Global Emissions Technology

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Environment,
ICAO Air Transport Bureau
• Pushing the technology envelope
• The Independent Expert Review on Fuel Burn Technology
• The development of the ICAO CO$_2$ Standard
• Summary
• The aerospace industry is a dynamic and advanced-technology sector.
• Historic trends show that aircraft entering today’s fleet are ~80% more fuel efficient than in the 1960s.

Source: ICCAIA
Contribution of Measures for Reducing International Aviation Net CO₂ Emissions

- 2010 Fleet and Operational Efficiency
- Aircraft Technology
- Sustainable Alternative Fuels and Market-Based Measures

Basket of Measures
- 4x traffic, 4.1x CO₂
- -10%
- -20%

Carbon Neutral Growth from 2020
Pushing the Technology Envelope
• To improve fuel efficiency there are continuous efforts in:
  – Structures
  – Propulsion
  – Aerodynamics

• Advanced technologies are already being incorporated into aircraft designs in order to contribute to carbon neutral growth by 2020.
• Reductions in weight are a key factor in reducing fuel burn:
  – Use of Carbon Fibre Reinforced Plastic (CFRP) and advanced alloys is increasing;

• Airbus A380 contains 25% composites.

• Boeing 787 and Airbus A350 have pushed the composite use to 50%.

Source: ICCAIA
Pushing the technology envelope

• Drive towards increased propulsive efficiency:
  – Higher by-pass ratio engines deliver thrust at a lower fuel consumption
  – Lighter and higher temperature materials

http://www.ecomagination.com/portfolio/genx-aircraft-engine
http://machinedesign.com/archive/fewer-trips-fuel-truck

Image courtesy of Pratt & Whitney
• Aerodynamics, for example:
  – Drag reduction technologies
  – Wingtip devices

http://www.airlinereporter.com/
Independent Expert Fuel Burn Technology Review
A review of the status of aircraft technology developments for fuel burn reduction;

An assessment of potential fuel burn reductions in the future;

Recommended mid- and long-term aircraft fuel burn/efficiency technology goals;

An assessment of the possibility of success in achieving the mid- and long-term fuel burn/efficiency technology goals.
• The IEs concentrated on two aircraft categories, the Single Aisle (SA) and Small Twin Aisle (STA) aircraft
  – ~85% of the aviation fuel is burned in these two categories;
• The IEs also adopted three Technology Scenarios (TS) for 2020 and 2030:
  – TS1 – “Continuation”: a continuation of the current trend of improvement;
  – TS2 – “Increased pressure”: increased pressure to incorporate more technologies to reduce fuel burn
  – TS3 – “Further increased pressure”: justifying more radical technology innovations
### Independent Expert technology review

#### Single Aisle (SA) vs Small Twin Aisle (STA)

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<td><strong>Propulsive efficiency</strong></td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>15</td>
<td>28*</td>
<td>6</td>
<td>9</td>
<td>7</td>
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<td>5</td>
<td>3*</td>
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<td>3</td>
<td>3</td>
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<td>5**</td>
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<td><strong>Induced non-viscous drag</strong></td>
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<tr>
<td><strong>Viscous drag</strong></td>
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<td>4</td>
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<td>2</td>
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<td><strong>Structural weight</strong></td>
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<td>20*</td>
<td>10</td>
<td>15</td>
<td>15</td>
<td>20</td>
<td>25**</td>
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* With Open Rotor compatible with the level of thrust of SA
** Without Open Rotor, which is judged incompatible with the high thrust requirement of twin engine STA

#### 2020 vs 2030

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<th>2020</th>
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<tr>
<td><strong>SA</strong></td>
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<td>TS1</td>
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<td>TS3</td>
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<td>TS3 Open Rotor</td>
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• **The 2020 goal** is a fuel burn reduction of 29% and 25% relative to baseline aircraft of 2000.

• **The 2030 goal** is a fuel burn reduction of 34% and 35% relative to baseline aircraft of 2000.
Developing the ICAO Aeroplane CO$_2$ Emissions Standard
CO₂ Standard Key Criteria

- General
- Open
- Objective
- Reasonable
- Robust
- Effective
Aeroplane CO₂ Standard Framework

- Technology Standard similar to current Noise and Engine Emissions Standards.
- Aircraft level Standard similar to Noise Standard.
• The aeroplane CO₂ Standard will result in a new Annex 16 Vol. III

• Two phases in the approach:
  - **Phase 1 (completed)**
    • Development of CO₂ Certification Requirement (metric system, measurement procedures);
  - **Phase 2 (ongoing)**
    • CO₂ Standard setting process (applicability, stringency levels, technology responses, cost effectiveness assessments and interdependencies).

Phase 1 has been completed. Phase 2 is on track and the cost effectiveness modelling assessment is underway.
The metric system aims to focus on reducing CO₂ emissions through integration of fuel efficiency technologies into aeroplane type designs, and:

- equitably reward fuel efficiency improvement technologies in an aircraft type design.
- be transport capability neutral;

**The Metric**
- Cruise point fuel burn performance

**The Correlating Parameter**
- Aeroplane Maximum Take-Off Mass (MTOM)
**Certification Test Points**

The CO$_2$ metric System will be evaluated at three representative cruise points, where each is represented by a fraction of aeroplane gross mass.
Using the Metric System as a basis, CAEP developed a mature CO₂ Standard certification requirement.

- Resulting in the certification test criteria for the implementation of the CO₂ metric system.
- Measurement of all parameters;
- Correction of measured data to reference conditions.

CO₂ certification requirement was agreed by CAEP/9 in February 2013 and published for information as Circular 337.
• The CO\textsubscript{2} Standard will be applicable at an aeroplane level.

• The CO\textsubscript{2} Standard will be applicable to new aeroplane types.
  – Discussions continue over including in-production types.

• The CO\textsubscript{2} Standard will be applicable to subsonic jet and propeller driven driven aeroplanes.

• The CO\textsubscript{2} Standard for new aeroplane types will likely be applicable in 2020 or 2023.
• To finalise the CO$_2$ Standard the following issues remain:
  – definition of a no-change criteria;
  – applicability requirements;
  – regulatory limit line;
  – applicability date for the limit.

• CAEP is currently working on a full cost and environmental benefits analysis.
• Importance of balancing a timely delivery and robust technical product that will meet the needs of ICAO.

• Significant technical challenges in developing ICAO Annex 16 Volume III has resulted in a delay to original Assembly aim to complete a CO$_2$ Standard by the end of 2013.

• CAEP has worked on developing a comprehensive CO$_2$ Standard setting work plan:
  – CAEP has agreed to a future work schedule with a deliverable by 2016 for the full CO$_2$ Standard.
Summary
The aerospace industry continues to push the technology envelope:

- Aircraft entering today’s fleet are ~80% more fuel efficient than in the 1960s.

ICAO continues to review the status of fuel burn technology.

ICAO is developing a CO₂ Standard which aims to encourage the use of the latest Aeroplane technologies:

- The CO₂ Standard will be complete by 2016.
For more information on ICAO activities on Global Emissions Technology...

ICAO Web Page
www.icao.int/

THANK YOU