Airing It Out

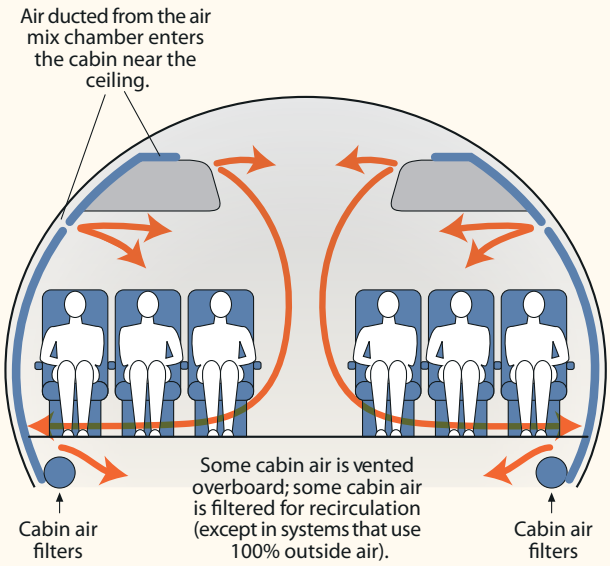
Studies have found no link between cabin air quality and health problems, but some crewmembers and passengers say those studies are wrong.

BY LINDA WERFELMAN

Airplane crewmembers have complained for years about the quality of air on the flight deck and in the cabin. Its uncomfortably low humidity leaves them susceptible to dry skin, eyes and nasal passages, and the dry environment — together with recirculated cabin air — has sometimes been blamed for helping to spread colds and other contagious diseases. Less frequently, complaints have centered on fumes from engine oil, hydraulic fluid or other sources that have permeated the airplane environment, resulting in nausea and respiratory or neurological problems.

The environment of most commercial jet airplanes, like that of an office building, is a mixture of outside air and recirculated air (Figure 1, p. 32). An environmental control system (ECS) maintains temperature, humidity, cabin pressure and ventilation; it also filters harmful contaminants to limit their introduction into

Dominant Cabin Airflow Pattern in Transport-Category Aircraft



Source: Derived from an illustration provided by Pall Corp.

Figure 1

the environment (see "Cabin Climate Control," p. 34). An ECS cannot eliminate all potential problems, however, and many issues have not yet been adequately addressed, the U.S. National Research Council (NRC) said in a 2002 report.[1]

"Environmental factors, including air contaminants, can be responsible for some of the numerous complaints of acute and chronic health effects in cabin crew and passengers," the NRC report said. Nevertheless, the report added, "The complaints tend to be so broad and nonspecific and can have so many causes that it is difficult to define or discern a precise illness or syndrome."

Dry Air and Dirt

A 2006 report based on a survey, conducted in 2000, of more than 600 SAS Scandinavian Airlines System pilots found that complaints about the flight deck environment were common and differed somewhat among different models of airplanes. Overall, 53 percent of pilots complained of dry air, and 48 percent said that they were bothered by dust and dirt. When questioned about medical symptoms, 10 percent reported "dry or flushed facial skin," and 9 percent said they had experienced an "irritated, stuffy or runny nose."[2]

The report, noting discussions of the health aspects of air recirculation, said that the survey also found that pilots of SAS McDonnell Douglas DC-9s — in which there was no recirculated air — experienced colds and other respiratory ailments at about the same frequency as pilots of airplane models with air recirculation.

A 2002 review of studies of the effects of cabin environment on the health of flight attendants found that "dryness symptoms attributable to low humidity" were among the flight attendants' most frequent complaints.[3]

These complaints typically are not associated with illness, said Anthony Evans, M.D., chief of the aviation medicine section at the International Civil Aviation Organization (ICAO).

"Low humidity is related to comfort rather than ill health; humidity levels found on aircraft [have] been demonstrated as not sufficient to cause clinical dehydration," Evans said.

A 2007 study discussed an unexpected factor: The interaction between oils in human skin and ozone in the cabin may produce chemical byproducts that worsen dry eyes and skin and contribute to headache and nasal irritation. Some airplanes have ozone-destroying substances in their ventilation systems; on airplanes that do not, the ozone levels can exceed those recorded in large cities on smoggy days, the study said.[4]

Cabin air quality is the subject of several ongoing studies, including one being conducted for the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). That study is designed to survey passengers on 160 flights about their perceptions of cabin air quality and then to scientifically evaluate the air quality using on-board monitoring instruments. An early phase of the research found that overall cabin air quality was considered "adequate" by passengers on four U.S. domestic flights.[5]

The survey coincides with ASHRAE's effort to develop standards for airplane air quality —

in terms of temperature, humidity and ventilation. The standards are expected to be published late in 2007.[6]

Quay Snyder, M.D., president and CEO of Virtual Flight Surgeons, an aeromedical consulting firm, and an associate aeromedical adviser for the Air Line Pilots Association, International, said that the physicians in his office "very, very rarely hear anything from the pilots regarding cabin air quality. … We occasionally hear about low humidity from pilots with ongoing sinus problems, primarily in the context of inquiries regarding strategies to deal with it, rather than complaints."

The NRC said that although a variety of studies have shown that upper respiratory infections and other contagious diseases are passed from one person to another in airplanes, the ECS apparently is not a factor in transmission. Instead, the most important transmission factors are density of airplane occupants and their nearness to one another, the NRC said.

Contaminants

Sometimes, when airplane systems malfunction, complaints may involve not dry air but contaminated air.

"Although the ECS is designed to minimize the concentrations of contaminants in the cabin, contaminant exposures do occur," the NRC said. "They can originate outside the aircraft, inside the aircraft, and in the ECS itself."

The NRC and other researchers define two types of contaminant exposures:

- Those that occur during routine operating conditions, such as when ozone enters an airplane along with ventilation air during flight at high altitudes, and when chemical residues from cleaning substances and other materials linger in an airplane; and,
- Those that occur during abnormal conditions, such as when engine oil, hydraulic fluid, deicing fluid and other substances enter an ECS and are then dispersed throughout the airplane.

Many specialists say that under routine operating conditions, there are no problems with air quality.

"The air quality is good on board aircraft in comparison to that found in buildings or outside in a city, for example, and the filters used for recirculation are highly efficient at removing viruses and bacteria," Evans said.

Russell B. Rayman, M.D., executive director of the Aerospace Medical Association, agreed.[7]

"Everything that makes an airplane run is toxic — the fuel, the hydraulics — but if an aircraft is properly functioning, there is no problem [with air quality]," he said.

The NRC said that research attempts to collect data on exposure to on-board contaminants have not presented a complete picture.

"The data represent only a small number of flights, and the studies have varied considerably in their sampling strategies, the environmental factors monitored and the measurement methods used," the NRC said. "Consequently, cabin air quality under routine conditions has not been well characterized."

Nevertheless, the NRC said that healthy people probably would not be adversely affected by exposure to reduced air pressure and elevated ozone levels.

Although the NRC said that "no published studies describe quantitative measurements of air quality under abnormal operating conditions," reports by accident/incident investigative boards in a number of countries discuss incidents in which oil fumes or hydraulic fumes have been introduced into the airplane by an ECS.

For example, a report by the Swedish Accident Investigation Board (SHK) described a Nov. 12, 1999, incident in which the captain and copilot of a Braathens Malmö Aviation BAE Systems BAe 146-200 were temporarily incapacitated during a descent from 15,000 ft in preparation for landing at Malmö after a flight from Stockholm.[8]

The SHK said that the probable cause of the incident — in which none of the 73 people in the airplane was injured and the airplane was not damaged — was "the pilots becoming temporarily affected by probably polluted cabin air."

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Investigators were unable to identify the source of the pollution, however.

The report cited a series of ailments experienced by the crew not only during the incident flight, which was the last of three one-hour flights that day, but also during the two prior flights. Those ailments included the purser's "unpleasant feeling of fainting" during the first flight and a flight attendant's "odd pressure in the head, nasal itching and ear pain" during the second flight, when the purser and another flight attendant also reported discomfort. During the third flight, the captain and the purser briefly detected a burning odor, followed by "more pronounced" discomfort experienced by all cabin crewmembers; later, the captain was dizzy and both flight crewmembers became nauseous. After several minutes of breathing oxygen, they conducted a normal approach and landing "without problems," the report said.

Cabin Climate Control

Commercial jet airplanes typically have an environmental control system (ECS) to establish a safe, comfortable environment by regulating cabin air pressure, air temperature and humidity and limiting the introduction of contaminants.

The ECS maintains cabin air pressure at no less than the atmospheric pressure at 8,000 ft — the limit set by civil aviation authorities. In most airplanes, the ECS uses a combination of engine bleed air — outside air brought into the system through the engines — and recirculated air — cabin air that is filtered and redistributed through the airplane. Some airplanes, such as the McDonnell Douglas DC-9 and the Boeing 787, use no recirculated air.

Outside air enters the jet engine compressors, where it is warmed as it becomes pressurized, then cooled by the engine's heat exchangers and the air conditioning units. Cooled air is mixed with a similar amount of filtered air from the cabin and then enters the cabin through overhead outlets. The air flows through the cabin in a circular pattern before it is either vented overboard or filtered to remove nearly all particles, including bacteria, viruses and liquid droplets of some contaminants, before it is recirculated.[1]

The recirculated air contains slightly more humidity; some airplanes also are equipped with humidifying systems.

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Note

1. Boeing Commercial Airplanes. Cabin Air Systems. <www.boeing.com/commercial/cabinair/>.

In another incident, the U.K. Air Accidents Investigation Branch (AAIB) said that on several days in November 2004, the flight crew and cabin crew of a Boeing 757 had a variety of symptoms on different flights between London Heathrow Airport and several European cities.[9]

"The aircraft experienced several incidents, on different flights, of fumes in the cockpit and cabin, and in some cases, this produced symptoms in the flight and cabin crew," the AAIB report said. "Although evidence was found of leaking hydraulic fluid having migrated inside a bleed air supply duct, the various investigations failed to definitively establish if this was the source of the fumes."

The report cited "numerous other reports of oil smells in the cockpit and/or cabin of the Boeing 757" and said that the fumes in the November 2004 incidents — described by crewmembers as "warm, sweet … but slightly burnt" and similar to "oily sewage" — might have indicated that the hydraulic fluid leak was unrelated.

The symptoms experienced by the crew during three days of problems included the captain's sensation of being "a bit spacey" and feeling "a little unwell," the first officer's "buzzy head and body" and several cabin crewmembers' sore throats, the report said.

The report said that, of the various reports of oil smells, "some of these events have been the result of genuine oil leaks from the engine or [auxiliary power unit] compressor oil seals. In other cases, no definite source of the fumes could be identified. However, service experience shows that overfilling the engines with oil can produce fumes in the aircraft interior."

The AAIB said that after a previous incident involving another 757 belonging to the same operator, that operator took "extensive measures to ensure that the engine oil is serviced correctly." In this incident, there was no indication that the engines were overfilled with oil.

Several years earlier, in 2000, a report by a committee of the Australian Parliament said that cabin air in BAe 146s had been "to use

the most commonly used description, 'smelly' since its introduction into passenger service in the mid-1980s." Cabin air quality was a "persistent problem" since the early 1990s, with periodic complaints of oil fumes in the cabin. As a result, the report said, a number of BAe 146 crewmembers experienced an "occupational health effect" that caused some to stop flying.[10]

In 2001, after several incidents involving the partial incapacitation of flight crewmembers, the U.K. Civil Aviation Authority (CAA) began a research program to evaluate cabin air quality. Researchers concluded, in a report published in 2004, that "fumes from engine oil leaking into the bleed air system, and hence into the cabin air supply, is the most likely cause of the incidents. There are over 40 different chemicals contained in oil breakdown products, and many have no published toxicity data, so it is not possible to be certain whether any of these products contribute to, or are the sole cause of, the recorded incidents."[11]

Lasting Symptoms?

The CAA research did not evaluate the long-term health effects of exposure to oil fumes. Some current and former airline pilots and flight attendants, however, say that they have experienced chronic fatigue, brain damage and a variety of respiratory and neurological symptoms and abnormal medical test results, and that they believe their symptoms were caused by repeated exposure to engine oil fumes that entered the airplane when the air supply was turned on.

One of them, Susan Michaelis, a former Australian airline pilot, said in a presentation to the U.K. Parliament in June 2007 that she still experiences these symptoms — 10 years after she stopped flying because of health problems and eight years after losing medical certification. Michaelis, now a researcher for the Global Cabin Air Quality Executive, said that she believes the symptoms result from repeated exposure to an engine oil additive called tricresyl phosphate.[12]

"I am well aware of many other pilots and flight attendants in Australia experiencing almost identical effects and similarly no longer able to fly, in most cases," she said. "I am also aware of the same effects being experienced by many pilots and flight attendants from … other countries. The pattern is remarkable."

Many aeromedical specialists, however, say that there is no scientific evidence to link the symptoms to any exposure to oil fumes in the airplane.

"Cabin air quality is an emotional issue," said Rayman, who noted that, although malfunctioning ECSs can cause medical problems, "I'm not aware of good scientific studies that have linked cabin air with illness."

ICAO's Evans agreed.

"It has yet to be reliably demonstrated that ill health effects claimed to be caused by such events are actually related to them," he said. "Having said that, I am open to the results of further studies … to try and identify the potential contaminants."●

Notes

1. U.S. National Research Council (NRC). *The Airliner Cabin Environment and the Health of Passengers and Crew*. Washington, D.C.: National Academy Press, 2002.

2. Lindgren, Torsten; Andersson, Kjell; Norbäck, Dan. "Perception of Cockpit Environment Among Pilots on Commercial Aircraft." *Aviation, Space, and Environmental Medicine* Volume 77 (August 2006): 832–837. The survey questioned pilots of Boeing 737-600s and 767-300s, and McDonnell Douglas DC-9s, MD-80s and MD-90s.

3. Nagda, Niren L.; Koontz, Michael D. "Review of Studies on Flight Attendant Health and Comfort in Airliner Cabins." *Aviation, Space, and Environmental Medicine* Volume 74 (February 2003): 101–109.

4. American Chemical Society. *Skin Oil–Ozone Interactions Worsen Air Quality In Airplanes*. <www.eurekalert.org/pub_releases/2007-09/acs-so090507.php>.

5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). *Major Study of Aircraft Cabin Air Quality Launched*. Jan. 10, 2007. <www.ashrae.org/pressroom/detail/16102>.

6. ASHRAE. *ASHRAE Revises Proposed Cabin Air Quality Standard*. Oct. 27, 2006. <www.ashrae.org/pressroom/detail/15950>.

7. Rayman also is a member of the *AeroSafety World* Editorial Advisory Board.

8. FSF Editorial Staff. "Cabin-Air Contamination Briefly Incapacitates Crew." *Cabin Crew Safety* Volume 37 (January–February 2002).

9. U.K. Air Accidents Investigation Branch. *AAIB Bulletin 7/2005*, Report nos. EW/G2004/11/08 and EW/G2004/11/12.

10. Parliament of the Commonwealth of Australia, Senate Rural and Regional Affairs and Transport References Committee. *Air Safety and Cabin Air Quality in the BAe 146 Aircraft*. 2000.

11. U.K. Civil Aviation Authority (CAA). CAA Paper 2004/04, *Cabin Air Quality*. February 2004.

12. Michaelis, Susan. *Memorandum: Air Travel and Follow-Up Inquiry*, presentation to U.K. Parliament, Science and Technology Select Committee. June 26, 2007.