Local Air Quality and ICAO Engine Emissions Standards

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- ICAO Engine Emissions Standards
- NOx Standards and Technology
- Developing a new Standard for Particulate Matter
- Summary





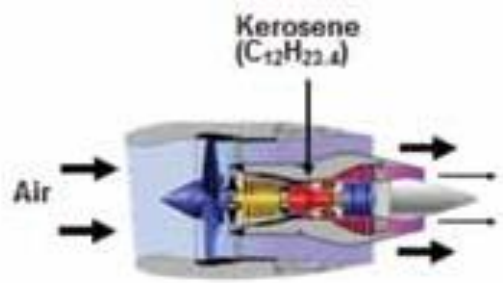
ICAO Engine Emissions Standards






ICAO Engine Emissions Standards

- Current ICAO Standards for emissions certification of aircraft engines are contained in Annex 16, Volume II:
  - The Engine Emissions Standards cover HC, CO, NOx and Smoke.

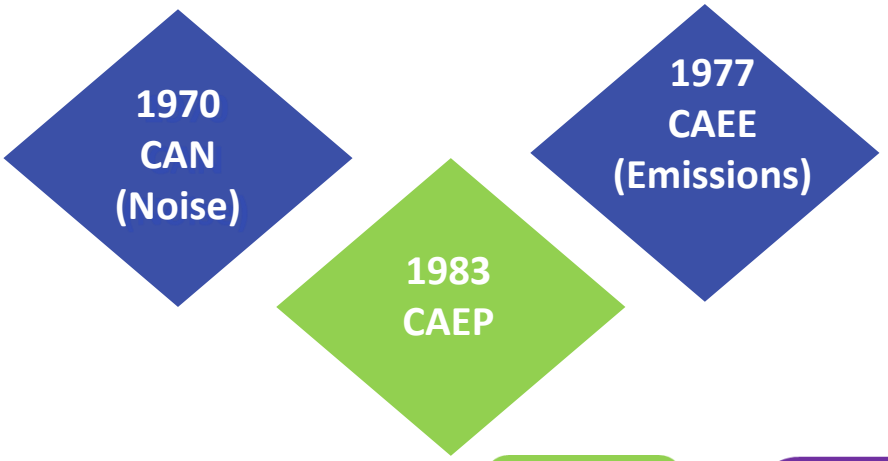


Emission	From 1 Kg fuel
CO_2	3160 g
H_2O	1290 g
NO_X	15 g
SO_X	1.2 g
CO	< 0.6 g
Hydrocarbons	< 0.01 g
Particulates	< 0.05 g
Air	lots

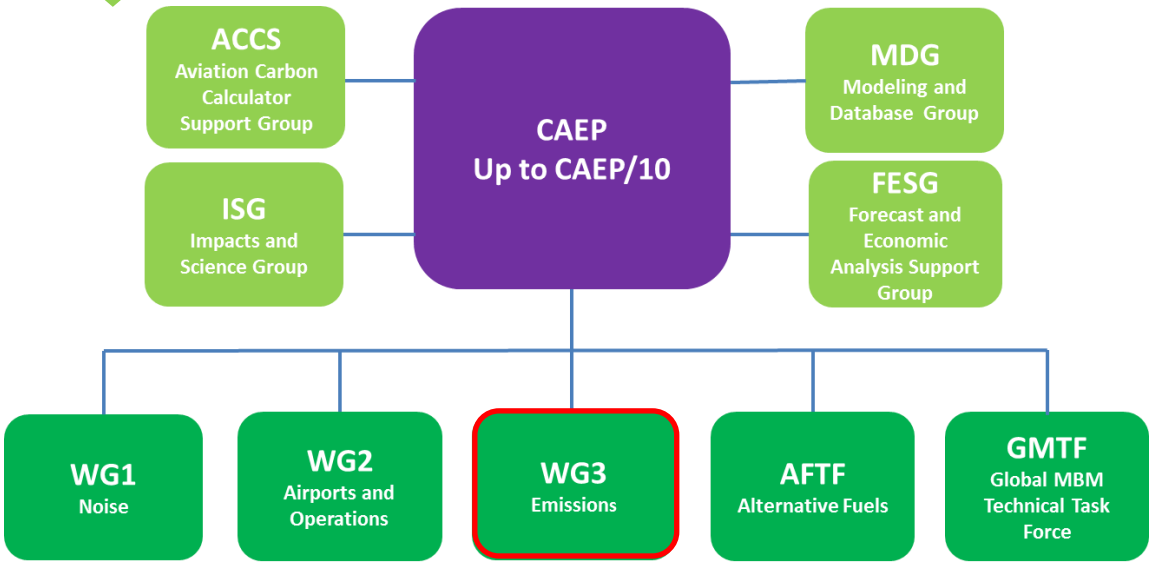
Around airports NOx is important, smoke (non-volatile particulate matter), and to a lesser extent UHC and CO all contribute to LAQ concerns.

- Concerns about Local Air Quality (LAQ) in the vicinity of airports focus on the effects of emissions released below 3,000 feet.

Committee on Aviation Environmental Protection (CAEP) – Working Group 3 – Emissions

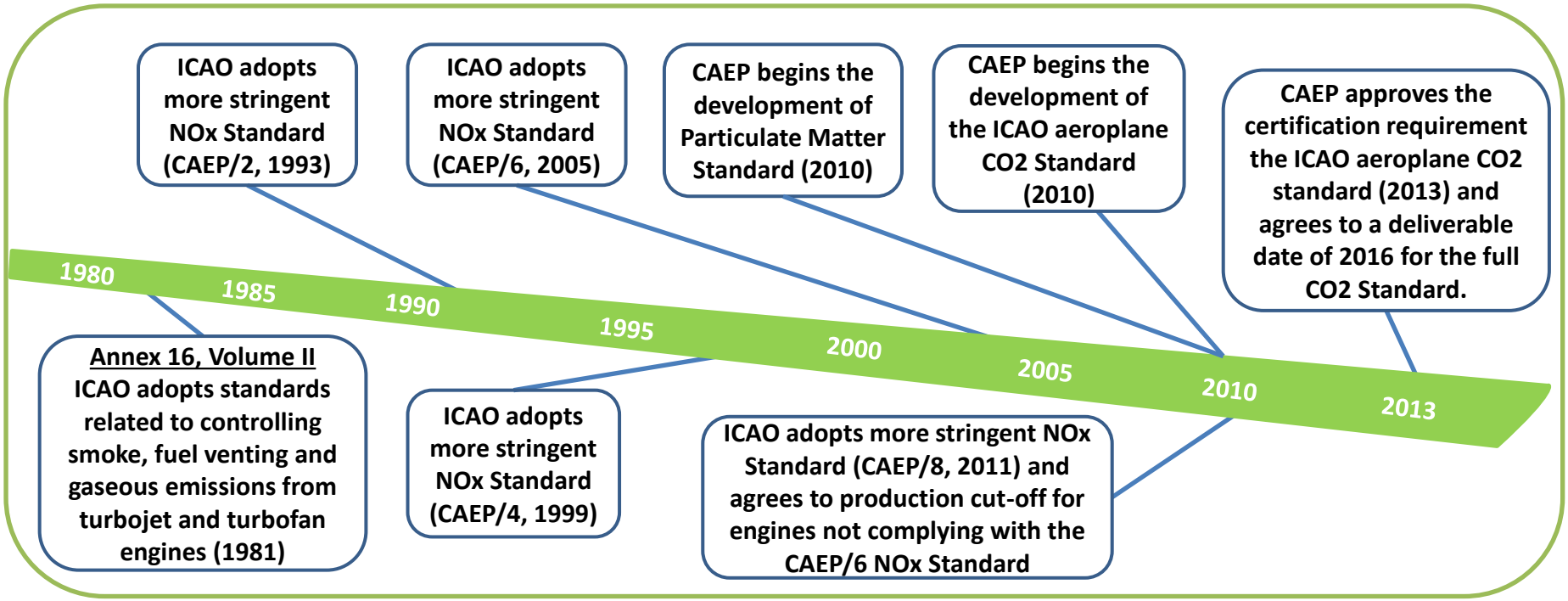


- **Established by the ICAO Council in 1983**, superseding the Committee on Aircraft Noise (CAN) and the Committee on Aircraft Engine Emissions (CAEE)



The history of ICAO Engine Emissions Standards

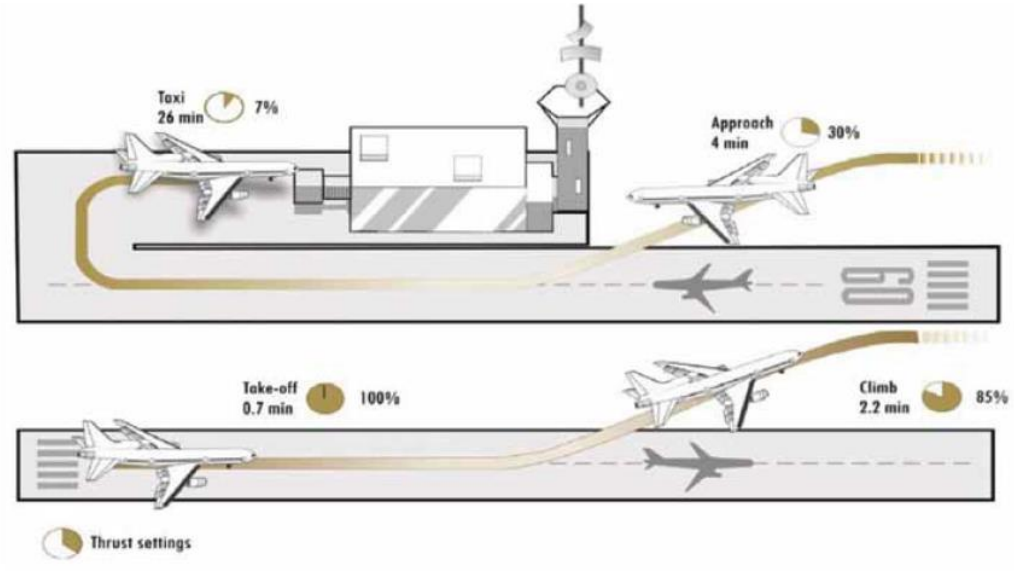
- ICAO adopted its first smoke, fuel venting and gaseous emissions from turbojet and turbofan engines in 1981.



Engine Emissions Certification Procedure

The certification process is based on the Landing Take-off (LTO) cycle.

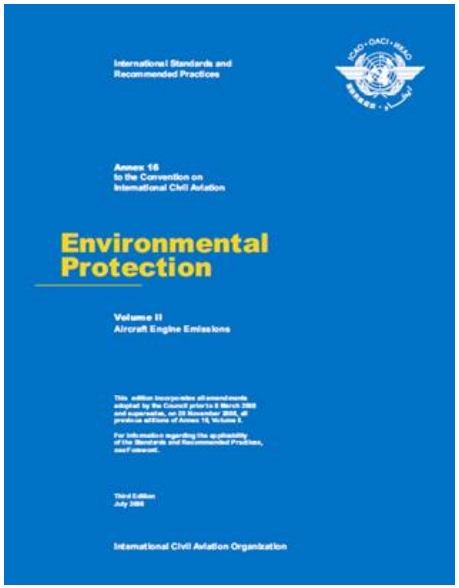
- **Take-off:** (100% available thrust) for 0.7 minutes;
- **Climb:** (85% available thrust) for 2.2 minutes;
- **Approach:** (30% available thrust) for 4.0 minutes;
- **Taxi:** (7% available thrust) for 26 minutes.



The certification process involves running the engine on a test bed at each thrust setting.

ICAO Engine Emissions Standards

- Result of the engine emissions certification:
  - Fuel flow (kg/s),
  - Emissions index (g/kg), and
  - Measured smoke number.
- Allows for the calculation of data values for each pollutant:
  - Emission rate (g/s)
  - Total gross emission (g)
  - Values of Dp/Foo (g/kn)
  - Maximum Smoke Number.



- Data are stored in the publically available ICAO emissions databank.





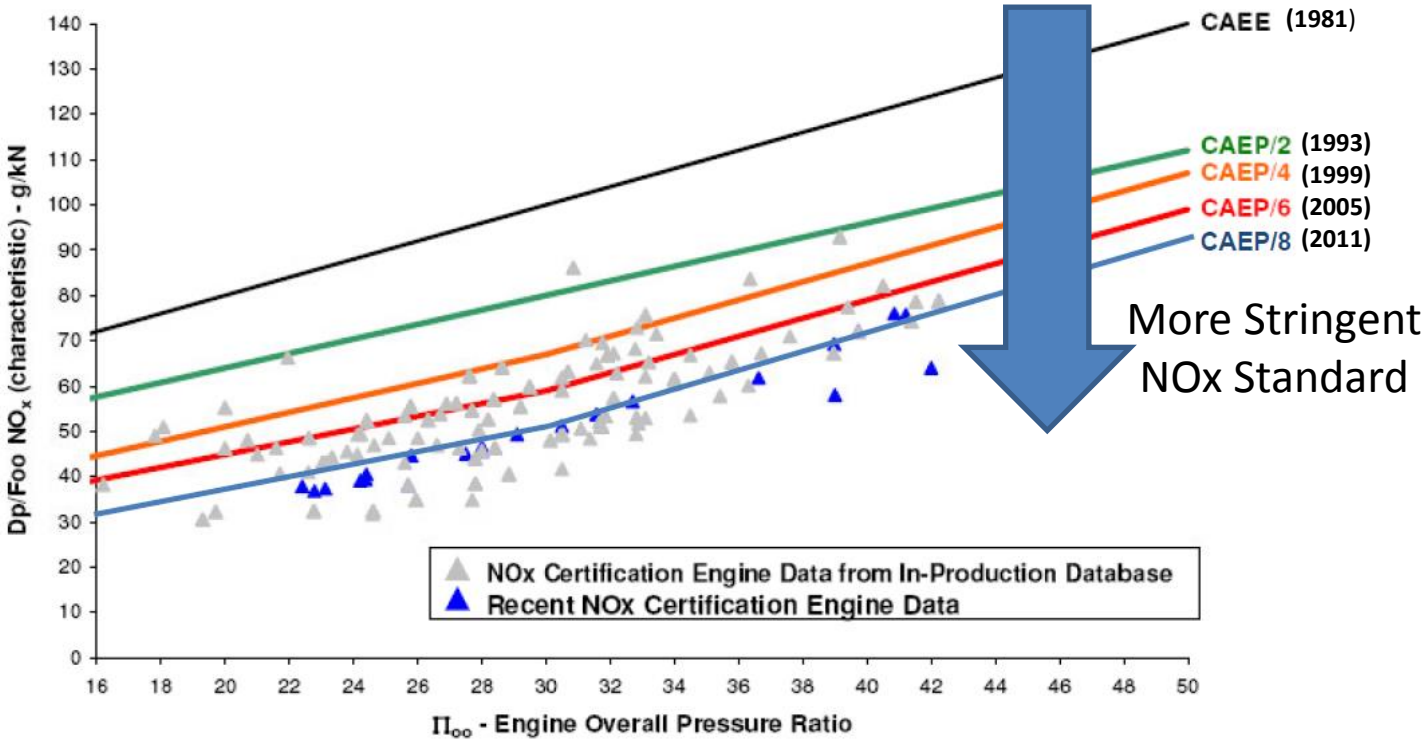

NOx Standards and Technology





NOx Standards and Technology

- Much of the international focus has been on the reduction of NOx.



Ref: Independent Experts NOx Review and the Establishment of Medium and Long Term Technology Goals for NOx (ICAO Doc 9887), 2006. CAEP/8 Standard line superimposed.

NOx Standards and Technology

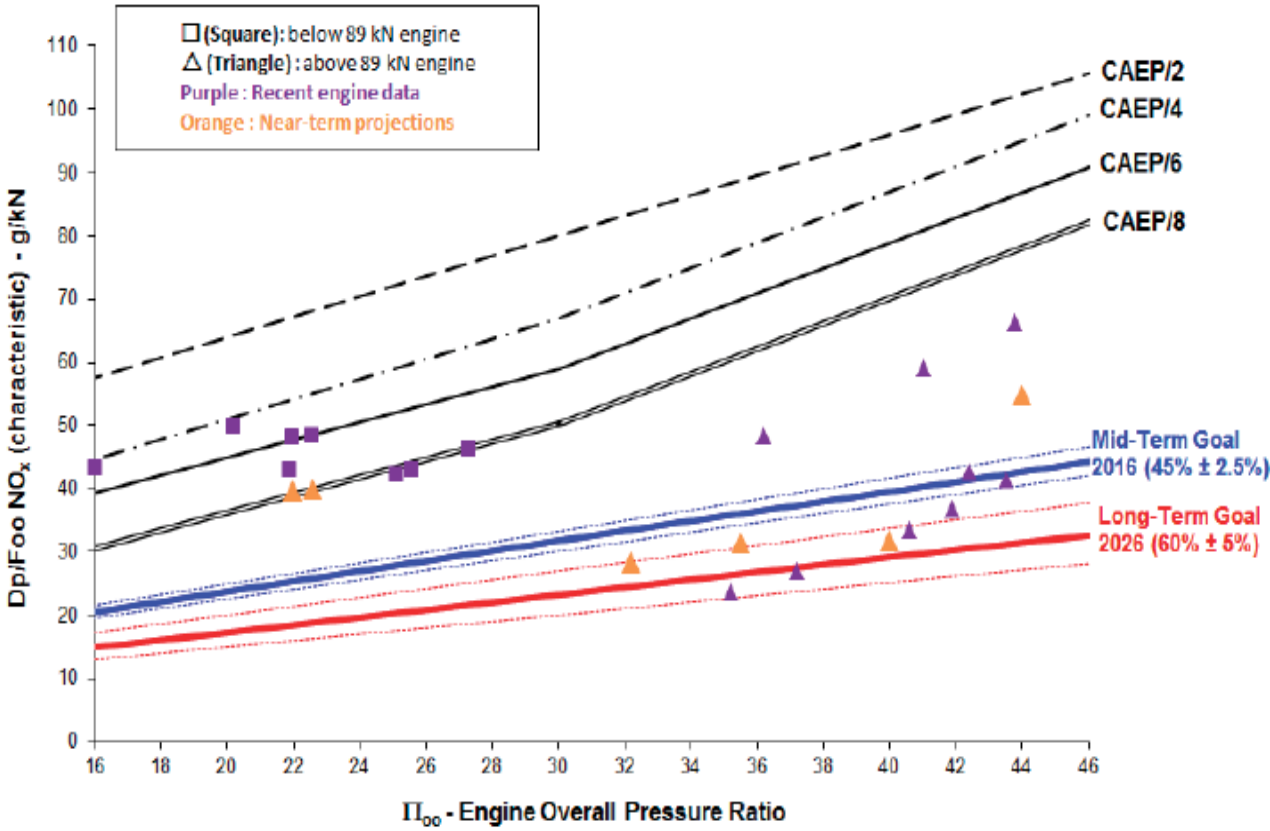
- Technological innovations continue to lead the way towards achieving ICAO's environmental goals
- CAEP developed, with the assistance of a panel of independent experts (in 2010), medium- and long-term NOx technology goals:
  - -45% of CAEP/6 for 2016;
  - -60% of CAEP/6 for 2026.
- Most recently an industry-led NOx technology review was performed and presented to CAEP.






Industry Led NOx Technology Review

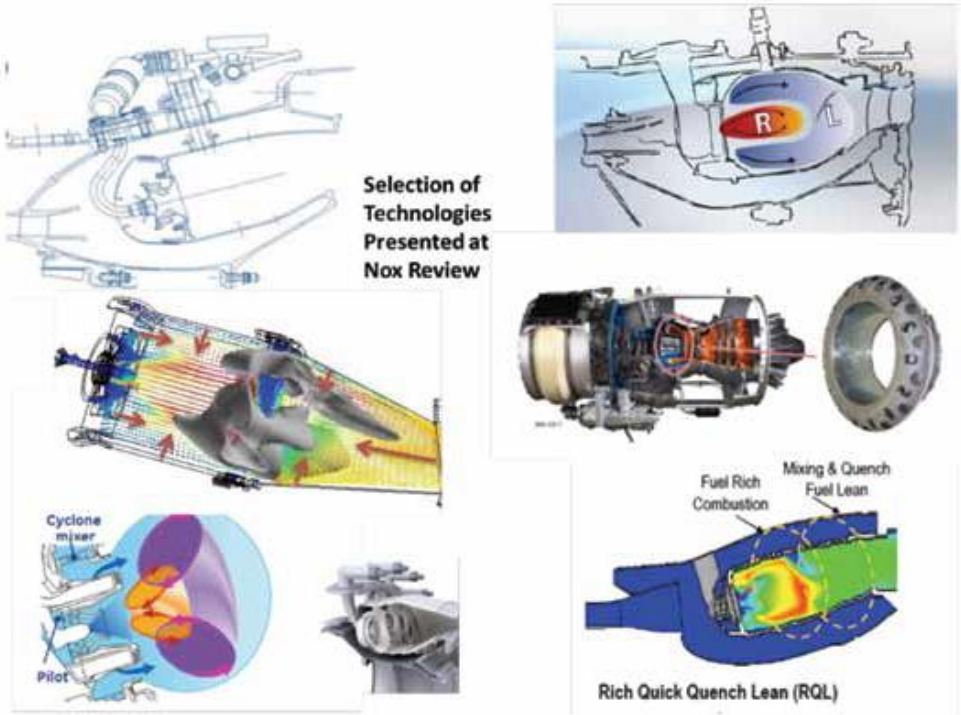
- Demonstrated the challenges in meeting the medium and long-term ICAO goals.
- For smaller engines it was not possible to conclude that the Mid-Term 2016 goal will be met.
- For the Long-Term 2026 goal it was demonstrated that no entire engine family has yet to meet the goal.



Industry Led NOx Technology Review

NOx reduction technologies include:

- Novel cycles that increase bypass ratios
- Incorporation of lean burn technology
- Rich Quick Quench Lean (RQL) technology



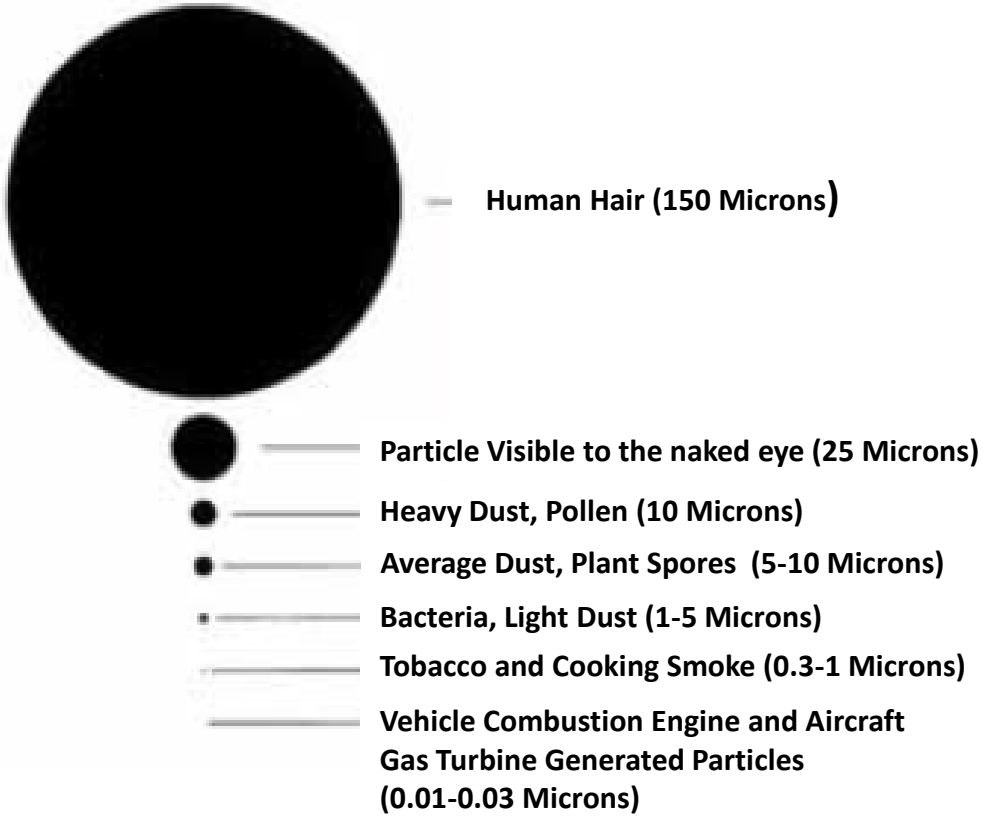
Developing a new Particulate Matter Standard






Developing a Particulate Matter Standard

- Aircraft engines burning hydrocarbon-based fuels emit gaseous and Particulate Matter (PM) emissions.
- Epidemiological evidence indicates that fine particles may impact human health.



- Soot or black carbon particles have also been shown to have climate impacts.

Developing a Particulate Matter Standard

- ICAO is currently developing the first non-volatile PM (nvPM) Standard for aircraft engines.
  - Developing an nvPM mass and number standard for turbofan/turbojet engines >26.7 kN.

- Technical work is underway to develop a potential nvPM emissions standard to turbofans/turbojets ≤26.7 kN:
  - Turboprops, Helicopter turboshaft, and APU engines.

Developing a Particulate Matter Standard

- Development of an nvPM Standard will address one of the gaps in the ICAO engine emissions Standards.
- An nvPM Standard will align aviation with other transportation modes.
- Will lead to better assessment of nvPM impacts.





Summary





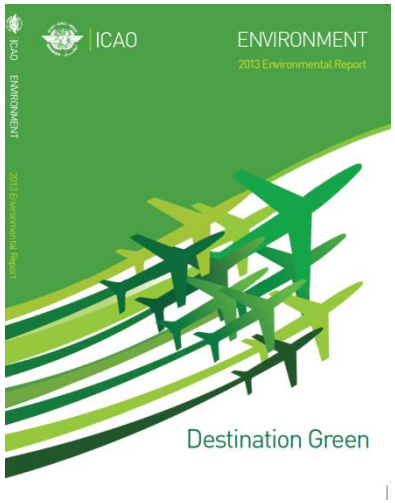

LAQ and Engine Emissions Standards

- Current ICAO Standards for engine emissions are contained in Annex 16, Volume II:
  - HC, CO, NOx and Smoke.
- Standard for NOx was first adopted in 1981.
- Made more stringent in 1993, 1999, 2005 and 2011.
- Development of an nvPM Standard will address a gap in the ICAO engine emissions Standards.
  - Main priority is to obtain nvPM emissions data to aid the development of the Standard.






For more information on ICAO activities on LAQ and Engine Emissions…



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THANK YOU