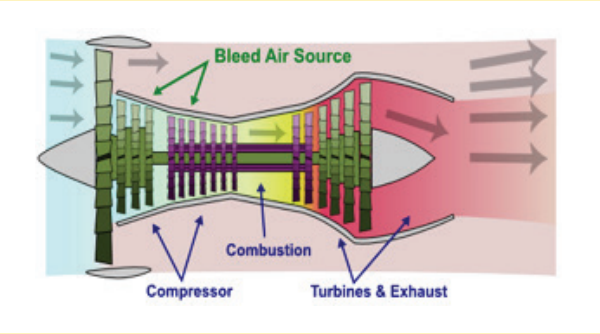
Onboard Fume Events

HEALTH AND SAFETY FACT SHEET

CUPE Canadian Union of Public Employees

When flying at altitudes higher than 8,000 feet, airplanes need to pressurize the interior cabins to allow passengers to breathe normally. Most jet-propelled airplanes achieve this pressurization by "bleeding" a small percentage of highly pressurized air from within the engines into the air circulation of the internal cabin (the exception of this is the Boeing 787).



[1]**Figure:** shows air entering the front of the engine where a series of turbines compress, warm and pressurize the air before it passes into the combustion chamber where it is ignited to create the airplane's thrust. This "bleed" air is drawn out of the engine into the cabin after it is pressurized, but before the combustion chamber.

What are the hazards of "bleed" air?

Bleed air is supposed to be fresh, clean, air taken from the compressor section of the engine before it is mixed with fuel or exhaust gasses. However, it isn't always "clean."

Synthetic lubricants with special heat-resistant additives are used to keep moving parts in a jet engine at a cool operating temperature. If there is a malfunction, the lubricating oil or other chemicals such as de-icing fluid can be pulled into the bleed air and fed directly into the aircraft cabin. Even engines under the strictest of maintenance schedules can malfunction or break down. Additionally, the seals inside engines can lead to low doses of exposure because of the way many of them are designed.

At elevated temperatures, such as those found inside a jet turbine, the additives in these products can degrade and become converted into a fine mist or fumes that becomes part of the air in the cabin. There is no filtration equipment currently onboard standard commercial aircraft designed to remove these toxic fumes before or after they enter the cabin.

It has been known for more than 60 years that the malfunctioning of an engine can introduce unwanted chemicals into the cabin and result in acute exposure. This is commonly known as a "fume event." A recent World Health Organization publication breaks down all the different chemicals that are in an engine before the combustion chamber.

"Turbine engines utilize synthetic lubricants that generally include an ester base stock (95%), a wide variety of triaryl phosphates (TAPs), organophosphate (OP) anti-wear additives (around 3%), amine antioxidants and proprietary ingredients (1–2%). The commercial formulation of the OP additive is generally cited as tricresyl phosphate (TCP). Exposure of such substances to extreme temperatures generates a large number of pyrolysed [decomposed through heating] compounds and hydrocarbons. Hydraulic fluids are made up primarily of tributyl phosphates

[1] Image: Polski: Schematyczny diagram https://commons.wikimedia.org/wiki/File:Turbofan_operation.svg

(TBPs) and triphenyl phosphates, while de-icing fluids consist of ethylene and propyl glycols."[i]

How to recognize exposure

While not all odours on an airplane are hazardous, it is crucial that airline crew, both pilots and flight attendants, understand what to look for and how to report concerns to ensure flight safety and the health of all on board. As a guideline from the International Civil Aviation Organization (ICAO) notes, "often, oil fumes do not smell like oil. Instead, they are typically described as smelling like dirty socks/smelly feet, foul, or musty. Hydraulic fluid often has a distinctive and recognizable odour that is often described as acrid." In many cases, due to ventilation system design, one air conditioning pack supplies air to the forward cabin and the other supplies the back. This means that a crew could be begin experiencing a fume event at one end, long before it become apparent to crew working the other end. Communication is key.

Complicating recognition is the fact that odour is subjective; different people can experience and describe the same fumes differently. One flight attendant might describe an odour as "old cheese" – but it may smell like dirty socks to someone else. Still, aircraft maintenance manuals and manufacturer bulletins consistently and clearly associate odours described as "dirty socks," "musty," "moldy," or "old cheese" with the presence of engine oil fumes. Regardless of how they're described, the presence of any such odours matters and must to be investigated. Other indications of a fume event are mist or smoke in the cabin and the quick onset of otherwise unexplainable symptoms (see section below).

It should also be noted that the phenomena of olfactory fatigue reduce a person's ability to detect odours over time (as little as three minutes). So just because a flight attendant can no longer sense the smell, doesn't mean it has passed.

Training

If fumes are coming from the cabin air vents and are consistent with the presence of either oil or hydraulic fluid, they may pose a hazard. For that reason, it is appropriate to recognize and respond to the presence of air supply system-sourced fumes. To be able to do that, flight attendants need to be trained. ICAO has issued a guide on what this training should entail: Circular 344: Guidelines on Education, Training, and Reporting of Fume Events (English PDF, French print product available to order). ICAO explains that if an unusual and unpleasant odour is reported either in the cabin or the flight deck, then airline workers should be trained to promptly determine whether the fumes are coming from the air supply vents or from somewhere in the cabin.

Determining what is in the air?

Airlines are not required to monitor cabin air for chemical content. Because of this, it can be very difficult to know what is in the air. Still, there are two things to note when you suspect an onboard fume event: source and odour.

The SOURCE of the fumes provides one clue. Flight attendants should attempt to determine where the smell is coming from (for example, vents or from something inside the cabin).

The specific type of ODOUR is another clue. As previously mentioned, various sources have different smells.

For example, imagine a scenario where the fumes appear to be coming from the vents. There is no obvious fume source in the cabin and the fumes became apparent during climb or descent, or when the auxiliary power unit is run on the ground. In this case, a fume event would be suspected, and the pilots and maintenance workers should investigate the presence of oil or hydraulic fumes in the air supply system. It should be noted that this is event is different than the "diesel" smell that frequently occurs at the start-up of the engines.

What are the results of exposure?

There is significant evidence showing exposure to chemicals through the bleed air is a hazard. In fact, any symptoms that might develop can be clues about the type of chemical that has been released into the air. It is important to document and report all symptoms as this may help substantiate the case that an exposure did in fact occur. This is especially important if additional health concerns arise in the future.

When flight attendants are exposed to hydraulic fumes, they often have a cough and experience burning or irritation of eyes, nose and upper airways, breathing difficulties and feelings of tightness in their chests.

People who breathe oil fumes typically report fewer respiratory issues and more cognitive impairments such as blurred or tunnel vision, headache or light headedness, dizziness, difficulty concentrating, nausea and vomiting. Another common symptom is a metal taste in the mouth, which may last well past the time of exposure. While many of these symptoms are common, not everyone reacts in the same manner, or at the same level.

Longer-term effects of exposure to contaminated bleed air may include damage to the respiratory and central nervous systems, impaired memory and cognitive function, weakened immunity, cardiovascular disorders and possibly cancers. Though flight attendants and pilots are most affected due to higher levels of exposure, passengers are also at risk. Some passengers who are more sensitive to chemicals and toxins may fall ill. Finally, any cognitive impairment of flight crew due to toxic fumes decreases their performance and jeopardize overall airline safety.

"Syndrome" debate calls for precaution

The term "Aerotoxic Syndrome" was first coined in 2000. This has led to much debate as to whether an actual syndrome exists or not. The Merriam-Webster dictionary defines a syndrome as "a group of signs and symptoms that occur together and characterize a particular abnormality or condition." Because it hasn't been recognized in all medical circles, CUPE doesn't use the term.

In CUPE's opinion, it is irrelevant whether symptoms that result from onboard exposure is a formal "syndrome". The evidence toward negative health impacts are significant. The International Civil Aviation Organization (ICAO) acknowledges that fumes in the cabin are a real concern. Their guidelines state, in part, that "there are various types of fumes, smoke, haze and mist that may contaminate the cabin and flight deck air supply system. The outside air may be contaminated with engine oil, hydraulic fluid, engine exhaust, ground service vehicle exhaust, fuel, de-icing fluid, or ozone."

CUPE advocates a precautionary approach. It can be shown that some of the potential chemicals present in a "fume event" are dangerous to human health. For this reason, CUPE calls on manufacturers to work with air operators to reduce exposure of these chemicals to levels that are as low as reasonably achievable. Given current technological advancements, a level of zero may be achievable in many cases, and will hopefully be achievable in all cases in the very near future.

What is a "safe" level of exposure?

Many chemicals have recommended Occupational Exposure Limits (OELs), sometime referred to as Threshold Limit Values (TLVs). However, OELs are not perfect thresholds between when an exposure is safe and when it becomes dangerous. Most OELs are set at a "level that the typical worker can experience without adverse health effects." They are not a "relative index of toxicology[ii]." Most clinical analysis of the chemicals that are believed to be onboard do not consider the synergistic, or multiplier effects on exposure caused by the environmental conditions that workers on an airplane are exposed to.

As such, the specific concentration of fumes that will pose a hazard to flight attendants is not well defined. First, the chemical mixture in the fumes is complex and varies with temperature. Second, additional factors can influence toxicity – such as single acute exposure, or repeated long-term low dose exposure, length of exposure, and whether the cabin is pressurized or is on the ground. And third, certain individual factors – including genetics, sex, endocrine function, liver function and medications – can influence each person's physiological response.

That said, it is known that oil fumes are toxic. First, almost all engine oils used in commercial fleets contain tricresyl phosphates (TCPs) which are toxic to the nervous and reproductive systems. Additionally, most oils contain phenyl napthylamine (PAN), an irritant and potential sensitizer that can impair the oxygen-carrying capacity of red blood cells. Some oils contain trixylenyl phosphates (TXPs) which are also toxic to the nervous and reproductive systems.

Note, the toxins listed above are only part of a complex mixture of chemicals that includes toluene, formaldehyde, and even carbon monoxide (if the bleed air temperature is hot enough).

Ultimately, this debate of whether an odour is hazardous is unhelpful. Oil and hydraulic fluid fumes should not be in the breathing air supplied to the cabin and flight deck. The breathing air supplied to an enclosed space operated at high altitudes should be clean and free of contaminates. Control measures to prevent exposure to these types of toxic fumes are necessary and justified.

Following the precautionary principle, CUPE contends that the only safe exposure to a toxic chemical is a level of zero. When zero cannot be achieved, it should be made as low as possible.

How to prevent exposure to fume events

CUPE calls on the airline industry to follow the hierarchy of controls to contain the hazard of foreign engine chemicals from entering the bleed air.

The only way to totally ensure that flight crews are not being exposed to contaminated bleed air is to actually change the way pressurized air is brought into the cabin when aircraft are designed. The Boeing 787, for example, uses electric compressors rather than bleed air to supply air to the cabin. If airplane manufacturers simply redesigned their air compression systems, we could eventually remove this hazard.

For the many thousands of planes that will remain in service for years with a traditional bleed system, CUPE calls on manufacturers to work with aircraft operators to fit aircraft with filtration systems that eliminate any potential air contamination before the air enters the cabin. CUPE also urges companies to research and examine the possibility of using chemicals that do not contain the same toxins found in current jet engine operations.

As an interim control measure, airlines could fit modified filters in the existing filtration system to filter out fumes when they do enter the cabin. Additionally, sensors could alert the pilots so that they could shut down the bleed air system on the side where a malfunction has occurred.

Finally, CUPE calls for greater oversight by regulators and supports the ICAO's call for regulatory changes, including a standardized reporting form and standardized mandated crew education. At a minimum, this education should cover:

- Sources and types of on-board fumes
- Odour descriptors and examples to help recognize presence of oil and hydraulic fluid fumes
- How to better determine location/source, type and intensity of fumes
- Potential for impairment
- Procedures to apply in fume events

- Reporting of onboard fumes and other required communications
- Passenger and cabin management
- Post-event procedures
- Applicable documentation

Flight and cabin crew should receive the same fume event training in order to promote efficient recognition, acceptance and communication when fume events do occur.

What to do if a suspected exposure happens

In summary, oil and hydraulic fluid fumes are toxic and can contaminate the ventilation air onboard. However, not all odours are toxic, and not all fumes are sourced to the air supply system. Pay attention to the presence of unusual or unpleasant odours or fumes even if there is no smoke or haze.

Action steps while in-flight

If you believe there is an in-flight incident of exposure to contaminated cabin air:

- Quickly assess whether the fumes seem to be sourced to the air supply vents or to something in the cabin
- Promptly report the presence of fumes if they are coming from the vents to the flight attendant in charge and pilots. You should:
    - Confirm that you ruled out in-cabin items
    - Report what it smells like
    - Report any smoke or haze
    - Report when you first noticed the fumes (for example, when the engine started, at the top of descent, etc.)
    - Report where in the cabin it is most noticeable, and where it is not noticeable (if relevant)
    - Report if anybody is sick or needs medical attention

Remember, if the ventilation air is contaminated with oil or hydraulic fluid fumes, it is a safety-of-flight issue with potentially serious consequences. For that reason, it is okay to call the flight deck to report fumes, even during "sterile flight deck" conditions. If they are unable to answer your call due to operational requirements, call back as they need to know about the situation to be able to take appropriate actions to ensure flight safety.

Action steps after you land and deplane

Take action after you land. CUPE recommends the following steps:

- **Send an email to Air@CUPE.CA to both to receive the most up-to-date documents and guide to obtaining post fume-event care.**
- Report any incident to your company, describing it exactly as it was reported to the pilots above, and fill out your company's injury declaration report, if available.
- Report the incident to your local health and safety committee member. The Union can only work on this issue if it knows the fume events are happening.
- Report the incident to your family physician. Make sure you tell the doctor about how the exposure happened, what you know and how you feel. Remember to avoid industry-specific language (for example, say "exposure to potentially toxic vapors" rather than "fume event").
- Provide the documentation you receive from the email on fume events to your physician. Don't assume that they already know. Most doctors have no training in occupational exposures.
- Seek immediate medical attention if you are experiencing symptoms. At the very least, report the incident to your family physician.

- If fumes came from the vents and odours or symptoms are consistent with oil or hydraulic fumes, then give the doctor the safety data sheets or at least the names of the relevant products. (Mobil Jet Oil II, or Skydrol hydraulic fluid, for example.) These can be obtained from your employer, who must provide them if it is suspected that you may have been exposed to a toxic breathable substance. Your health and safety committee can help if needed.
- Complete a worker's compensation form for the provincial compensation board under which you are based (such as WSIB, CSST, Worksafe). Remember that the long-term effects of fume event exposure are still not completely understood. Even if you are not experiencing significant symptoms now, CUPE recommends following procedures to protect against future losses. Remember that by reporting a workplace illness or accident to the worker's compensation board, you aren't committing to actually taking time off on workers compensation. You are contributing to a permanent record of your work-related health events with the government, which may benefit you down the line.

CUPE maintains that airline operators, manufacturers and Transport Canada must take much more concerted action in eliminating toxic fumes to protect the health of passengers and crew members.

[i] Michaelis, S., Burdon, J., Howard, C.V.; (2017) Aerotoxic Syndrome: A New Occupational Disease? Public Health Panorama, World Health Organization

[ii] 2017 TLVs and BEIs, (2017) American Conference of Governmental Industrial Hygienists, Cincinnati, OH

FOR MORE INFORMATION CONTACT:
CUPE National Health and Safety Branch, 1375 St. Laurent Blvd.,
Ottawa, ON K1G 0Z7 tel (613)237-1590 fax (613) 237-5508 Air@CUPE.CA