



Local Air Quality and ICAO Engine Emissions Standards

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

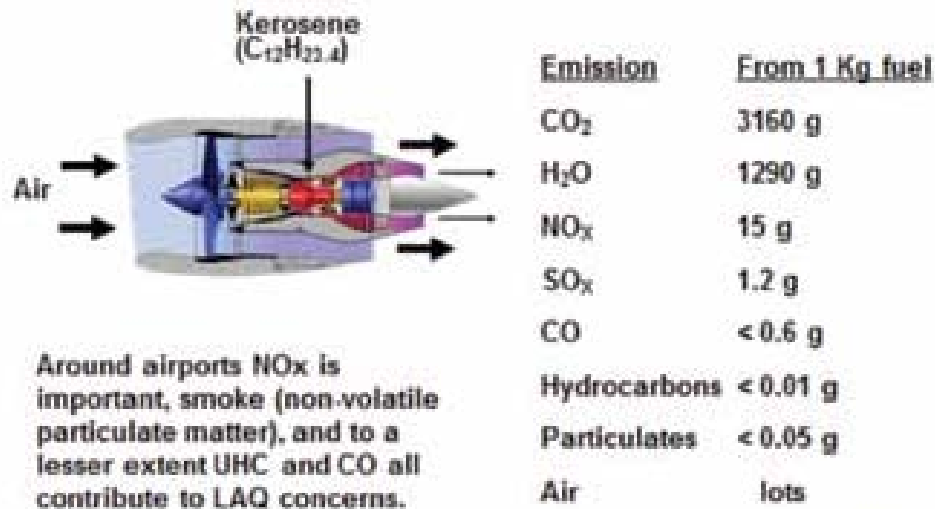




ICAO Engine Emissions Standards

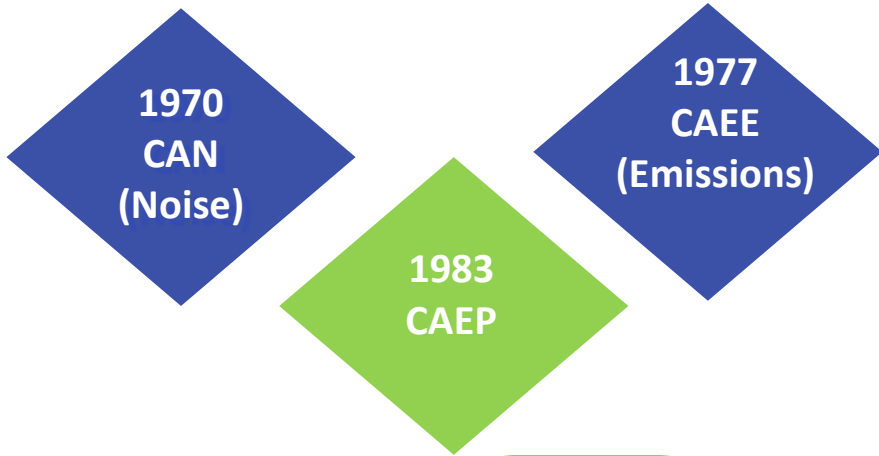


- Current ICAO Standards for emissions certification of aircraft engines are contained in Annex 16, Volume II:
 - The Engine Emissions Standards cover HC, CO, NO_x and smoke.

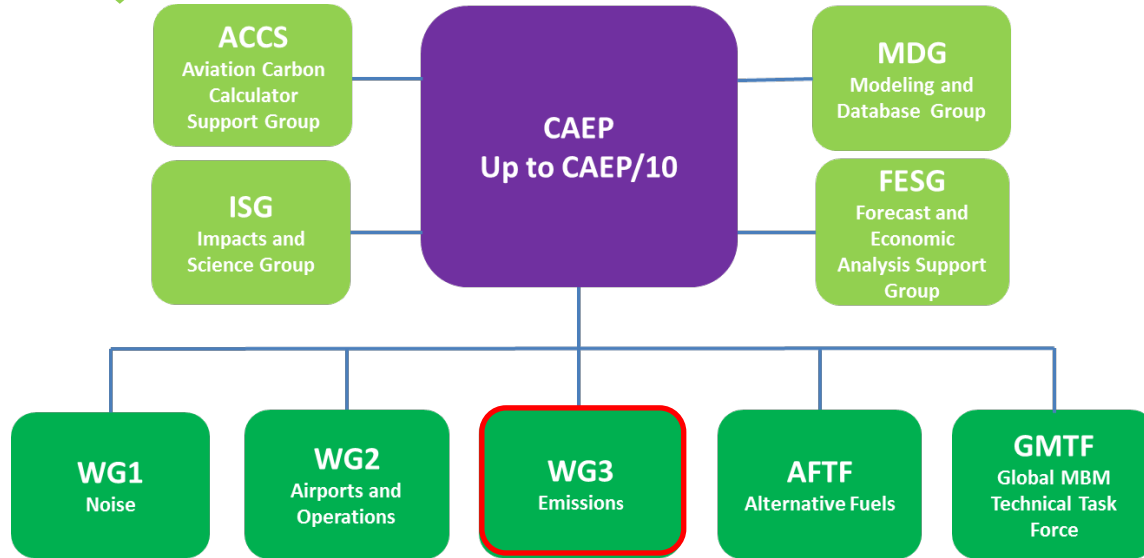


- Concerns about Local Air Quality (LAQ) in the vicinity of airports focus on the effects of emissions released below 3,000 feet.

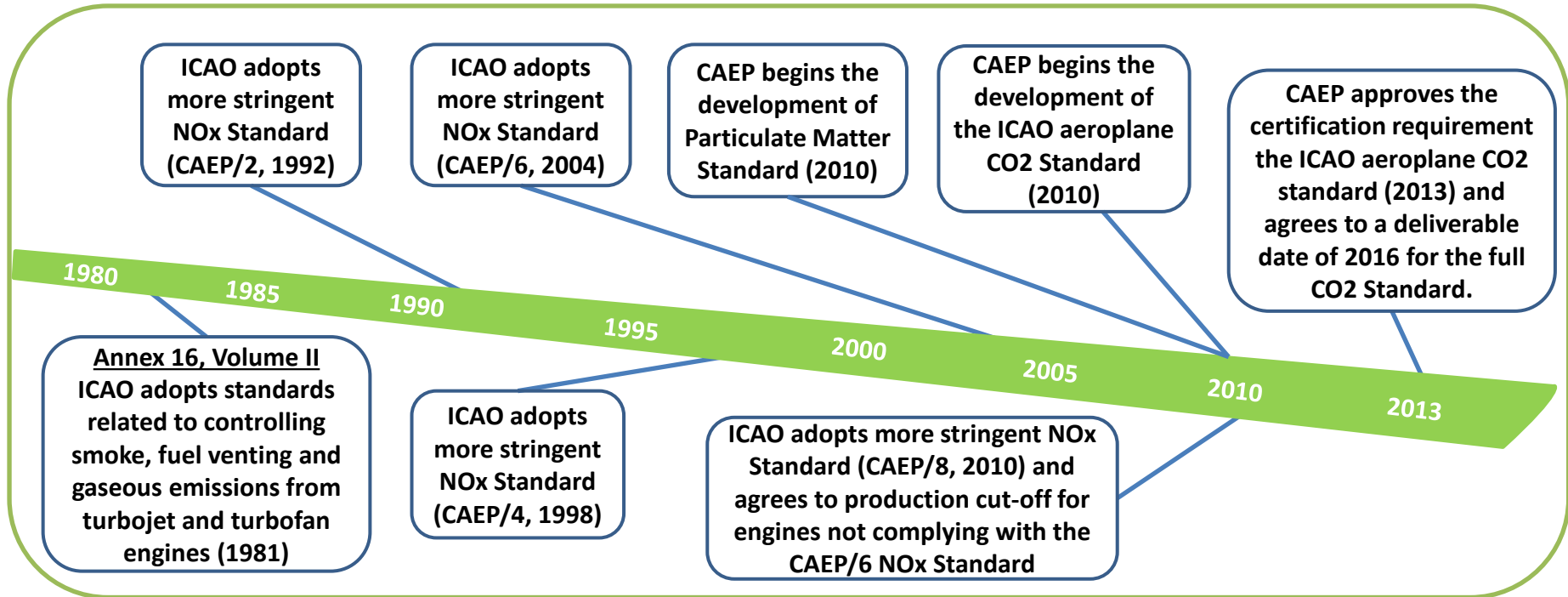




- Established by the ICAO Council in 1983, superseding the Committee on Aircraft Noise (CAN) and the Committee on Aircraft Engine Emissions (CAEE)



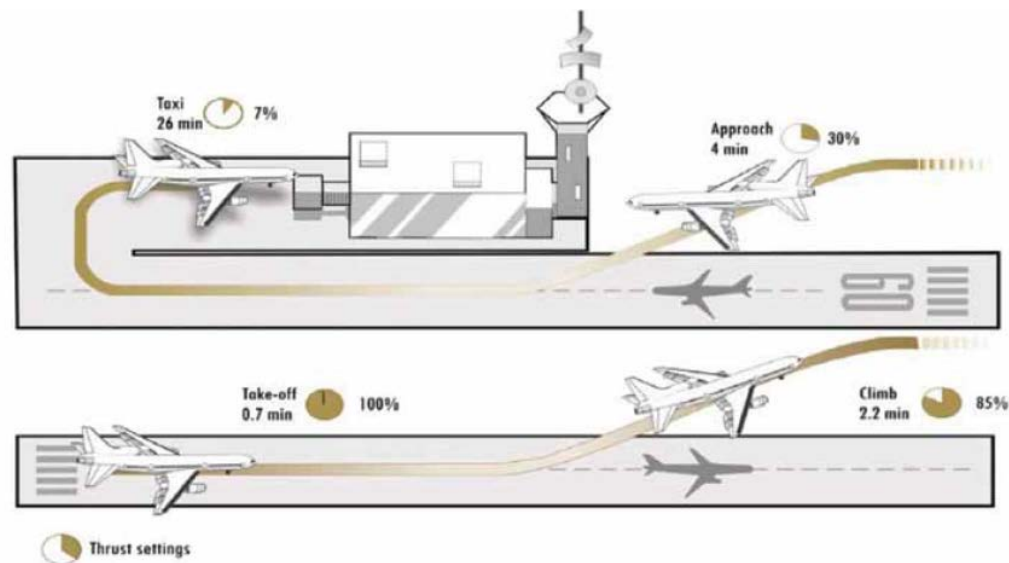
- ICAO adopted its first smoke, fuel venting and gaseous emissions from turbojet and turbofan engines in 1981.



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.



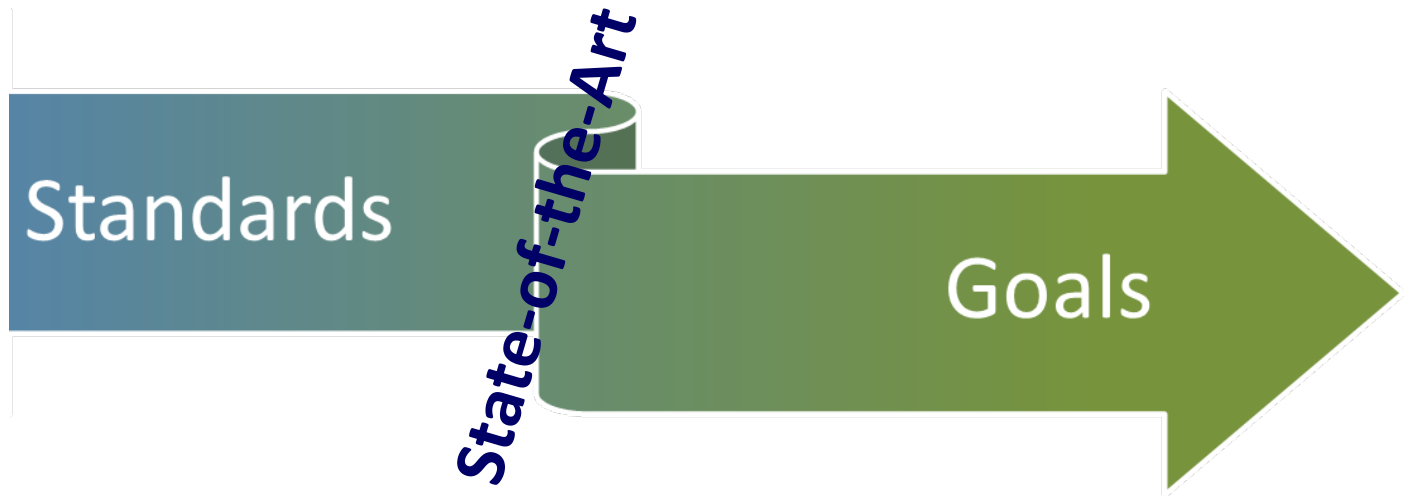
- Result of the engine emissions certification:
 - Fuel flow (kg/s),
 - Emissions index (g/kg), and
 - Measured smoke number.
- Allows for the calculation of data values for each pollutant:
 - Emission rate (g/s)
 - Total gross emission (g)
 - Values of Dp/Foo (g/kn)
 - Maximum Smoke Number.
- Data are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





NOx Standards and Technology

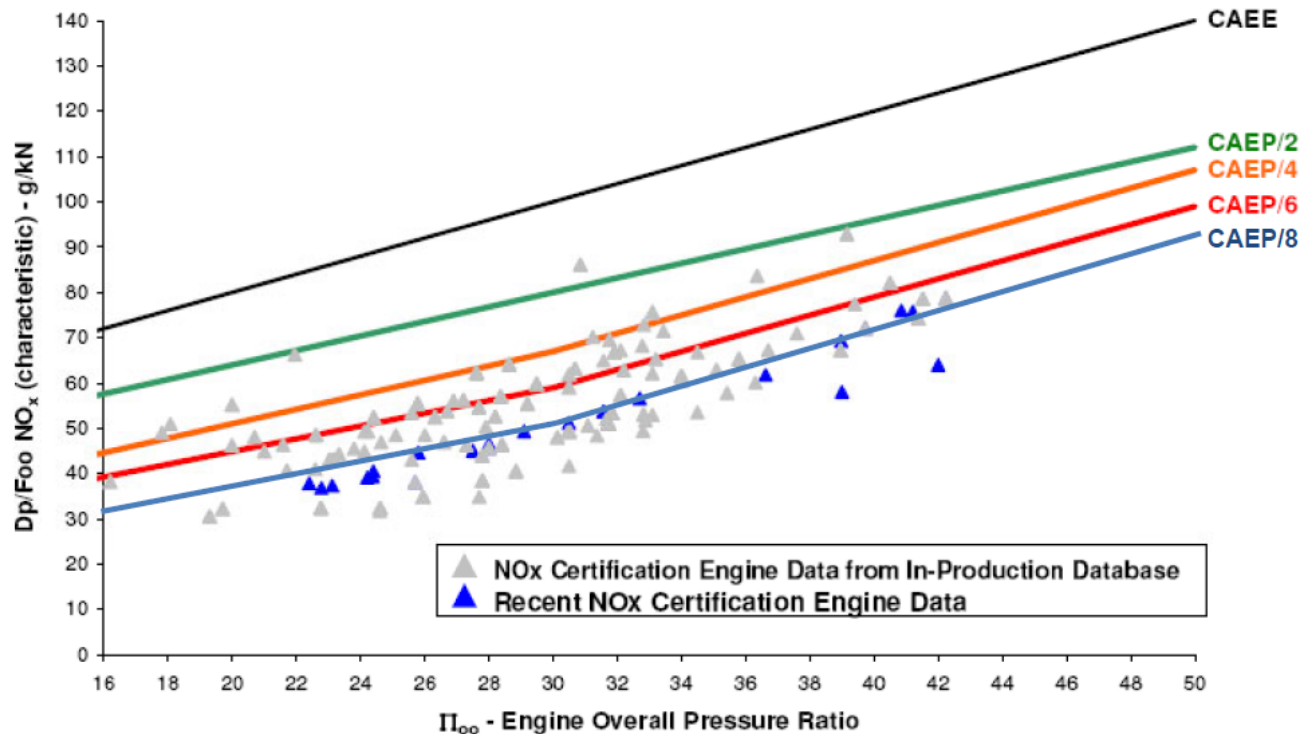




Establishing Technology Standards



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



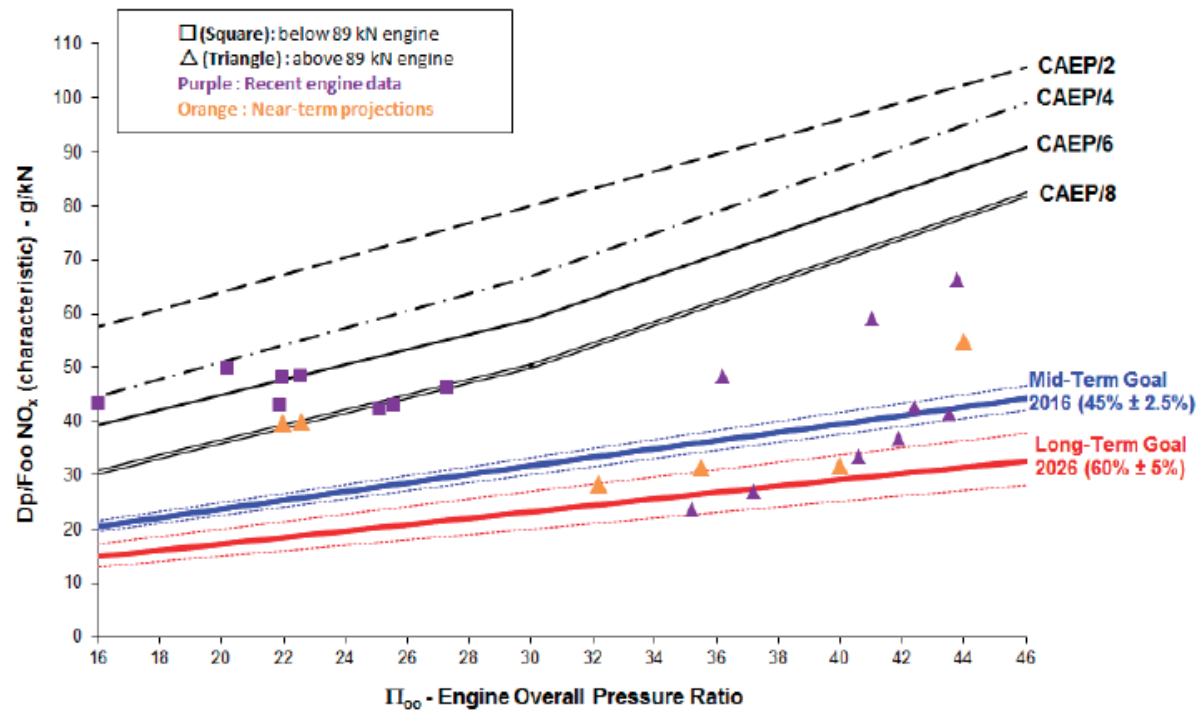
Ref: Independent Experts NO_x Review and the Establishment of Medium and Long Term Technology Goals for NO_x (ICAO Doc 9887), 2006. CAEP/8 Standard line superimposed.



- 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.

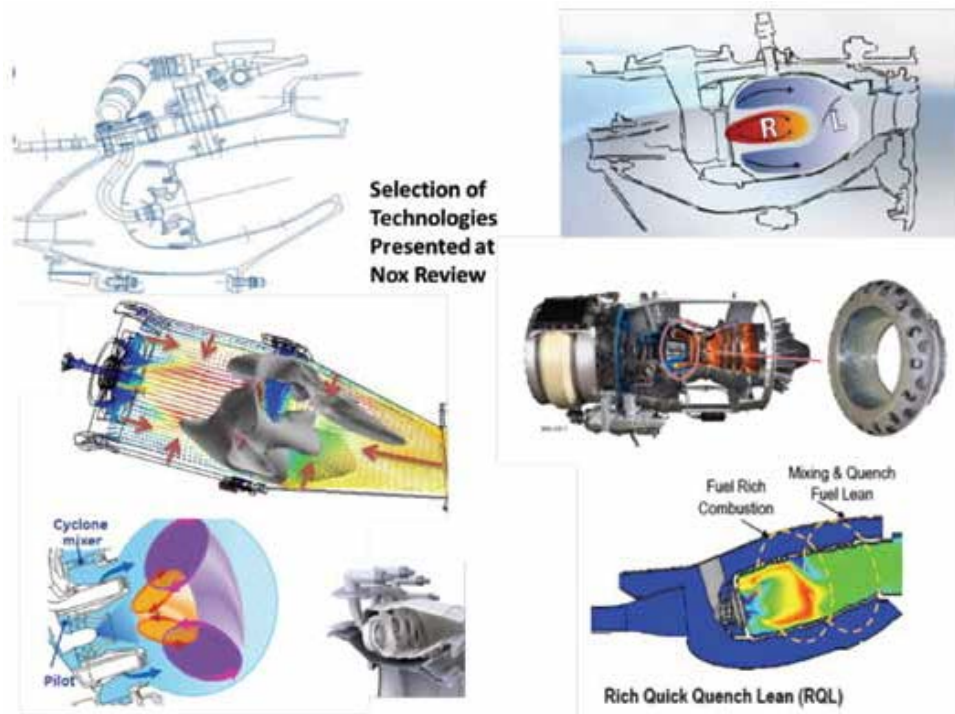


- Demonstrated the challenges in meeting the medium and long-term ICAO goals.
- For smaller it was not possible to conclude that the Mid-Term 2016 goal will be met.
- For the Long-Term 2026 goal it was demonstrated that no entire engine family has yet to meet the goal.



NOx reduction technologies include:

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





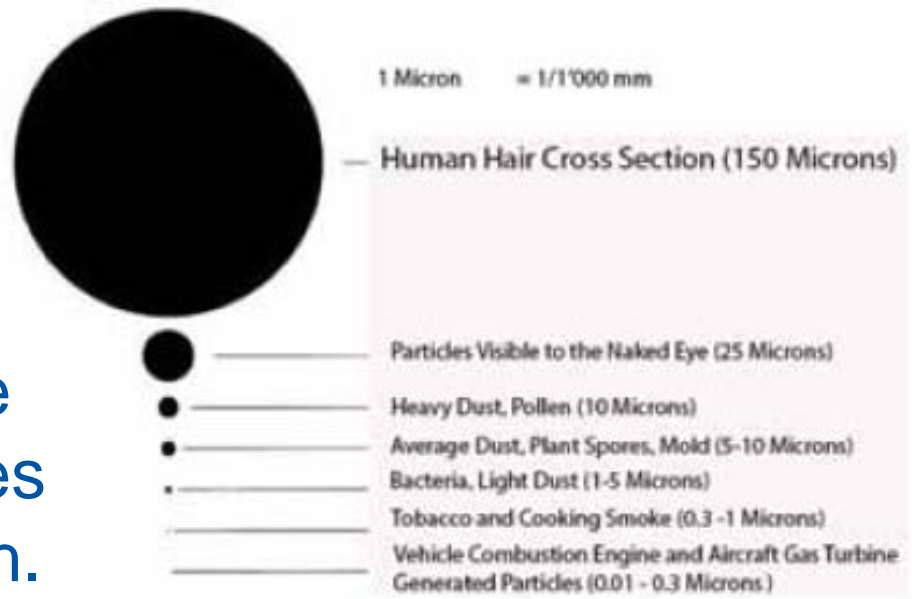
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ENVIRONMENT

Developing a new Particulate Matter Standard



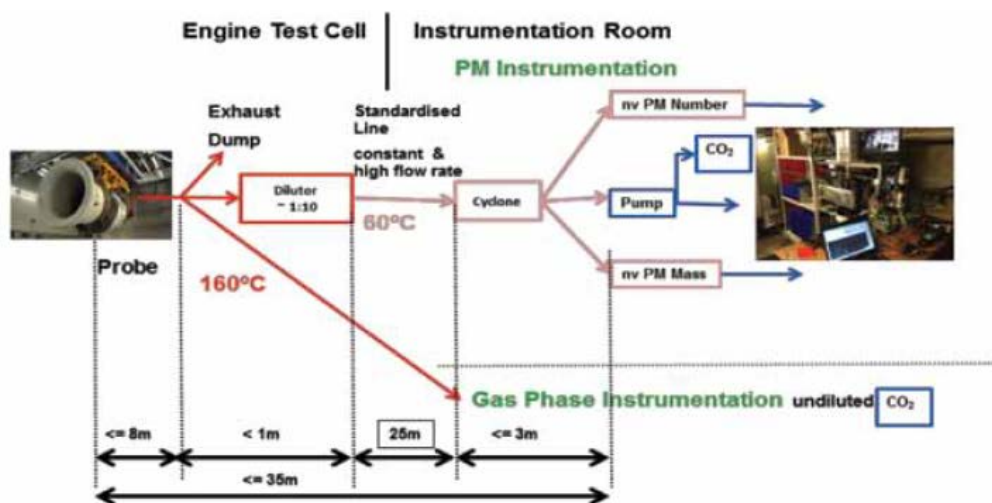
- Aircraft engines burning hydrocarbon-based fuels emit gaseous and Particulate Matter (PM) emissions.
- Epidemiological evidence indicates that fine particles may impact human health.
- Soot or black carbon particles have also been shown to have climate impacts.



- 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.



- Data on nvPM engine emissions is crucial to informing the ICAO Standard-setting process.
- Standardization of the instrumentation to measure nvPM is crucial.
- Technically demanding measurement of nvPM from aircraft engines.



- 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



- Current ICAO Standards for engine emissions are contained in Annex 16, Volume II:
 - HC, CO, NO_x and Smoke.
- Standard for NO_x 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...



ICAO Web Page
www.icao.int/

THANK YOU

