ICE and European preStandard on health and cabin environment
Dr. Christian Wolff (EADS Innovation Works)
Content

Existing European Cabin Air Standard
Need for New Cabin Air Standard
From ICE Project to New Cabin Air Standard
Status and Highlights of New Cabin Air Standard
Summary and Conclusion
1. Existing European Cabin Air preStandard

ASD-STAN European preStandard prEN4618
“Aircraft internal air quality standards, criteria and determination methods”

General

- prepared by a working group of CabinAir (EU 5th framework project)
- the first standard of its kind for aeronautical air quality and comfort
- the standard is intended for newly certificated commercial passenger aircraft programmes and may also apply to current production aircraft (if technically feasible and economically justifiable)
- the standard is intended for use in design, manufacturing, maintenance and normal operation of commercial aircraft
1. Existing European Cabin Air preStandard

ASD-STAN European preStandard prEN4618

Content

- specifies requirements and determination methods for indoor air quality and thermal comfort
- the standard distinguishes between safety, health and comfort conditions for passengers and crew under a variety of phases of flight, including embarkation and disembarkation
- the standard committee has tried to make the standard performance based

Publication

- EN publication expected by the end of March 2009
2. Need for New Cabin Air Standard

- Aircraft traffic is expected to continuously grow (number of flights and flight distance)
- Wide spectrum of today’s travelling public
  - More elderly people
  - People with known medical conditions
  - Children
- So far, no scientifically based standard for cabin pressure

Air travel has grown sixfold in 30 years, and will double by the Year 2020

3. From ICE Project to New Cabin Air Standard

Two parallel processes

3.1 Elaboration of Standard Document (through ICE project)

3.2 Formal Approval of New Cabin Air Standard (through ASD-STAN)
3. From ICE Project to New Cabin Air Standard

3.1 Elaboration of Standard Document (through ICE project)

Data Acquisition → Scientifically Based Data Pool → Predictive Design Model → Standard Document
3. From ICE Project to New Cabin Air Standard

3.2 Formal Approval of New Cabin Air Standard (through ASD-STAN)

ASD-STAN

- established in October 2005 (former AECMA-STAN)
- well recognised as the European body for the development of global aerospace standards by the International Aerospace Quality Group (IAQG)
- taking control of establishing, developing and maintaining standards requested by the European aerospace industry
- streamlined process for standardisation is in agreement with the European Committee for Standardization (CEN)

http://www.asd-stan.org
3. From ICE Project to New Cabin Air Standard

3.2 Formal Approval of New Cabin Air Standard (through ASD-STAN)

Working Group & Main Tasks

**Executive**
- ASD-STAN Member
- coordinates standardisation
- manages the publication of standards

**Domain Technical Co-ordinator (DTC)**
- ASD-STAN Member
- facilitates the standardisation work
- validates deliverables

**Experts & Specialists**
- ICE Members
- author of standard
- respond to DTC and Executive

**Focal Points (GB, DE, FR, SE, IT, ES)**
- arrange vote on new projects
- identify experts and specialists
- arrange vote on deliverables
3. From ICE Project to New Cabin Air Standard

3.2 Formal Approval of New Cabin Air Standard (through ASD-STAN)

**Step 1: From new work proposal to preStandard (simplified procedure)**

- New Work Proposal Stage: 2 months
- Working Draft Stage: 4 months
- Consensus Draft Stage: 6 months

**Step 2: From preStandard to EN (simplified procedure)**

- Formal Vote Stage: 5.5 months
- EN Publication stage: 3 months

*In parallel*

*current status*

Total 20.5 months
4. Status and Highlights of New Cabin Air Standard

ASD-STAN European preStandard prEN4666

“Aircraft integrated air quality and pressure standards, criteria and determination methods”

General & Content

- prepared by a working group of ICE (EU 6th framework project)
- after EN4618, the first standard of its kind, now including cabin air pressure
- complementary to EN4618, indentifying amendments and additional requirements

Publication

- final working draft stage to be reached in March 2009
4. Status and Highlights of New Cabin Air Standard

ASD-STAN European preStandard prEN4666

Presentation of highlights:

- safety, health and comfort limits do exist
- only health and comfort limits shown
- cabin parameters
  a) pressure conditions
  b) air quality
  c) thermal conditions
  d) humidity conditions
  e) noise & vibration
  f) combined effects
4. Status and Highlights of New Cabin Air Standard

a) Pressure Conditions

i) Rates of Change of Cabin Air Pressure [SAE ARP1270 (2001), ASHRAE Standard 161 (2007)]

The rate of change of cabin air altitude should be limited to

- 2.5 m/s (500 ft/min) [sea level equivalent] for decreasing air pressure (increasing altitude)
- 1.5 m/s (300 ft/min) [sea level equivalent] for increasing air pressure (decreasing altitude)

The rate of change of cabin air pressure should be

- as low as possible
- as constant as possible during climb or descent
4. Status and Highlights of New Cabin Air Standard

a) Pressure Conditions

   ii) Absolute Cabin Air Pressure

   Pressurised cabins and compartments to be occupied currently must be equipped to provide a cabin air pressure altitude of not more than 2438 m (8000 ft, 10.9 psi, 75 kPa) at the maximum operating altitude of the aeroplane under normal operating conditions.
4. Status and Highlights of New Cabin Air Standard

a) Pressure Conditions

ii) Absolute Cabin Air Pressure

The needs of three distinct groups must be taken into account:

1. The safety, health and comfort of **passengers**
   - Young, fit and healthy
   - Elderly but without known medical conditions
   - Those with known medical conditions

2. The ability of **pilots** to perform both normal and abnormal operations, including on long-duration flights

3. The ability of the **cabin crew** to perform normal duties, including moderate exercise, and emergency procedures involving significant exertion
b) Air Quality

All limits for the compounds defined in [EN 4618 (2009)] apply:

- Carbon dioxide
- Carbon monoxide
- Ozone
- Ultrafine particles
- PM2.5
- PM10
- Acetone (Propanone)
- Methyl Ethyl Ketone (Butanone)
- Acetaldehyde
- Acrolein
- Formaldehyde
- Benzene
- Toluene
- Methylene Chloride (Dichloromethane)
- Endotoxins
- Bacteria, viruses and fungi
### 4. Status and Highlights of New Cabin Air Standard

#### c) Thermal Conditions

#### i) Cabin Air Temperature

<table>
<thead>
<tr>
<th>Level</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health</strong></td>
<td>$19^\circ\text{C} &lt; ta &lt; 34^\circ\text{C}$</td>
</tr>
<tr>
<td><strong>Comfort</strong></td>
<td>$21^\circ\text{C} &lt; ta &lt; 25^\circ\text{C}$ while $20^\circ\text{C} &lt; ta,01 &lt; 25^\circ\text{C}$ $(\Delta ta =</td>
</tr>
<tr>
<td></td>
<td>ta ambient temperature</td>
</tr>
<tr>
<td></td>
<td>ta,01 ambient temperature at ankle height (0.1 m)</td>
</tr>
<tr>
<td></td>
<td>ta,11 ambient temperature at head height (1.1 m)</td>
</tr>
</tbody>
</table>
4. Status and Highlights of New Cabin Air Standard

c) Thermal Conditions

ii) Surface Temperature [ISO 13732]

<table>
<thead>
<tr>
<th>Level</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>Minimum contact temperature:</td>
</tr>
<tr>
<td></td>
<td>t(c,min) = 7°C</td>
</tr>
<tr>
<td></td>
<td>Maximum surface temperatures:</td>
</tr>
<tr>
<td></td>
<td>t(s,max) = 48°C for contact durations less than 10 min</td>
</tr>
<tr>
<td></td>
<td>t(s,max) = 43°C for contact durations less than 8 h</td>
</tr>
<tr>
<td>Comfort</td>
<td>Minimum contact temperature:</td>
</tr>
<tr>
<td></td>
<td>t(c,min) = 15°C</td>
</tr>
<tr>
<td></td>
<td>Maximum surface temperature:</td>
</tr>
<tr>
<td></td>
<td>t(s,max) = 40°C</td>
</tr>
</tbody>
</table>

≥t(c) – contact temperature, t(s) – surface temperature
4. Status and Highlights of New Cabin Air Standard

c) Thermal Conditions

iii) Local Airflow

<table>
<thead>
<tr>
<th>Level</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>No specific health limits</td>
</tr>
<tr>
<td>Comfort</td>
<td>( v(a) &lt; 0.2 \text{ m/s} ) at draft sensitive bare body parts: ankles (0.1 \text{ m}) and neck (1.1 \text{ m})</td>
</tr>
<tr>
<td></td>
<td>( v(a) &lt; 0.36 \text{ m/s} ) otherwise</td>
</tr>
<tr>
<td></td>
<td>as addressed through [ASHRAE standard 161 (2007)]</td>
</tr>
<tr>
<td></td>
<td>( v(a) ) – air velocity</td>
</tr>
</tbody>
</table>
4. Status and Highlights of New Cabin Air Standard

d) Humidity Conditions

<table>
<thead>
<tr>
<th>Level</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>No specific health limits</td>
</tr>
<tr>
<td>Comfort</td>
<td>No specific comfort limits</td>
</tr>
</tbody>
</table>
4. Status and Highlights of New Cabin Air Standard

e) Noise & Vibration

i) Noise

<table>
<thead>
<tr>
<th>Level</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health</td>
<td>L(ex,8h) = 87 dB(A) and Peak limit = 140 dB(C) addressed through Directive 2003/10/EC</td>
</tr>
<tr>
<td>Comfort</td>
<td>No limit recommended</td>
</tr>
</tbody>
</table>
4. Status and Highlights of New Cabin Air Standard

e) Noise & Vibration

ii) Vibration [ISO 2631-1 (1997)]

<table>
<thead>
<tr>
<th>Level</th>
<th>Limit</th>
</tr>
</thead>
</table>
| Health   | $L(\text{ex}, 8h) = 1.15 \text{ m/s}^2$ (whole-body vibration)  
as addressed through Directive 2002/44/EC |
| Comfort  | $L(\text{ex}) < 0.315 \text{ m/s}^2$  
approximate indication for permanent exposure |
f) Combined Effects

The ICE study has shown that changing one cabin parameter may have an influence on other parameters. This is defined as possible “combined effects”.

- Temperature & Humidity [a]: no evidence of combined effect
- Temperature & Noise [a]: evidence of combined effect determined
- Humidity & Noise [a]: no evidence of combined effect
- Perceived Air Quality & Enthalpy: evidence of combined effect determined

General analysis of combined effects may be analysed with complex models such as the Predictive Design Model elaborated within the ICE project.

[a] 21 °C to 25 °C; 10 % RH to 40 % RH; 64 dB(A) to 74 dB(A)
5. Summary and Conclusion

existing cabin air standard covers indoor air quality and thermal comfort

a new cabin air standard is required to cover cabin air pressure

the new cabin air standard addresses – for the first time – combined effects

The new European ICE cabin air standard is on its way and will significantly contribute to enhance the already high comfort level onboard of commercial passenger aircraft.