing effects such as blurred vision, disorientation, memory loss, lack of coordination, nausea, that if they occurred in flight crew, are direct threats to flight safety. Further, there is factual evidence that flight deck, cabin crew and passengers can be directly exposed to trace chemicals on aircraft in sufficient concentrations to cause acute, immediate to long term symptoms.

These exposures can produce symptoms of toxicity. Symptoms associated to the aerotoxic syndrome clearly include neurotoxicity as neuropsychological effects, as well as other symptoms typically correlated to chemical intoxication. Links between neurotoxic effects and certain contaminants known to be neurotoxic (such as the phosphate esters) are suspected.

Aerotoxic syndrome presents significant issues with regard to the health of pilots, cabin crew and passengers, but most notably with regard to air safety if pilots are incapacitated and cabin crew cannot supervise cabin evacuations during emergencies. Health effects include short term irritant, skin, gastrointestinal, respiratory and nervous system effects, and long term central nervous and immunological effects. Some of these effects are transient, others appear more permanent. The exacerbation of pre-existing health problems by toxic exposures is also highly probable.

This is a hidden issue. Staff of the airlines are worried about job security and what might happen to them if they complain about working conditions and make their symptoms public. At present, with only a few cases proceeding in the courts, little compensation has been awarded to airline workers affected by toxic fumes. Therefore, staff are reluctant to come forward until their health is jeopardised sufficiently that they can no longer fly without compromising their health and safety.