

## **Health Impact Of Exposure To Contaminated Supply Air On Commercial Aircraft**

- **Summary:** Outside air is bled off the engines/auxiliary power unit and supplied to the cabin/flight deck on commercial aircraft. Under certain failure conditions, toxicants such as pyrolyzed engine oils and hydraulic fluids may leak into the aircraft cabin and flight deck air supply systems. Airline workers may develop acute and/or chronic health effects and seek attention from health care providers. This quick guide focuses on oil exposures. The complete reference guide is available at [www.ohrca.org/healthguide.html](http://www.ohrca.org/healthguide.html).
  
- **Exposures:** The “bleed air” is not filtered and contaminant levels are not monitored. Airborne toxicants include a complex mixture of oil-based compounds, irritant gases, and ultra-fine particles. Exposures of particular concern include tricresylphosphates (TCPs) and N-phenyl-L-naphthylamine (PAN), and carbon monoxide (CO). The primary exposure pathway is inhalation. Some crewmembers describe low-level chronic exposures to fumes (e.g., routine and transient fumes on engine start up); others describe acute, visible fume events, which may result in a flight diversion or cancellation. Other exposures in the cabin/flight deck include ozone gas, insecticides, deicing fluid, exhaust and fuel fumes, and cleaning products. Also, the cabin altitude is typically 6,000-8,000 feet inflight, with a corresponding reduction in the partial pressure of oxygen.
  
- **Documentation:** Crewmembers submit written reports of smoke, fumes and/or odor to their airline. Aircraft mechanical records and pilot log book entries sometimes document air supply contamination. Health care providers can request Material Safety Data Sheets for the particular oil/hydraulic fluid. Ask for the date, flight number, aircraft number, aircraft type, phase of flight when the problem was noted, whether there was odor or visible smoke/fumes, duration, whether the aircraft was sprayed with insecticides, and any supplementary documentation from the airline/maintenance regarding cause. Obtain past medical history, occupational history, and family/social health history.
  
- **Health Effects:** The most common symptoms reported are acute respiratory, neurological, systemic, and/or psychiatric symptoms. These typically occur within minutes to a few hours following the contaminated bleed air event. Symptoms vary depending on the duration and magnitude of exposure, plus individual factors. Chronic and sometimes delayed neurological, psychiatric, respiratory, systemic, and dermal symptoms have been reported.
  
- **Suggested Case Definition:** There is either a documented exposure to bleed air contaminants or a history of flying on aircraft type(s) documented to have an increased risk of air supply contamination events; and Initial symptoms occur within 48 hours following exposure; and there is objective documentation of acute and/or persistent respiratory, neurological, systemic, or psychiatric symptoms. Note that crewmembers with routine, low-level exposures may also develop chronic symptoms but may not have documented acute, individual exposure events. Symptoms may start many months or years prior to examination by the HCP. Attempt to identify the exposure and make a precise diagnosis (e.g., avoid generic terminology such as “inhalation exposure”) based on a combination of symptoms and objective evidence of health effects (physical examination findings and/or medical tests).

- **Examination:** Evaluate for respiratory effects, with attention to mucous membrane erythema and mucous discharge (upper), and wheezing, rhonchi and crackles (lower). Neurological examination should be performed, with assessment of cerebellar function, tremor and gait disturbance. Neuropsychological screening examination may be useful if symptoms suggest cognitive dysfunction, with assessment of short-term memory function, concentration and color vision loss.
  
- **Lab Data and Other Tests:** A blood test for the TCP additives in aviation engine oils is being developed but is not yet available for routine use. Diagnostic tests include: plasma butylcholinesterase, oxygen saturation, arterial carboxyhemoglobin, \ pulmonary function tests with pre/post bronchodilators, and chest radiograph. There are currently no tests of sufficient sensitivity and specificity to definitively assess exposure or other health outcomes. Preliminary research suggests that tests of the autonomic nervous system and autoantibodies may be useful in evaluating exposure and chronic neurotoxicity
  
- **Treatment:** Promptly remove the individual from the aircraft environment and other airborne contaminants such as diesel exhaust, jet fuel, and cleaning products. Respiratory effects should be treated according to standard protocols for acute chemical inhalation, including aerosolized bronchodilators and supplemental oxygen where bronchospasm and/or pneumonitis are present. The use of intravenous corticosteroids after acute chemical inhalation with bronchospasm may improve prognosis. Following CO exposure, hyperbaric oxygen may be appropriate. As limited treatment options are available for neurotoxic injury, some individuals may seek alternative treatment techniques. Alternative treatments such as vitamin and nutritional supplementation, nebulized glutathione, oxygen therapy, yoga, and sauna detoxification are reported by some patients to be of some benefit. However, these treatments have not been adequately assessed as beneficial in peer-reviewed studies. The HCP should encourage improvement of functional status through exercise, adequate sleep, well balanced diet, and adequate hydration.
  
- **Disability Management:** Prognosis varies widely. Symptoms often improve and resolve within a few weeks. If all respiratory, neurological, systemic, and psychiatric symptoms have resolved, the airline worker can be cleared to return to work on full duty. If symptoms have not completely resolved within two months following one or more contaminated bleed air exposures, the clinician should consider the likelihood that persistent health effects have occurred. Depending on the severity, persistent asthma, neurological problems, systemic symptoms (muscle/joint aches, sensitivity to chemicals, fatigue) and/or psychiatric problems (PTSD, depression, anxiety) may preclude the airline worker from return to his/her usual job. Modified duty (such as a ground job) may be suitable for some crewmembers depending on their functional status.
  
- **Send correspondence to:** Robert Harrison, MD, MPH, University of California, San Francisco, Division of Occupational and Environmental Medicine, 2330 Post Street, Suite 460, San Francisco, CA 94115; Robert.Harrison@ucsf.edu.

*Funding provided by the Federal Aviation Administration Office of Aviation Medicine as part of a collaborative project between the Occupational Health Research Consortium in Aviation (OHRCA) and the Airliner Cabin Environment research (ACER) Center of Excellence.*