ICAO Environmental Goals

Limit or reduce the number of people affected by significant aircraft noise

Limit or reduce the impact of aviation emissions on local air quality (LAQ)

Limit or reduce the impact of aviation GHG emissions on global climate

Quantify, Mitigate, Implement

ICAO Strategic Objective on Environmental Protection:
Minimize the adverse effect of global civil aviation on the environment
ICAO Standard Setting Principles

- Technical feasibility
- Economic reasonableness
- Environmental benefit
- Interdependence of measures
Purpose of Standards

• SARPs are part of ICAO policies to mitigate environmental impacts:

“The prime purpose of noise certification is to ensure that the latest available noise reduction technology is incorporated into aircraft design demonstrated by procedures which are relevant to day to day operations, to ensure that noise reduction offered by technology is reflected in reductions around airports.”

The seventh meeting of the Committee on Aviation Environment Protection (CAEP/7), 2007
ICAO Technology Standards – Annex 16

• Volume I – Aircraft Noise
• Volume II – Engine Emissions
  – Includes SARPs on: HC, CO, NO\textsubscript{x}, Smoke, nvPM;
  – Focuses on emissions released below 3,000 feet in order to manage Local Air Quality (LAQ) near airports;
• Volume III – Aeroplane CO\textsubscript{2} Emissions
Aircraft Engine Emissions

Typical Emissions from an Aero Engine at Cruise

Emission | From 1 Kg fuel
--- | ---
CO₂ | 3160 g
H₂O | 1290 g
NOₓ | 15 g
SOₓ | 1.2 g
CO | < 0.6 g
Hydrocarbons | < 0.01 g
Particulates | < 0.05 g
Air | lots

Around airports NOₓ is important, smoke (non-volatile particulate matter), and to a lesser extent UHC and CO all contribute to LAQ concerns.

1990 | 2004 | 2020
LAQ NOx and nvPM Trends
History of Engine Emission SARPs

1980: ICAO adopts more stringent NO\textsubscript{x} Standard (CAEP/2, 1993)

1985: ICAO adopts its first smoke, fuel venting, and gaseous emissions standard for turbojet and turbofan engines (1981)

1990: CAEP begins development of:
- Particulate Matter (PM) Standard
- ICAO Aeroplane CO\textsubscript{2} Standard (2010)

1995: CAEP approves the certification requirement of ICAO Aeroplane CO\textsubscript{2} Standard and agrees to a deliverable date of 2016 for the full CO\textsubscript{2} Standard (2013)

2000: ICAO adopts more stringent NO\textsubscript{x} Standard (CAEP/6, 2005)

2005: ICAO adopts more stringent NO\textsubscript{x} Standard and agrees to cut-off for engines not complying with the CAEP/6 NO\textsubscript{x} Standard (CAEP/8, 2011)

2010: CAEP approves nvPM mass and number Standard and end date 2023 of SN Standard (CAEP/11, 2019)

2015: ICAO Council adopts:
- nvPM Standard
- CO\textsubscript{2} Standard (2017)

2019: ICAO Council adopts:
-nvPM Standard
- CO\textsubscript{2} Standard (2017)
Evolution of NOx Standard

- Focus has been put on reducing NOx emissions from engines;
- Technological innovations continue to lead the way towards achieving ICAO’s environmental goals;
- CAEP developed with assistance of independent experts panel mid-term technology goal:
  - -54% of CAEP/8 for 2027
Development of nvPM Standard

- CAEP/10 recommended the first nvPM mass Standard for aircraft turbofan/turbojet engines with rated thrust >26.7 kN (from 1 January 2020);
- ICAO Council adopted nvPM mass SARPs, 2017;
- CAEP/11 recommended the nvPM mass and number Standards for in-production and new type aircraft turbofan/turbojet engines with rated thrust >26.7 kN (from 1 January 2023);
CAEP/11 Work on LAQ SARPs

• Updated LAQ trends assessment, which include PM and NOx;
• New engine NOx emission technology goals;
• Agreed as Annex 16 Volume II Chapter 4:
  – New regulatory limits for nvPM mass and number;
  – Applies to both in-production and new engine types from 1 January 2023;
• End Smoke Number Standard applicability for engines of rated thrust beginning 1 January 2023;
• Updates to ICAO Doc 9889 Airport Air Quality Manual;
• CAEP/12 work plan to update Annex 16, Volume II, Part III Chapter 3 LTO emissions SARPs for supersonic aircraft engines.
Conclusions

• ICAO completed a suite for Engine Emissions SARPs with development nvPM mass and number Standard;

• Successful development of LAQ SARPs facilitates the ICAO Strategic Objective on Environmental Protection;

• Future ICAO work addresses LAQ SARPs.
THANK YOU