Global Emissions Technology

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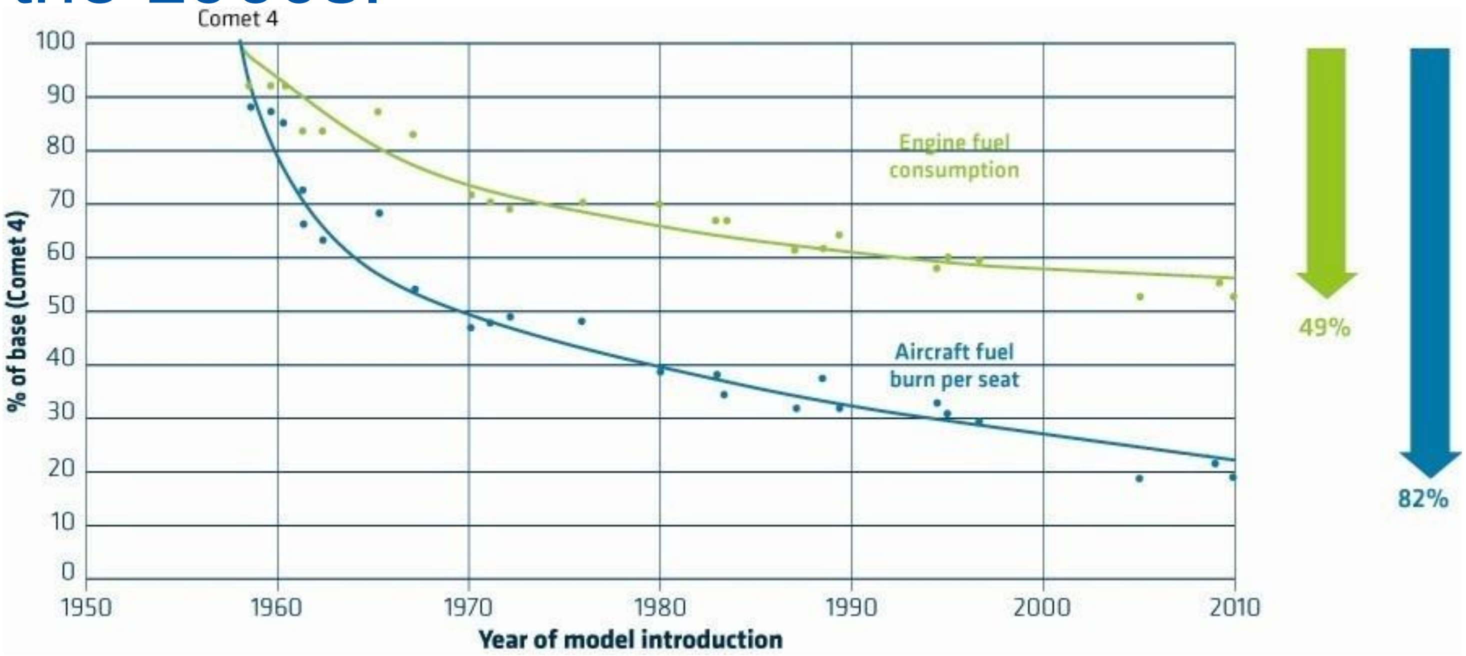
- Pushing the technology envelope
- The Independent Expert Review on Fuel Burn Technology
- The development of the ICAO CO_2 Standard
- Summary

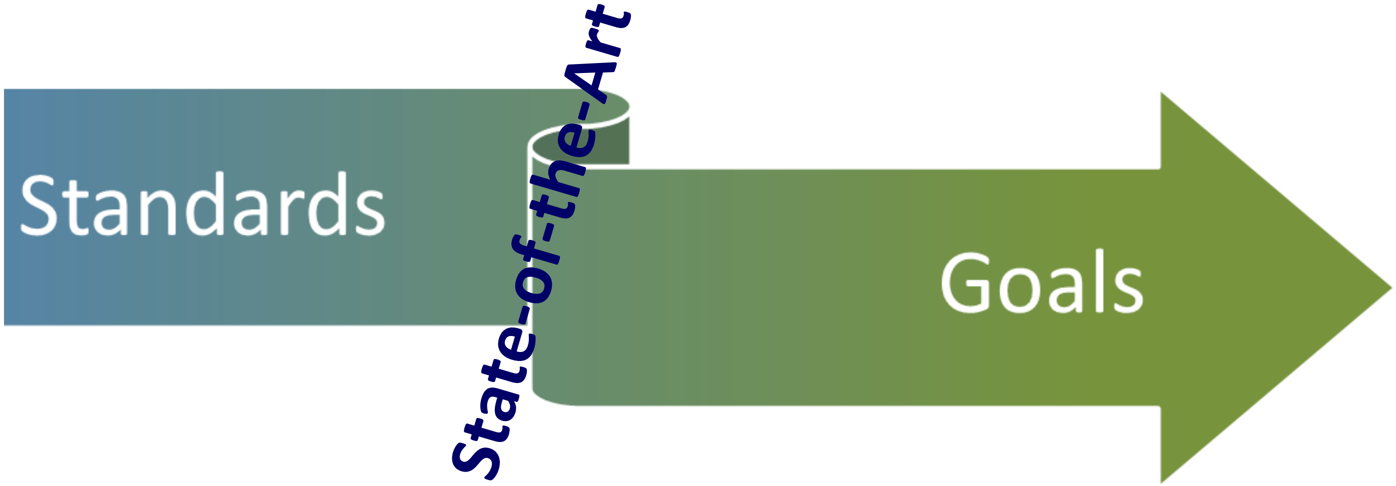
Pushing the technology envelope

- 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

Environmental Standard Principles



Establishing Technology Standards

Pushing the Technology Envelope

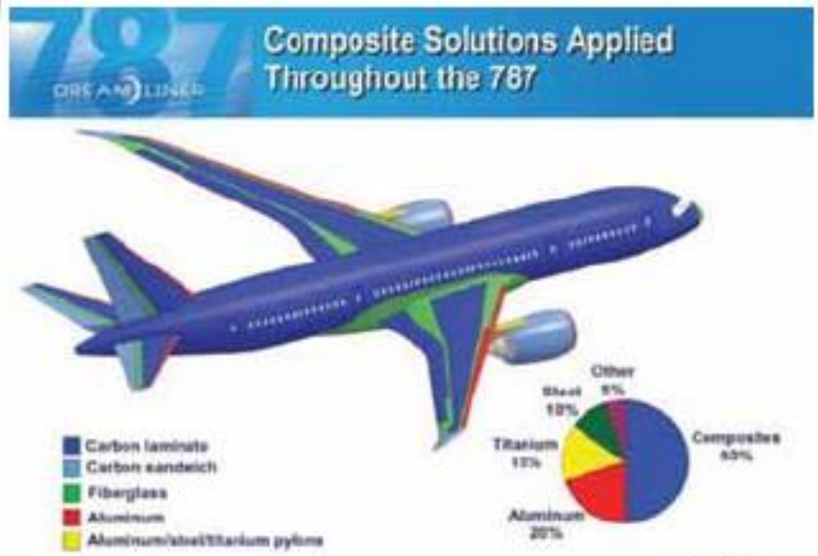
Pushing the technology envelope

- 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.

Pushing the technology envelope

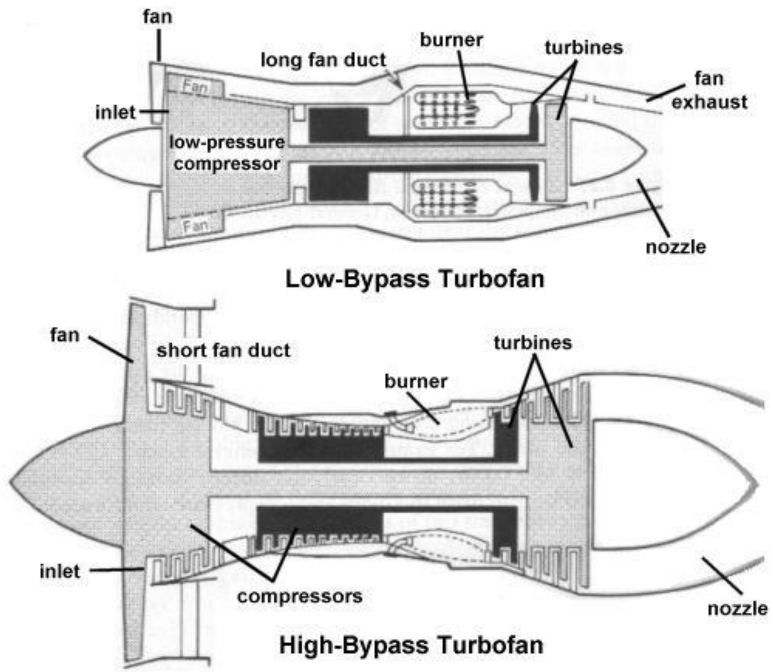
- Reductions in weight are a key factor in reducing fuel burn:
  - Use of Carbon Fibre Reinforced Plastic (CFRP) and advanced alloys is increasing;
- Airbus A380 contains 25% composites.
- Boeing 787 and Airbus A350 have pushed the composite use to 50%.

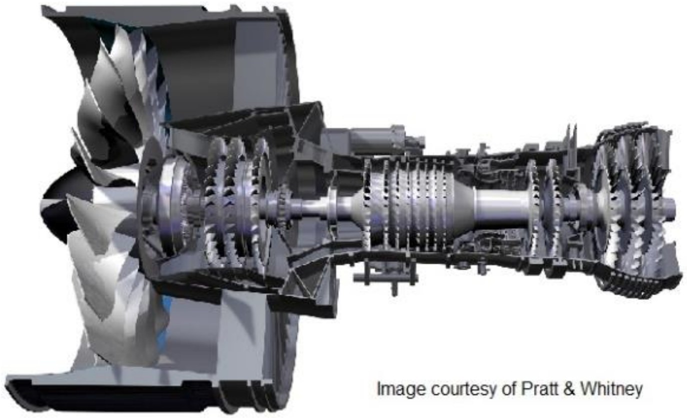


Source: ICCAIA

Pushing the technology envelope

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

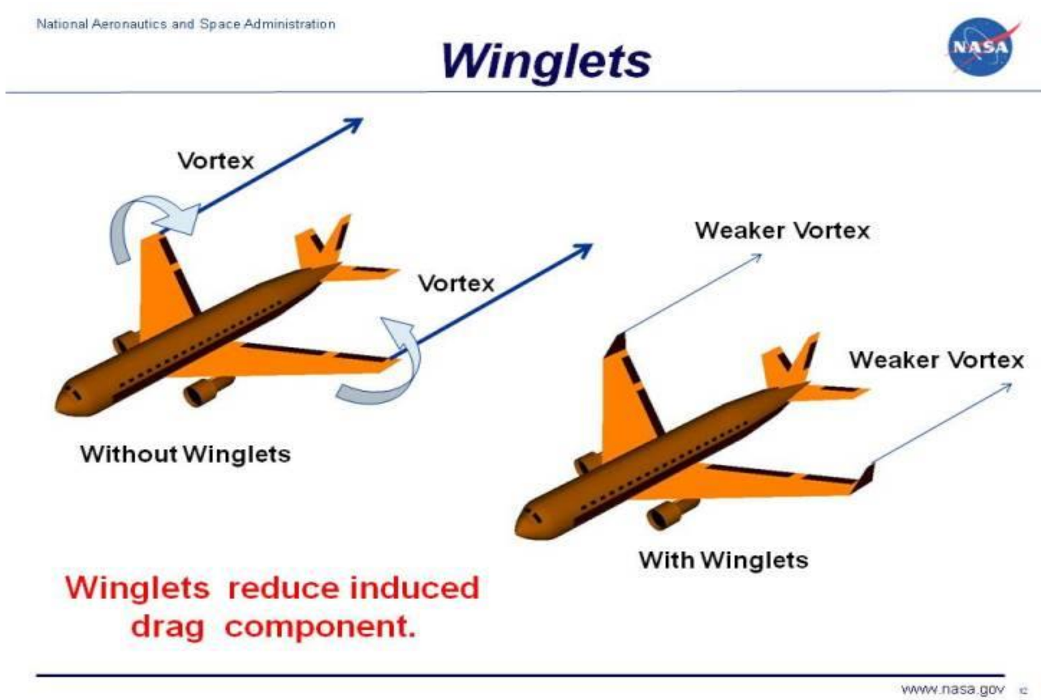




http://www.ecomagination.com/portfolio/genx-aircraft-engine
http://machinedesign.com/archive/fewer-trips-fuel-truck

Pushing the technology envelope

- Aerodynamics, for example:
  - Drag reduction technologies
  - Wingtip devices



http://www.airlinereporter.com/

Independent Expert Fuel Burn Technology Review

Independent Expert 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.

Independent Expert technology review

- 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)					Small Twin Aisle (STA)				
	2020	2030	2020	2030	2030	2020	2030	2020	2030	2030
	TS1	TS1	TS2	TS2	TS3	TS1	TS1	TS2	TS2	TS3
Propulsive efficiency	13	14	14	15	28*	6	9	7	10	12**
Thermodynamic efficiency	3	4	4	5	3*	2	3	3	4	5**
Induced non-viscous drag	2	4	4	6	7	2	4	4	6	7
Viscous drag	2	4	4	7	9	2	6	4	8	10
Structural weight	10	15	15	20	20*	10	15	15	20	25**

* 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

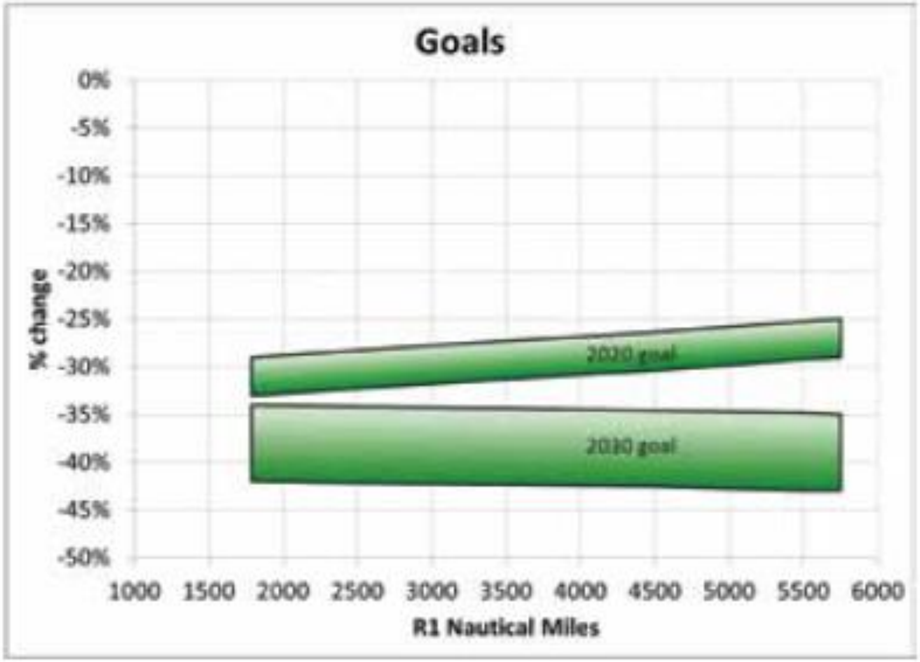
	2020		2030	
	SA	STA	SA	STA
TS1	23	19	29	26
TS2	29	25	34	35
TS3			41	41
TS3 Open Rotor			48	



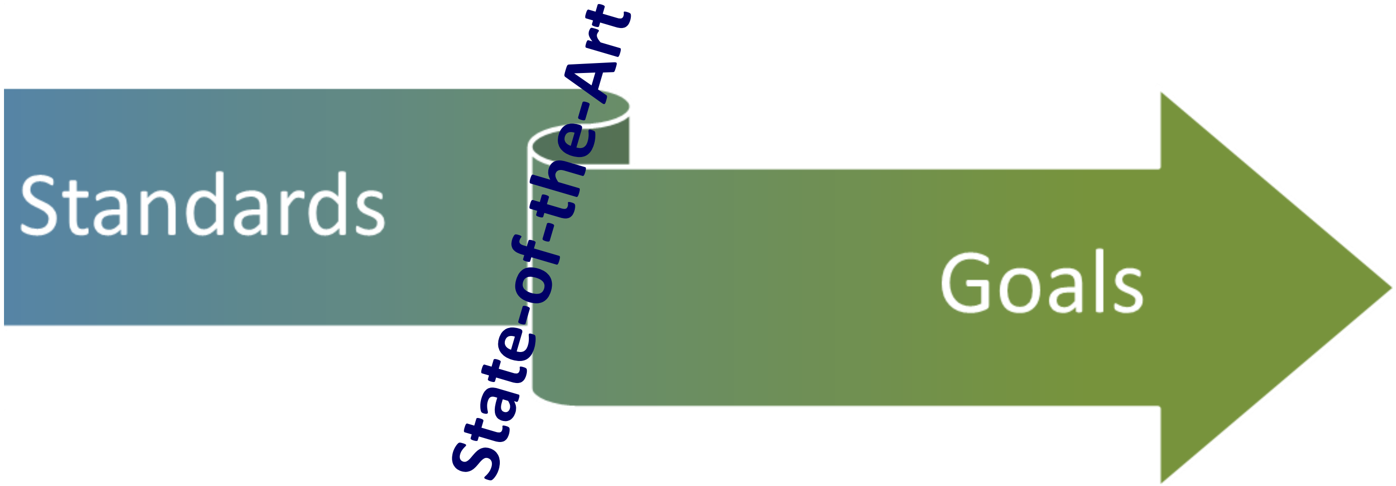


- **The 2020 goal** would be met if an aircraft achieves a reduction in excess of between 29% and 25% relative to baseline aircraft of 2000.

- **The 2030 goal** would be achieved if the corresponding reduction were between 34% and 35% relative to baseline aircraft of 2000.

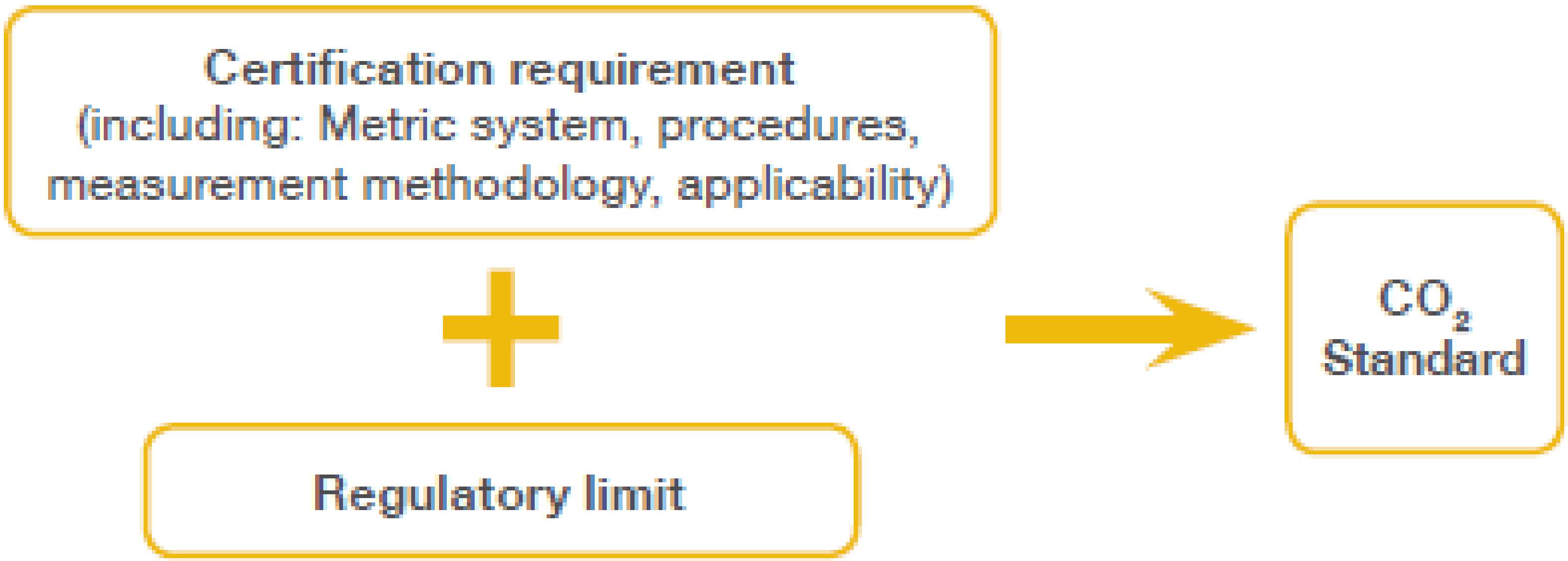


Developing ICAO CO_2 Standard



Establishing Technology Standards

Aeroplane CO_2 Standard Framework

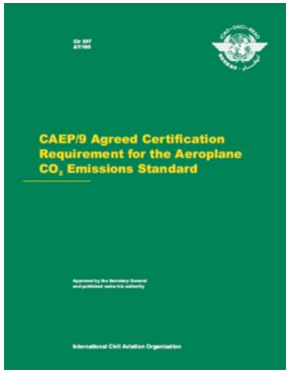


- Technology Standard similar to current Noise and Engine Emissions Standards.
- Aircraft level Standard similar to Noise Standard.

CO_2 Standard Progress

- **The aircraft CO_2 Standard will result in a new Annex 16 Vol. III**
- **Two phases in the approach:**
  - **<u>Phase 1 (completed)</u>**
    - Development of CO_2 Certification Requirement (metric system, procedures);
  - **<u>Phase 2 (ongoing)</u>**
    - CO_2 Standard setting process (stringency levels, technology responses, cost effectiveness assessments and interdependencies).

CO_2 certification requirement was agreed by CAEP/9 in February 2013 and published for information as Circular 337.



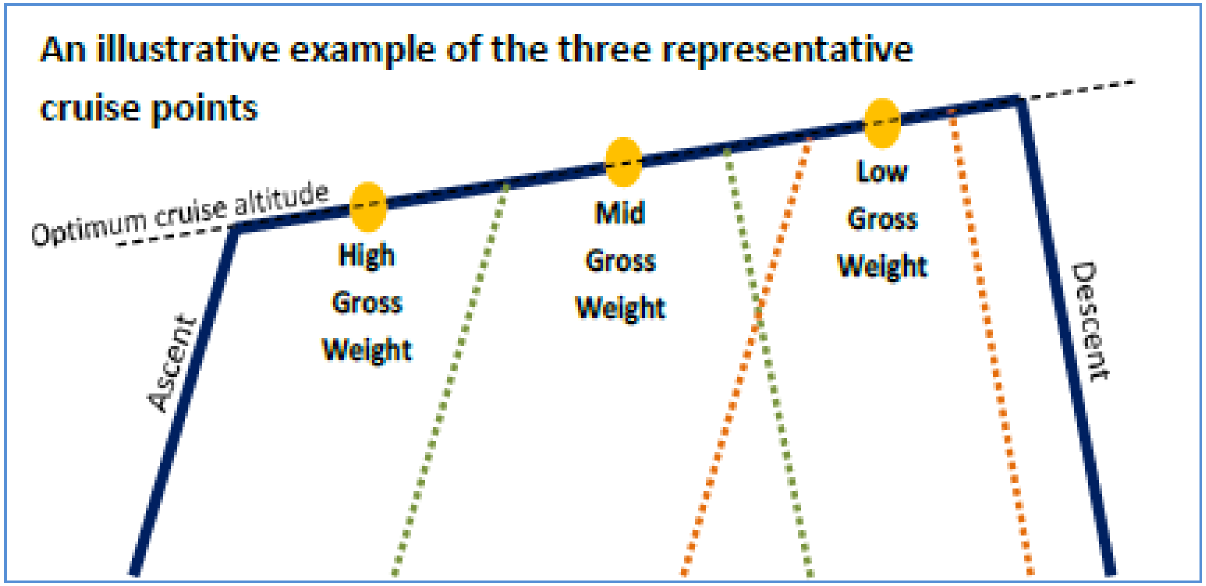
CO_2 Standard - Metric System

The CO_2 Standard contains a CO_2 metric system, which includes:

A Metric: Cruise point fuel burn performance and aeroplane size.

A Correlating parameter: Maximum aeroplane mass.

Three Certification test points: Based on aeroplane mass.



CO_2 Standard - Certification Procedures

- Using the Metric System as a basis, CAEP developed the CO_2 Standard certification requirement.
  - Developed using a group of certification experts from States and international organizations.
- Resulting in the certification test criteria for the implementation of the CO_2 metric system.
- Development of procedures to measure the elements of the CO_2 metric system:
  - measurement of all parameters;
  - correction of measured data to reference conditions.

CO_2 Standard - Applicability

- The CO_2 Standard will be applicable at an aeroplane level.
- The CO_2 Standard will be applicable to new aeroplane types.
  - Discussions continue over including in-production types.
- The CO_2 Standard will be applicable to subsonic jet and propeller driven aeroplanes.
- The CO_2 Standard will likely be applicable in 2020 or 2023.

Finalising the CO_2 Standard

- 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.

CO_2 Standard Progress

- 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

Global Emissions Technology

- 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 CO_2 Standard which aims to encourage the use of the latest Aeroplane technologies:
  - The CO_2 Standard will be complete by 2016.

For more information on ICAO activities on Global Emissions Technology…

ICAO Web Page

www.icao.int/

THANK YOU