THE CAEP/10 RECOMMENDATION ON A NEW ICAO AEROPLANE CO_2 EMISSIONS STANDARD

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Following six years of development, ICAO's Committee on Aviation Environmental Protection (CAEP) at its tenth meeting (CAEP/10) recommended an Aeroplane Carbon Dioxide (CO_2) Emissions Certification Standard. This new standard is part of the ICAO "basket of measures" to reduce greenhouse gas emissions from the air transport system, and it is the first global technology Standard for CO_2 emissions for any sector with the aim of encouraging more fuel efficient technologies into aeroplane designs.

This technology-based approach is similar to the current ICAO Annex 16 Standards on engine emissions for local air quality (Volume II) and aircraft noise (Volume I). The recommended CO_2 Standard has been developed at the aeroplane level, and therefore has considered all technologies associated with the aeroplane design (e.g. propulsion, aerodynamics and structures). Once adopted by the ICAO Council, the Aeroplane CO_2 Emissions Certification Standard will be published as a new Annex 16, Volume III.

The framework for the CO_2 Standard consists of a certification requirement and regulatory limit, as shown in Figure 1, and the work to develop the CO_2 Standard was divided into two phases. Phase 1, which was completed at the ninth meeting of the CAEP (CAEP/9) in February 2013, resulted in the approval of some of the details regarding the applicability of the Standard, the CO_2 Metric System and the development of a CO_2 Standard certification requirement. Phase 2 involved the development of the regulatory limit lines and the applicability requirements such as scope and date.

In the ICAO Environmental Report 2013, a summary was provided of the work that had been completed during Phase 1. This new article provides an overview of both phases over the past six years, the lead up to the CAEP/10 meeting and the recommendation from the CAEP/10 meeting on the first ICAO Aeroplane CO_2 Emissions Certification Standard.

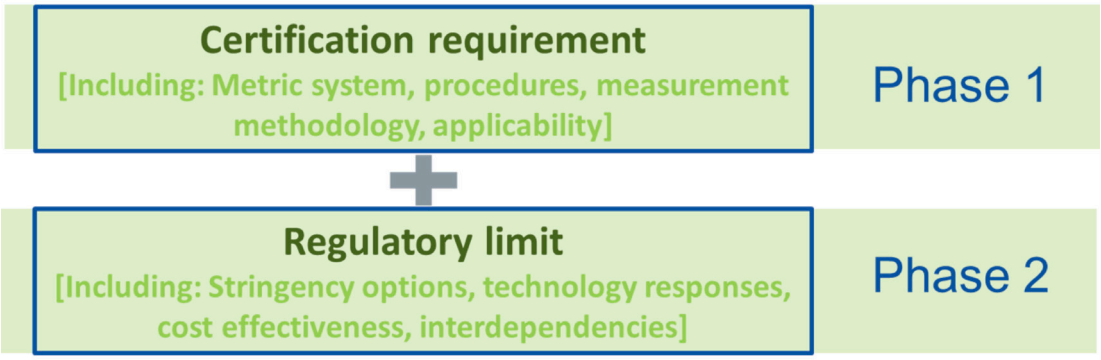

Figure 1. The framework and development phases of the CO_2 Standard.

Phase 1 work- The Development of Certification Requirement

An important Phase 1 milestone in the development of the CO_2 Standard was the agreement on a CO_2 metric system to measure the aeroplane fuel burn, and therefore CO_2 emissions, performance. The intent of this CO_2 metric system is to equitably reward advances in aeroplane technologies (e.g. propulsion, aerodynamics and structures) that contribute to reductions in aeroplane CO_2 emissions, and differentiate between aeroplanes with different generations of these technologies. As well as accommodating the full range of technologies and designs which manufacturers can employ to reduce CO_2 emissions, the CO_2 metric system has been designed to be common across different aeroplane categories, regardless of aeroplane purpose or capability. An overview of the CO_2 Metric System can be found in **Figure 2**.

GENERAL CO_2 STANDARD APPLICABILITY SCOPE FOR AEROPLANE CATEGORIES

- Subsonic Jet Aeroplanes Over 5700 kg
- Propeller-Driven Aeroplanes Over 8618 kg

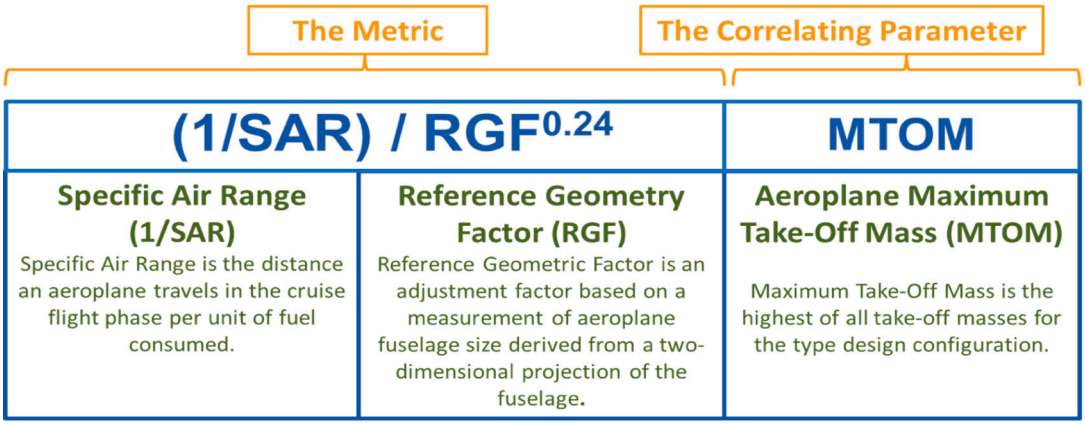

Figure 2. An overview of the CO_2 Metric System

To establish the fuel efficiency of the aeroplane, the CO_2 metric system uses multiple test points to represent the fuel burn performance of an aeroplane type during the cruise phase of flight. Specifically, there are three averaged (i.e. equally weighted) points representing aeroplane high, middle and low gross masses, which are calculated as a function of Maximum Take-Off Mass (MTOM). Each of these represents an aeroplane cruise gross mass seen regularly in service. The objective of using three gross mass cruise points is to make the evaluation of fuel burn performance more relevant to day-to-day aeroplane operations.

The metric system is based on the inverse of Specific Air Range (i.e. 1/SAR), where SAR represents the distance an aeroplane travels in the cruise flight phase per unit of fuel consumed. In some aeroplane designs, there are instances where changes in aeroplane size may not reflect changes in aeroplane weight, for example when an aeroplane is a stretched version of an existing aeroplane design. To better account for such instances, not to mention the wide variety of aeroplane types and the technologies they employ, an adjustment factor was used to represent aeroplane size. This is defined as the Reference Geometric Factor (RGF), and it is a measure of aeroplane cabin size based on a two-dimensional projection of the cabin. This improved the performance of the CO_2 metric system, making it fairer and better able to account for different aeroplane type designs.

The overall capabilities of the aeroplane design is represented in the CO_2 metric system by the certified MTOM. This accounts for the majority of aeroplane design features which allow it to meet market demand.

Based on the CO_2 metric system, CAEP developed procedures for the certification requirement including, inter alia, the flight test and measurement conditions; the measurement of SAR; corrections to reference conditions; and the definition of the RGF used in the CO_2 emissions metric. CAEP utilised manufacturers' existing practices in measuring aeroplane fuel burn in order to understand how current practices could be used and built upon for the new Standard. Based on this information, the ICAO Annex 16 Volume III CO_2 Standard certification requirement was developed; and, pending some future work, this was initially approved by the CAEP/9 meeting in February 2013. This was a crucial component in the CO_2 Standard development and allowed CAEP to move onto Phase 2 of the work.

Phase 2 Work – Setting the Regulatory Limit

ICAO environmental Standards are designed to be environmentally effective, technically feasible, economically reasonable, while considering environmental interdependencies. These four tenets of CAEP guided Phase 2 work, which involved carrying out a comprehensive assessment of the costs and benefits of all the options which could be selected to form the CO_2 Standard. This involved defining an analytical space within which CAEP would work to investigate the options available. This included the development of options for the regulatory limit line, applicability options and dates, and all the associated assumptions which allowed the CAEP working groups to perform the cost-effectiveness analysis required to make an informed decision on the Standard at the CAEP/10 meeting. The foundation of the CAEP/10 recommendation on the CO_2 emissions Standard was supported by this significant data informed process, involving input from ICAO member states and stakeholders. The modelling exercise involved several analytical tools, including fleet evolution modelling, environmental benefits, recurring costs, non-recurring costs, costs per metric tonne of CO_2 avoided, certification costs, applicability scenarios and various sensitivity studies to inform the decision-making process. This work allowed CAEP to conduct an analysis, with the aim of providing a reasonable assessment of the economic costs and environmental benefits for a potential CO_2 standard in comparison with a "no action" baseline.

CHOICES CONSIDERED DURING THE CO_2 STANDARD WORK

- Ten Regulatory Limit Lines;
- Treatment of aeroplanes above and below 60 tonnes;
- New Type and In-Production applicability;
- Production cut-off; and
- Applicability dates of 2020, 2023, 2025 and 2028.

A WIDE COVERAGE OF AEROPLANES
The standard is most stringent for larger aeroplanes with an MTOM of greater than 60 tonnes. This accounts for more than 90% of international aviation emissions.

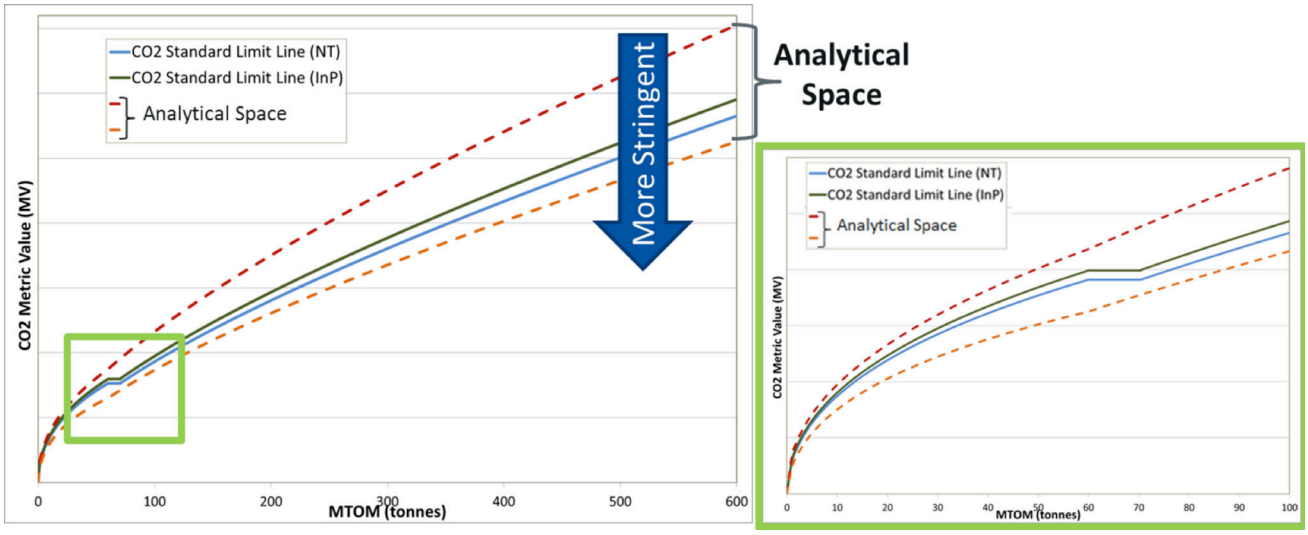

Figure 3. The CO_2 Standard regulatory limits

A full overview of the work and input into the CAEP/10 meeting can be found in the *Report of CAEP/10*, ICAO Doc 10069.

The CAEP/10 Recommendation

Taking into account all the analysis and data, the CAEP/10 meeting was able to make a recommendation on the first ICAO aeroplane CO_2 Standard.

The Standard will apply to subsonic jet and turboprop aeroplanes that are new type (NT) designs from 2020. It will also apply to in-production (InP) aeroplanes from 2023 that are modified and meet a specific change criteria. This is subsequently followed up by a production cut-off in 2028 which means that InP aeroplanes that do not meet the standard can no longer be produced beyond 2028 unless the designs are modified to comply with the Standard. Figure 3 shows an overview of the CO_2 Standard regulatory limit lines for both NT and InP CO_2 Standards.

The CO_2 Standard covers a broad range of aeroplane masses and types and is especially stringent where it will have the greatest impact: for larger aeroplane types with an MTOM of greater than 60 tonnes. CAEP considers technical feasibility very carefully during the development of environmental standards, and as such, the decision at CAEP10 recognised the fact that the larger aeroplane designs have access to the broadest range of CO_2 emissions reduction technologies. This is less so for aeroplanes below 60 tonnes where the standard provides additional margin for a sector. This is particularly recognised for aeroplanes of MTOMs less than 60 tonnes and with fewer than 19 seats maximum passenger seating capacity, where for new aeroplane type designs the applicability date of the standard is 2023.

The Contribution of the CO_2 Standard to Reducing CO_2 Emissions from International Aviation

It is complex to fully understand the impact of the CO_2 Standard due to potential unknown market driven responses to the regulation, and the fact that the CO_2 Standard cost-effectiveness analysis was a comparative investigation of regulatory limit lines. However, it is clear that the new standard will have direct effects by increasing the importance of fuel efficiency in the design process such that an aeroplane type not just meets the regulatory limit but also has good relative product positioning in terms of a margin to the limit.

The Next Steps and Consideration by the ICAO Council

The CAEP/10 recommended CO_2 Standard is currently going through the adoption process within ICAO. This involves a review for the Air Navigation Commission (ANC), a consultation process with all the 191 ICAO Member States, before being considered by the Council for adoption during early 2017. Following this the First Edition of Annex 16, Volume III should become applicable during the latter part of 2017.

References

ICAO Circular 337 - CAEP/9 agreed certification requirement for the aeroplane CO2 emissions standard
ICAO Doc 10069 - *Report of CAEP/10*
ICAO Environment Report, Destination Green, 2013