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ASSEMBLY — 40TH SESSION

EXECUTIVE COMMITTEE

Agenda Item 15: Environmental Protection – General provisions, Aircraft Noise and Local Air Quality– Policy and Standardization

ICAO GLOBAL ENVIRONMENTAL TRENDS – PRESENT AND FUTURE AIRCRAFT NOISE AND EMISSIONS

(Presented by the Council of ICAO)

EXECUTIVE SUMMARY

The first ICAO Global Environmental Trends were presented and endorsed at the 37th Session of the Assembly, and since then the updated global environment trends have been developed and presented to every Assembly Session to form the basis for their considerations and decisions. This paper presents the latest update to the ICAO Global Environmental Trends, as requested by the 39th Session of the Assembly.

Action: The Assembly is invited to endorse the use of the ICAO global environmental trends, as provided in this paper, as the single, robust information basis for decision-making on environmental matters, and that the next Assembly be updated thereon.

Strategic Objectives:	This working paper relates to Strategic Objective – *Environmental Protection*.
Financial implications:	The activities referred to in this paper will be undertaken subject to the resources available in the 2020 – 2022 Regular Programme Budget and/or from extra budgetary contributions.
References:	Doc 10075, *Assembly Resolutions in Force* (as of 6 October 2016) A40-WP/57, *Consolidated statement of continuing ICAO policies and practices related to environmental protection – General provisions, noise and local air quality*

1. INTRODUCTION

1.1 The sustainable growth of aviation is important for future economic growth and development, trade and commerce, cultural exchange and understanding among peoples and nations, and by 2045, international air traffic (expressed in revenue tonne kilometres) is expected to increase by 3.3 times. It is therefore crucial to understand the future global trends in growth and the associated environmental implications in terms of aircraft noise and emissions.

1.2 In the 35th Session of the Assembly, the Council was requested to regularly assess the present and future impact of aircraft noise and aircraft engine emissions and to continue to develop tools for this purpose. The Organization has since started to work on the development of global environmental trends and the first ICAO Global Environmental Trends were presented and endorsed at the 37th Session of the Assembly, and have been updated at subsequent sessions of the Assembly. The establishment of the global environmental trends is crucial to the work of ICAO as it provides a robust single reference for sound discussion and decision-making. This paper presents the latest update to the ICAO Global Environmental Trends, as requested by the 39th Session of the Assembly.

2. ICAO GLOBAL ENVIRONMENTAL TRENDS

2.1 The 39th Session of the Assembly endorsed the environmental trends as the basis for decision-making on environmental matters, and that the 40th Session of the Assembly should be updated thereon[1]. In response to this request and in support of a data-driven decision-making process, a significant modelling and analysis exercise has been conducted during the triennium. An updated set of trends, including noise, local air quality, and emissions that affect the global climate was delivered. Details are provided in the appendix. The updated trends show lower long-term projections for fuel burn, noise, and NOx than those presented at A39 (see A39-WP/55) and this can be attributed to a combination of aircraft with better technology entering the fleet, as well as a reduction in the forecasted long-term traffic demand.

2.2 Trends in Aircraft Fuel Burn and CO_2 Emissions

2.2.1 International aviation consumed approximately 160 megatons (Mt) of fuel in 2015. By 2045, compared with an anticipated increase of 3.3 times growth in international air traffic (expressed in revenue tonne kilometres), fuel consumption is projected to increase by 2.2 to 3.1 times compared to 2015, depending on the technology and Air Traffic Management (ATM) scenario. Regarding sustainable aviation fuels, a number of near-term scenarios evaluated by CAEP indicate that up to 2.6% of fuel consumption could potentially consist of sustainable aviation fuels by 2025. It should be noted that CAEP did not consider lower carbon aviation fuels as part of its work on fuel burn trends, and that further work to consider such fuels is part of the CAEP/12 work programme.

2.2.2 Information gathered at the first "ICAO Stocktaking Seminar toward the ICAO 2050 Vision for Sustainable Aviation Fuels (SAF) in April 2019 shows that commercial production of SAF increased from an average of 0.29 million litres per year (2013-2015) to 6.45 million litres per year (2016-2018). Additionally, up to 6.5 Mt (8 billion litres) per year of SAF production capacity may be available by 2032. There is significant uncertainty on the share of this capacity that will be directed to SAF compared to other fuels and in this regard, the second ICAO Conference on Aviation and Alternative Fuels (CAAF/2) in October 2017 encouraged States to promote policies that strive to establish a level playing field between aviation and other transportation sectors on the use of sustainable fuels.

2.3 Trends in Aircraft Engine Emissions that Affect Local Air Quality

2.3.1 In 2015, landing and take-off (LTO) NOx emissions were approximately 0.18 Mt. In 2045, they are projected to range from 0.44 to 0.80 Mt depending on the technology and ATM scenario,

[1] ICAO Doc 10080, A39-Min. P/1-7, Assembly 39th Session, Plenary Meetings, Minutes; and associated A39-WP/488, paragraph 20.2.4 refers.

which represents a growth of between 2.4 and 4.4 times over the period and can be compared with the forecasted 3.3 times growth in international air traffic.

2.4 **Trends in Aircraft Noise**

2.5 In 2015, the total area exposed to yearly average day-night noise levels (DNL) above 55 dB was 14,400 square-kilometres, and its growth by 2045 ranges from 1.0 time to 2.2 times compared to 2015 depending on the technology scenario. The total population inside this 55 dB DNL area was approximately 30 million people in 2015. As with previous trends results, a decoupling of growth in yearly average DNL from air traffic growth can be observed. Of note is that under an advanced aircraft technology scenario, from about 2030, the total yearly average DNL may no longer increase with an increase in air traffic. A number of ambitious actions would need to be carried out on the part of Member States for that scenario to be realized.

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APPENDIX

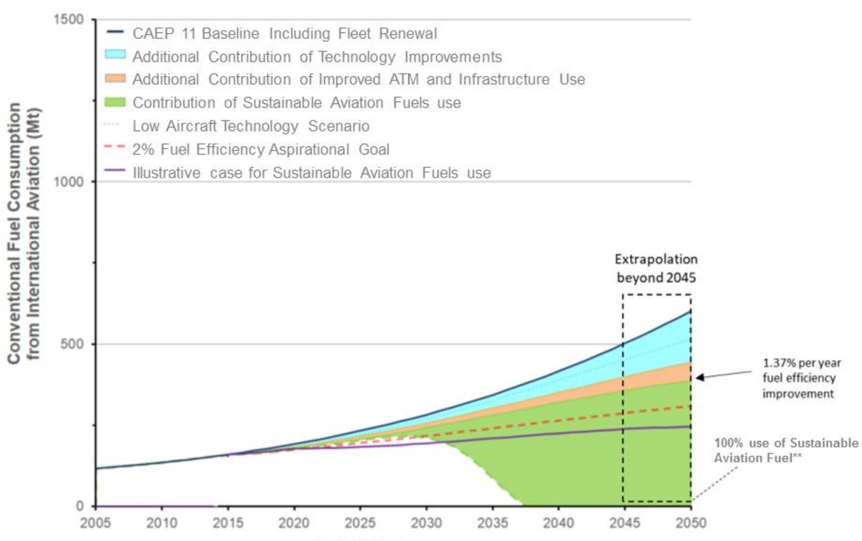
ICAO GLOBAL ENVIRONMENTAL TRENDS – PRESENT AND FUTURE AIRCRAFT NOISE AND EMISSIONS

1. TRENDS IN EMISSIONS THAT AFFECT THE GLOBAL CLIMATE

1.1 Trends in Aircraft Fuel Burn and CO_2 Emissions

1.1.1 As shown in Figure 1, international aviation consumed approximately 160 megatons (Mt) of fuel in 2015. By 2045, compared with an anticipated increase of 3.3 times growth in international air traffic (expressed in revenue tonne kilometres), fuel consumption is projected to increase by 2.2 to 3.1 times compared to 2015, depending on the technology and ATM scenario. Even under the most optimistic scenario, the projected long-term fuel efficiency of 1.37% falls short of ICAO's aspirational goal of 2% per annum. The long-term fuel burn from international aviation is lower by about 25% compared with the prior trends projections presented to the 39th Session of the Assembly. This lower fuel burn projection can be attributed to a combination of more fuel efficient aircraft entering the fleet, as well as a reduction in the forecasted long-term traffic demand. The 1.37% long-term fuel efficiency computed herein includes the combined improvements associated with both technology and operations. The individual contributions from technology and operations are 0.98% and 0.39%, respectively. The 0.98% is slightly lower than the 1.3% cited in the latest Independent Experts Integrated Review (IEIR) for single aisle aircraft. In addition, the technology improvement scenarios represented herein bound the range of scenarios in the latest IE Review.

1.1.2 The trends presented were developed in the context of a longer-term view. Global traffic and fuel consumption projections can be affected substantially by a wide range of factors such as fluctuations in fuel prices, and global economic conditions.

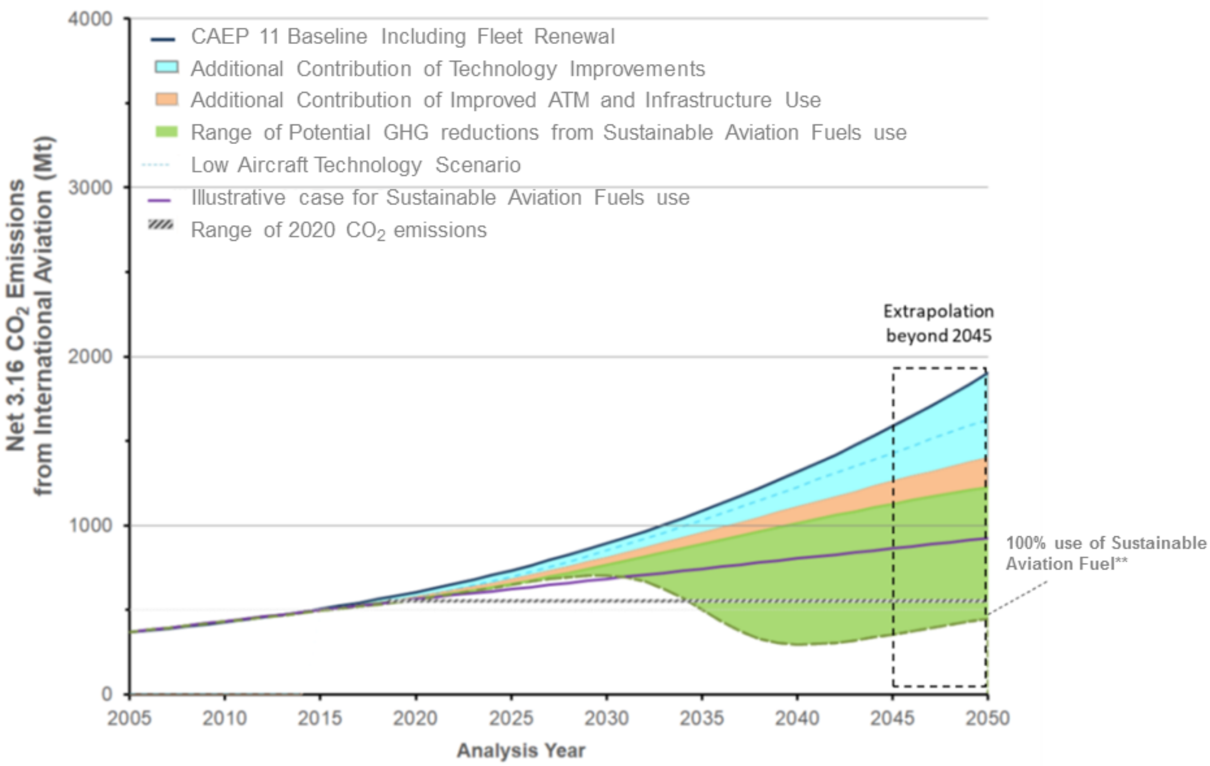


* Illustrative case would require high availability of bioenergy feedstock, the production of which is significantly incentivized by price or other policy mechanisms; **100% replacement with sustainable aviation fuel would require a complete shift in aviation from petroleum refining to sustainable aviation fuel production and a substantial expansion of the agricultural sector, both of which would require substantial policy support.

Figure 1. Conventional Fuel Consumption from International Aviation, 2005 to 2050, including Potential use of Sustainable Aviation Fuels

1.1.3 Significant uncertainties exist in predicting the contribution of sustainable aviation fuels in the future. However, a number of near-term scenarios evaluated by AFTF indicate that up to 2.6% of fuel consumption could potentially consist of sustainable aviation fuels by 2025. This analysis also considered the long-term availability of sustainable aviation fuels, finding that, by 2050, it would be physically possible to meet 100% of international aviation jet fuel demand with sustainable aviation fuels, corresponding to a 63% reduction in emissions. However, this level of fuel production could only be achieved with extremely large capital investments in sustainable aviation fuel production infrastructure, and substantial policy support. The effort required to reach these production volumes would have to significantly exceed historical precedent for other fuels, such as ethanol and biodiesel for road transportation. The effect of such an expansion in the use of sustainable aviation fuels on net CO_2 emissions from international aviation is shown in Figure 2.

1.1.4 It should be noted that CAEP did not consider lower carbon aviation fuels as part of its work on fuel burn trends, and that further work to consider such fuels is part of the CAEP/12 work programme.



Note: Reductions in atmospheric carbon from sustainable aviation fuel use occur from feedstock production and fuel conversion and not from fuel combustion.

Figure 2. Net 3.16 CO_2 Emissions from International Aviation, 2005 to 2050, including Sustainable Aviation Fuels Life Cycle CO_2 Emissions Reductions

1.2 Trends in Aircraft Full-Flight NOx Emissions

1.2.1 Full-flight nitrogen oxides (NOx) emissions trends were evaluated as they have an effect on the global climate. This complements the NOx emissions generated during the landing and take-off (LTO) cycle, shown in paragraph 3.1, which primarily affect local air quality. In 2015, the full-flight NOx emissions of international aviation were 2.50 Mt. In 2045, the full-flight NOx emissions projection ranges from 5.53 Mt to 8.16 Mt, which represents a 2.2 to 3.3 times growth compared to 2015, against the

3.3 times forecasted growth in international air traffic. As with fuel burn, the long-term full-flight NOx from international aviation is lower by about 21% compared with prior trends projections. This lower NOx emissions projection can be attributed to a combination of aircraft with lower NOx engines entering the fleet, as well as a reduction in forecasted long-term traffic demand.

2. TRENDS IN AIRCRAFT NOISE

2.1 Figure 3 presents the total area exposed to yearly average day-night noise levels (DNL) above 55 dB around 315 airports representing approximately 80% of global traffic. In 2015, this total area was 14,400 square-kilometres, and its growth by 2045 ranges from 1.0 time to 2.2 times compared to 2015 depending on the technology scenario. The total population inside this 55 dB DNL area was approximately 30 million people in 2015. As with previous trends results, a decoupling of growth in yearly average DNL from air traffic growth can be observed. Of note is that under an advanced aircraft technology scenario, from about 2030, the total yearly average DNL may no longer increase with an increase in air traffic. A number of ambitious actions would need to be carried out on the part of Member States for that scenario to be realized. The long-term total DNL 55 dB contour area is lower by about 10%, compared with the prior trends projections. This lower contour area can be attributed to a combination of quieter aircraft entering the fleet, as well as a reduction in the forecasted long-term traffic demand.

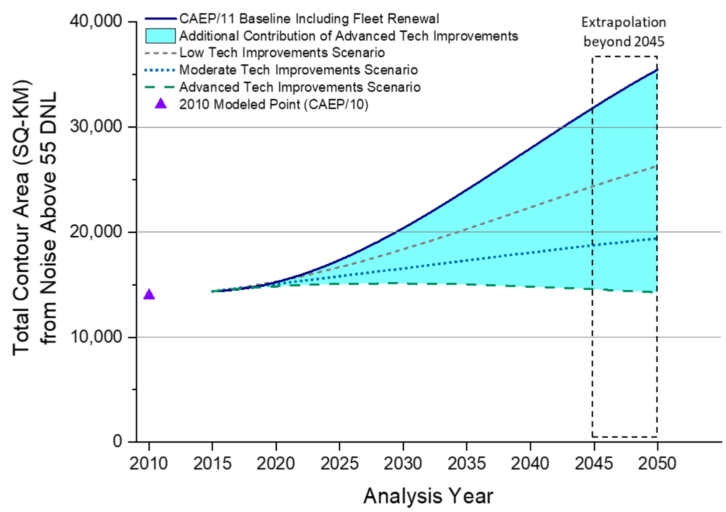


Figure 3. Total Aircraft Noise Contour Area above 55 dB DNL for 315 airports

3. TRENDS IN AIRCRAFT ENGINE EMISSIONS THAT AFFECT LOCAL AIR QUALITY

3.1 Figure 4 provides results for NOx emissions within the LTO cycle, that is, below 3,000 feet above ground level (AGL) from international aviation. In 2015, LTO NOx emissions were approximately 0.18 Mt. In 2045, they are projected to range from 0.44 to 0.80 Mt depending on the technology and ATM scenario, which represents a growth of between 2.4 and 4.4 times over the period and can be compared with the forecasted 3.3 times growth in international air traffic. As with full-flight NOx, LTO NOx projections are lower by about 2%, compared with the prior trends projections, again due to a combination of aircraft with lower NOx engines, a reduction in the forecasted long-term traffic demand, as well as a refinement to the method used for computing LTO NOx.

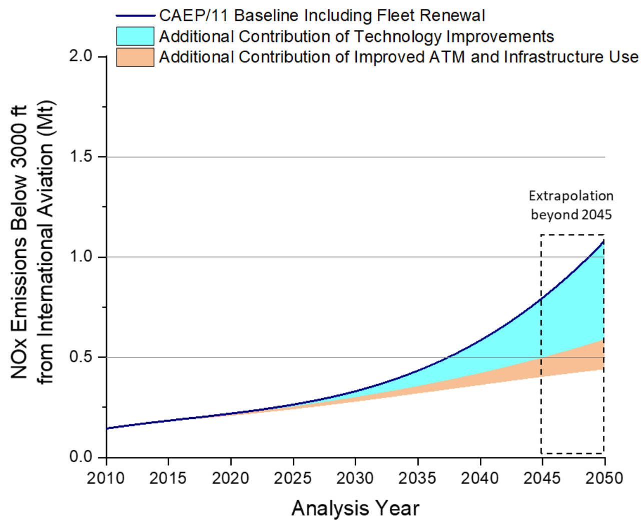


Figure 4. NOx Emissions below 3,000 feet from international aviation

3.2 Figure 5 provides results for total particulate matter (PM, both volatile and non-volatile) emissions below 3,000 feet from international aviation. In 2015, LTO PM emissions were approximately 1,243 tonnes. In 2045, they are projected to increase to 3,572 tonnes (operational improvements could provide reductions of up to 1,160 tonnes by 2050). This represents a growth up to 2.9 times over the period compared with 3.3 times growth in international air traffic. LTO PM projections are lower by about 9%, compared with the prior trends projections, due to a combination of aircraft with lower PM engines, a reduction in the forecasted long-term traffic demand, and a modification to the method used to compute LTO PM.

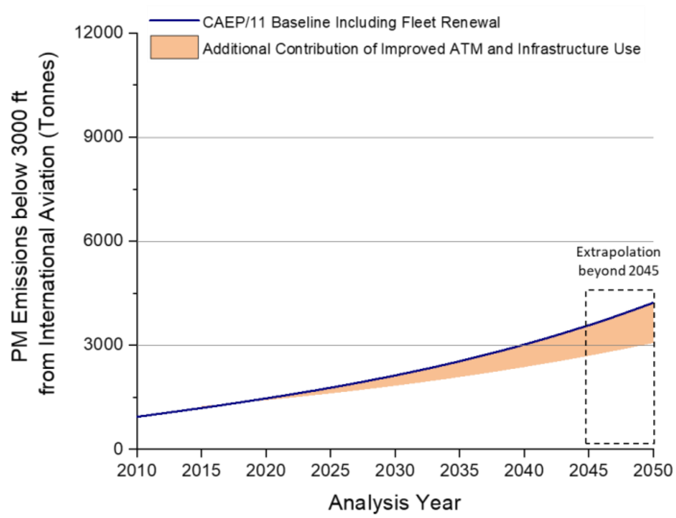


Figure 5. PM Emissions below 3,000 ft from international aviation

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