Closing the Loop
An Air Quality Standard for Aircraft

Byron W. Jones
Kansas State University
Report On:

American Society of Heating, Refrigerating and Air-Conditioning Engineers

Special Project Committee 161P

“Air Quality in Commercial Aircraft”
Disclaimer:

ASHRAE SPC 161P has issued no official draft standard or parts of a standard nor any official status or position documents. Statements made in this presentation do not necessarily represent the position of ASHRAE or SPC 161P. They are intended only to reflect the observations and opinions of the author.
Title, Purpose and Scope

ASHRAE specifies these items when a special project committee is formed to write a standard.

Used to guide the committee in its work.

May be changed as the work progresses.

Normally, the only “official” statement by ASHRAE until a draft standard is released for public review.
Title:

Air Quality Within Commercial Aircraft

Purpose:

This Standard defines the requirements for air quality in air-carrier aircraft and specifies methods for measurement and testing in order to establish compliance with the standard.
Scope:

1) This standard applies to commercial passenger air-carrier aircraft carrying 20 or more passengers and certified under Title 14 CFR Part 25.

2) This standard considers chemical, physical, and biological contaminants, as well as, but not limited to, factors such as moisture, temperature and pressure that may affect air quality.

3) Considering safe operation of the aircraft, the diversity of sources and types of contaminants in aircraft cabin air, and the range of susceptibility in the population, compliance with this standard will not necessarily ensure acceptable aircraft cabin air quality for everyone.
Key Aspects of the Standard

General Requirements

Ventilation Requirements

Episodic Contamination

Measurements

Ground and Flight Operations
General Requirements

Cabin Pressure: Probably will not be more stringent than current 8000 foot (2400 meters) cabin altitude limit. Some committee members would be more comfortable with a lower limit, e.g. 6000 feet (1800 meters).

Rate of Change of Cabin Pressure: Not to exceed 0.266 psi/min (18.3 hPa/min) when decreasing and not exceed 0.159 psi/min (11.0 hPa/min) when increasing. Equivalent to about 500 ft/min (150 m/min) and 300 ft/min (90 m/min) rate of change in cabin altitude, respectively.
General Requirements

Cabin thermal requirements more or less based on ASHRAE Standard 55 and ISO 7730.

Operative Temperature in a Zone: 71-76°F (22-24°C)
Vertical Air Temperature Variation: +/- 2.5°F (1.4°C) for individual seat.
Air Velocity: <70 fpm (0.36 m/s) in occupied zone, <30 fpm (0.15 m/s) for draft sensitive areas.
Radiant Temperature: within 10°F (5°C) of air temperature.
General Requirements

Cabin Relative Humidity: No specific requirements with the upper limit, at least in flight, primarily determined by safety considerations. Reluctant to make lower limits that result in decreased outside air or require humidification even though low relative humidity is a recognized problem.
General Requirements

Contaminant Limits: Have agreed there is a need for specified limits, but have not agreed on items included or the limits.

Ozone – Along the lines of the current FAA requirement but applied to every flight (0.25 ppm peak, 0.1 ppm 3-hour avg.).
Carbon dioxide - As a contaminant, but not as an indicator for ventilation (5000 ppm peak, 3500 ppm avg).
Carbon monoxide - (35 ppm peak, 9 ppm avg.)
Particles (PM10) - ??? (150 microgram/m^3 avg.)
Volatile Organic Compounds - ???
Semi-Volatile Organic Compounds - ???

Additionally, general information about limits in other standards and guidelines similar to ASHRAE Standard 62.
Ventilation Requirements

Outside Air Requirements: Very controversial and a major stumbling block to completion of the standard. Positions range from 15 cfm/person (6.5 l/s-person) corrected to sea level to 5 cfm/person (2.2 l/s-person) not corrected for cabin altitude. Speculate that we will end up somewhere in the 7-10 cfm/person (3- 4.4 l/s-person) range.


Requirements apply to each cabin or zone rather than aircraft as a whole.
Ventilation Requirements

Local Ventilation Effectiveness: To be determined. Personal air outlets may be one means of assuring local ventilation effectiveness.

Special Requirements: For galleys, lavatories, crew rest areas, and possibly aisles.

Ventilation Shut Down: Minimum needed for special operations. Must deplane if it lasts for more than 30 minutes when on the ground.
Ventilation Requirements

Quality of Outside Air Used for Ventilation: Primarily a factor on the ground. May utilize the Episodic Contamination requirements to ensure adequate outside air quality. Probably will not require measures to clean outside air if problem is just generally poor air quality at the airport but probably will require measures to deal with episodic contamination.
Episodic Contamination

Some important air quality concerns are episodic in nature and need to be addressed through means other than general requirements or ventilation requirements for routine operations. Each source is different. **Control measures, monitoring, and remedies** for each one are included. Some may be mandatory, some may be guidelines. The list may be subject to some changes.
## Episodic Contamination

List of factors currently included:

<table>
<thead>
<tr>
<th>General APU Ingestion</th>
<th>Lavatory Fluids/Odors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deicing Fluid</td>
<td>Cargo/Carry On Baggage</td>
</tr>
<tr>
<td>Exhaust Fumes</td>
<td>Bird Strikes</td>
</tr>
<tr>
<td>Fuel</td>
<td>Anti-Corrosion Spray &amp; Paint</td>
</tr>
<tr>
<td>Hydraulic Fluid</td>
<td>Human Bioeffluents</td>
</tr>
<tr>
<td>Engine Oil</td>
<td>Ozone</td>
</tr>
<tr>
<td>Bacteria and Viruses</td>
<td>Galley Odors</td>
</tr>
<tr>
<td>Pesticides</td>
<td>Electrical Odors</td>
</tr>
<tr>
<td>Solvents</td>
<td>Chem. and Bio. Agents</td>
</tr>
</tbody>
</table>
Measurements

General agreement that it is not feasible to measure everything we need to measure to ensure good air quality.

Real time monitoring
Compliance verification checks
Comprehensive design performance evaluations

Standard may not address measurements, but that would require a change to the official Purpose.
Ground and Flight Operations

Standard applies from time the first passenger or crew member boards the plane for the purpose of making a flight and extends until the last passenger or crew member deplanes after a flight. Three distinct phases of operation: ground - door open, ground - door close, and flight.
Ground and Flight Operations

Ground - Door Open: Applies during boarding and deplaning. Characterized by one or more open doors and, in most locations, access to ground air and power sources.

Ground - Doors Closed: Applies during taxiing and ground holds. Characterized by total reliance on onboard environmental control systems and engines operating at low power.

Flight - Aircraft not in contact with the ground.
The Challenge Remaining

It is a consensus process conducted mostly by unpaid volunteers. The committee is made up of people from the following backgrounds:

Flight Crew, General Interest, Manufacturers, Owner/Operators, and Passengers

There is not a consensus amongst these groups on outside air requirements.

Outside air requirements are a critical part of an aircraft air quality standard.
Why There Is No Consensus

Numbers are for illustration purposes only.
Optimistic Time Line

Starting from the point where it is agreed as to how to deal with outside air requirements.

Complete Review Draft: 6-12 months
ASHRAE Approval of Review Draft: 3-6 months
Public Review: 3 months
Resolve Comments and Revise Standard: 6-12 months
ASHRAE/ANSI Approval for Publication: 3-9 months
Total: 21-42 months

There could (most likely will) be multiple public review cycles. ASHRAE could return public review draft or final standard to committee for more work.
Closing Comments

At times, completion of a meaningful aircraft air quality standard appears to be an unachievable goal. However, to not have a meaningful aircraft air quality standard is unacceptable.

The stakes are large. It could cost millions if not billions of dollars to comply with possible standard requirements. Unwarranted, costly requirements must be avoided.

The stakes are large. Hundreds of millions of people fly on commercial aircraft; many fly routinely. Warranted, effective requirements must be implemented.