International Civil Aviation Organization

WORKING PAPER

ASSEMBLY — 38TH SESSION

EXECUTIVE COMMITTEE

Agenda Item 17: Environmental Protection

PRESENT AND FUTURE TRENDS IN AIRCRAFT NOISE AND EMISSIONS

(Presented by the Council of ICAO)

EXECUTIVE SUMMARY

As requested by Assembly Resolution A37-18, Appendix A, the Committee on Aviation Environmental Protection (CAEP) has assessed "the present and future impact and trends of aircraft noise and aircraft engine emissions." As requested by Assembly Resolution A37-19, the Secretariat is developing a capability that will allow the Organization to regularly report CO_2 from international aviation to the United Nations Framework Convention on Climate Change (UNFCCC), and measure progress made in implementing actions in the aviation sector based on information approved by Member States.

In absolute terms, the total global population exposed to aircraft noise, total global aircraft emissions that affect local air quality, and total global aircraft emissions that affect the global climate are expected to increase throughout the analysis period, but at a rate slower than aviation demand. Under Scenario 9, fuel efficiency is expected to improve at an average rate of 1.4 per cent per annum to 2040, and 1.76 per cent per annum in the mid-term from 2020 to 2030. Beyond the considered aircraft technology and operational improvements, additional measures will be needed to achieve carbon neutral growth relative to 2020. Sustainable alternative fuels have the potential to make a significant contribution, however insufficient data are available to confidently predict their availability.

Action: The Assembly is invited to:

a) accept the global environmental trends as the basis for decision making on environmental matters during this session of the Assembly;
b) request the Council to continue work in these areas with the support of States and to ensure that the next session of the Assembly is provided with an updated global environmental trends assessment;
c) urge States to submit fuel consumption data required by ICAO to support the Assembly request to the Council of reporting on aviation emissions; and
d) consider the information in this paper for inclusion in the revisions to Assembly Resolutions A37-18 and A37-19.

Strategic Objectives:	This working paper relates to Strategic Objective C – *Environmental Protection and Sustainable Development of Air Transport.*
Financial implications:	The activities referred to in this paper will be undertaken subject to the resources available in the 2014–2016 Regular Programme Budget and/or from extra budgetary contributions.
References:	A38-WP/34, *Consolidated statement of continuing ICAO policies and practices related to environmental protection – Climate change.*

1. INTRODUCTION

1.1 As requested by Assembly Resolution A37-18, Appendix A, Committee on Aviation Environmental Protection (CAEP) has assessed "the present and future impact and trends of aircraft noise and aircraft engine emissions." Substantial input from Member States and Observer Organizations contributed to the trends presented in this paper, including models, databases, and expertise. They were reviewed by and reflect the consensus of CAEP.

1.2 In addition, in response to a request in Assembly Resolution A37-19, the Secretariat is developing a capability that will allow the Organization to regularly report CO_2 from international aviation to the UNFCCC and measure progress toward the goals for international aviation fuel efficiency and CO_2 established by that Resolution.

2. TRENDS BACKGROUND

2.1 Since prior to the 36th Session of the ICAO Assembly, CAEP has modelled future scenarios in noise, local air quality (LAQ), and greenhouse gas (GHG) emissions. At the 37th Session of the ICAO Assembly, the trends were presented for the entire aviation sector (domestic and international aviation combined) and the Assembly requested that the Council further disseminate this information. Since the last Assembly, the work has focussed on the improvement of the trends related to global climate. Substantial improvement has been achieved in the method to produce the trends that now enables the assessment of the contribution of international aviation separately along with the different measures available for reducing its associated fuel burn and CO_2. CAEP has produced fuel burn and CO_2 emissions trends from international aviation for presentation to this Assembly. The trends for noise and LAQ presented to the 37th Session, and also provided in Appendix A, were reviewed; CAEP was of the view that there was no need for updates.

2.2 The fuel burn and CO_2 emissions results presented in this paper are based on the CAEP-produced, unconstrained[1], central demand forecast and are representative of the trends observed across the range of scenarios considered.

2.3 Assembly Resolutions A37-18 and A37-19 refer to the "environmental impact" of aviation, and acknowledge the non-CO_2 impacts as initially studied by the Intergovernmental Panel on Climate Change (IPCC) in 1999. CAEP continues to monitor and report best consensus available data and science progress through its Impacts and Science Group, which provided reports to the ninth meeting of CAEP.

3. TRENDS IN FUEL BURN AND CO_2 EMISSIONS FROM INTERNATIONAL AVIATION

3.1 Analysis Assumptions

3.1.1 A total of nine scenarios, as defined in Appendix B were modelled to illustrate the range of possible technological and operational improvements. The results are based on the CAEP central demand forecast that used a base year of 2010. Data presented for 2005 and 2006 were reproduced from the trends assessment presented to the 37th Session of the ICAO Assembly.

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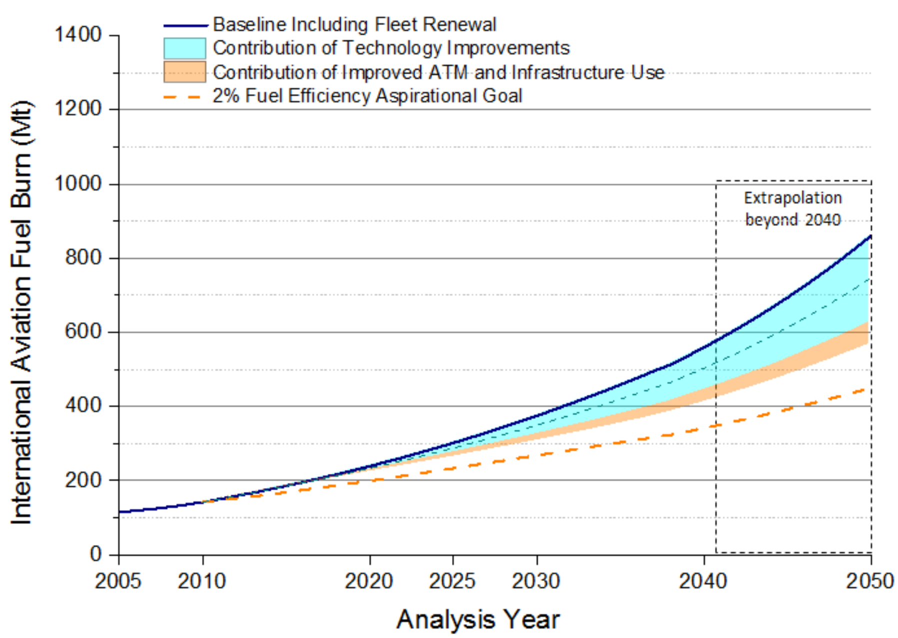
[1] That is, there are no physical or operational constraints that limit the growth of traffic at airports over the forecast time horizon (implicitly) assuming that sufficient investment is made over time in the infrastructure (e.g. airports and air traffic management systems), the technology, the operational improvements, etc. to accommodate the traffic growth). However, the constraints that currently exist in the network are built-in.

3.1.2 Three models contributed results to the trends assessment: FAA's Aviation Environmental Design Tool (AEDT); EUROCONTROL's Advanced Emissions Model (AEM); and Manchester Metropolitan University's Future Civil Aviation Scenario Software Tool (FAST).

3.2 Trends in Aircraft Fuel Burn

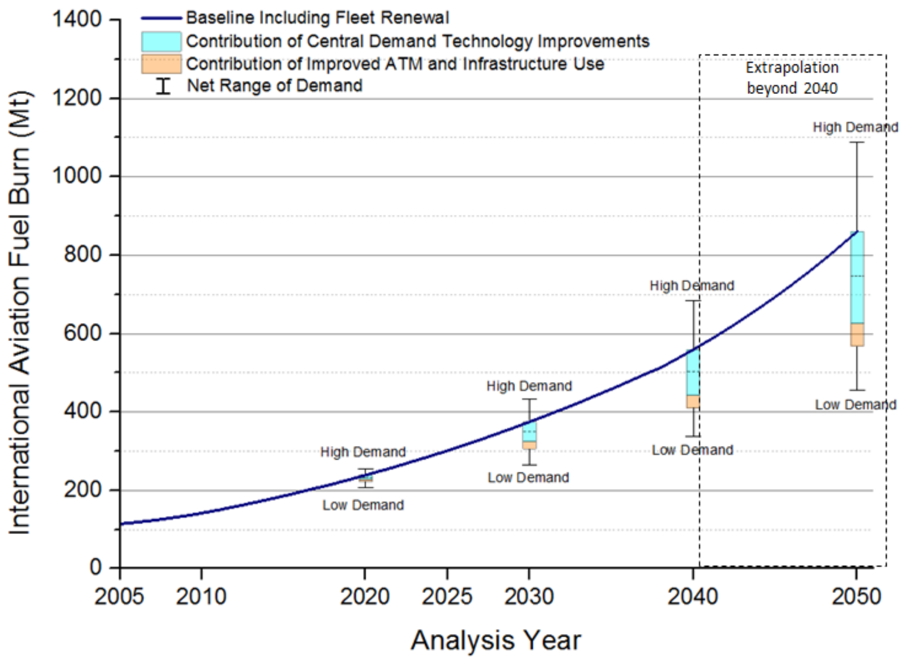
3.2.1 Figure 1 provides results for global full-flight fuel burn for international aviation from 2005 to 2040, and then extrapolated to 2050. The fuel burn analysis takes into account the contribution of aircraft technology, improved air traffic management and infrastructure use (i.e., operational improvements) to reduce fuel consumption. The figure also illustrates the fuel burn that would be expected if the 2 per cent annual fuel efficiency aspirational goal were achieved. Figure 2 puts these contributions in context with the uncertainty associated with the forecasted demand, which is notably larger than the range of potential contributions from technological and operational improvements.

3.2.2 The results presented in Figures 1 and 2 are for international aviation only. In 2010, approximately 65 per cent of global aviation fuel consumption was from international aviation. Based on CAEP's analysis, this proportion is expected to grow to nearly 70 per cent by 2050.



*Dashed line in technology contribution sliver represents the "Low Aircraft Technology Scenario."
Note: Results were modelled for 2005, 2006, 2010, 2020, 2025, 2030, and 2040 then extrapolated to 2050.

Figure 1. Aircraft Fuel Burn from International Aviation, 2005 to 2050.



Note: Fuel burn was only modelled for the central demand forecast. The effects of the high and low demand sensitivities shown are based on the ratio of forecasted revenue passenger kilometres for high/low demand relative to central demand.

Figure 2. Range of Uncertainties Associated with Demand Forecast, 2005 to 2050.

3.3 **Trends in Aircraft CO2 Emissions**

3.3.1 Figure 3 presents full-flight CO_2 emissions for international aviation from 2005 to 2040, and then extrapolated to 2050. This figure only takes into the account the CO_2 emissions associated with the combustion of jet fuel, assuming that 1 kg of jet fuel burned generates 3.16 kg of CO_2. As with the fuel burn analysis, this analysis takes into account the contribution of aircraft technology, improved air traffic management and infrastructure use (i.e., operational improvements). In addition the range of possible CO_2 emissions in 2020 are displayed for reference to the global aspirational goal of keeping the net CO_2 emissions at this level. Although, not displayed in a separate figure, the demand uncertainty effect on the fuel burn calculations shown in Figure 2 has an identical effect on the CO_2 results.

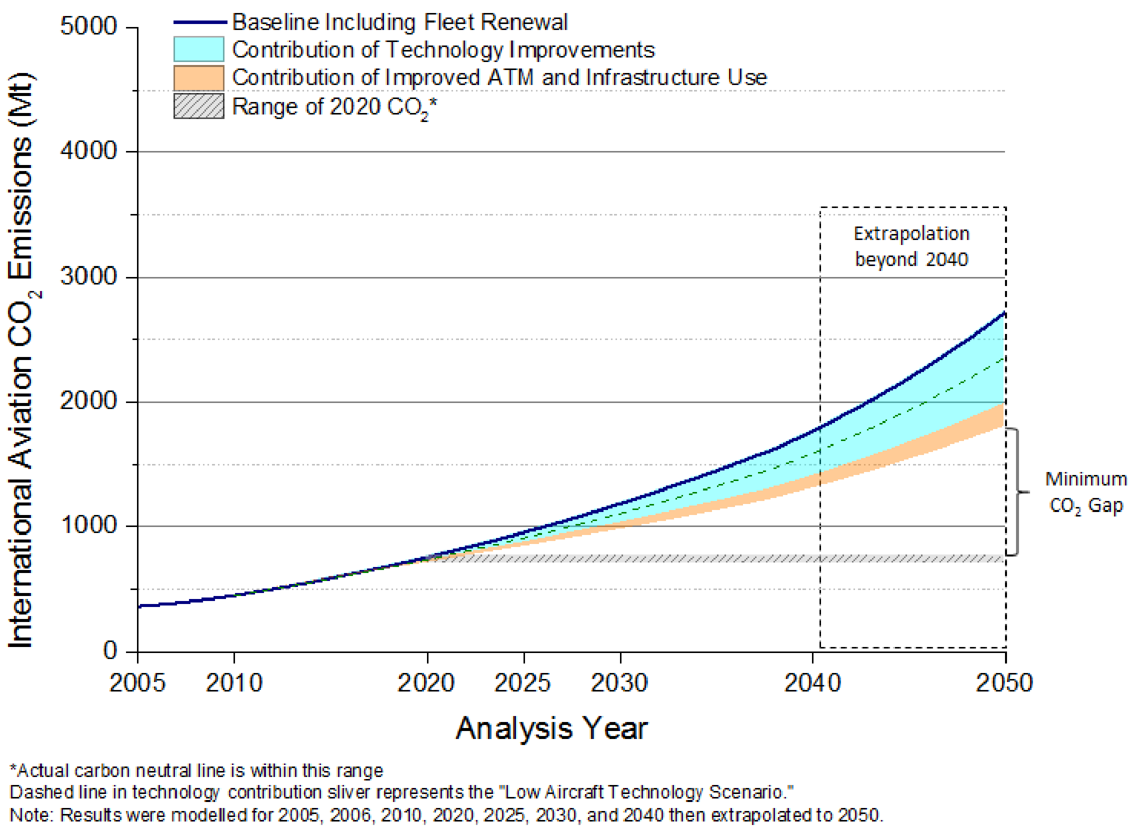


Figure 3. Aircraft CO_2 Emissions from International Aviation, 2005 to 2050.

3.4 **Consideration of Sustainable Alternative Fuels**

3.4.1 The information presented in Figure 4 for alternative fuels in 2020 and 2050 is based on Member State and Observer Organization responses to two CAEP memoranda and State letter AN 1/17 12/59. The information presented for 2020 and 2050 reflect the targets articulated by States for potential sustainable alternative fuel development. Given the limited information available, it was not possible to estimate the potential development of sustainable alternative fuels in the interim years.

3.4.2 Figure 4 illustrates the maximum potential for sustainable alternative fuels to contribute to international aviation net life cycle CO_2 reduction in 2050. Net life cycle emissions account for the emissions from both fuel creation and fuel combustion. Accordingly, the life cycle emissions of conventional jet fuel and of sustainable alternative fuels are both reflected in the figure. For this figure, the emissions created from the production of jet fuel are assumed to be 0.51 times the fuel amount and from their combustion, 3.16 times the fuel amount. Such an approach has yet to be fully vetted and endorsed by ICAO. In the absence of international agreement and specific ICAO guidance on life cycle analysis methodologies, for the purposes of this analysis the contribution of alternative fuels are presented assuming they have zero net life cycle CO_2 emissions. Greenhouse gas emissions are not reported to the UNFCCC on a life cycle basis. Aviation CO_2 emissions are reported to the UNFCCC using a value that is equal to 3.16 times the fuel amount, while jet fuel production emissions are reported under a separate category. Similarly, the aircraft technology and operational improvements described in this paper will not directly contribute to the reduction of jet fuel production emissions.

3.4.3 In order to improve the future consideration of the contribution of sustainable alternative fuels toward reducing international aviation emissions, there may be a need to further develop methodologies to take account of aviation net life cycle emissions. Figure 4 does not represent an allocation of emissions responsibility or a policy decision or recommendation.

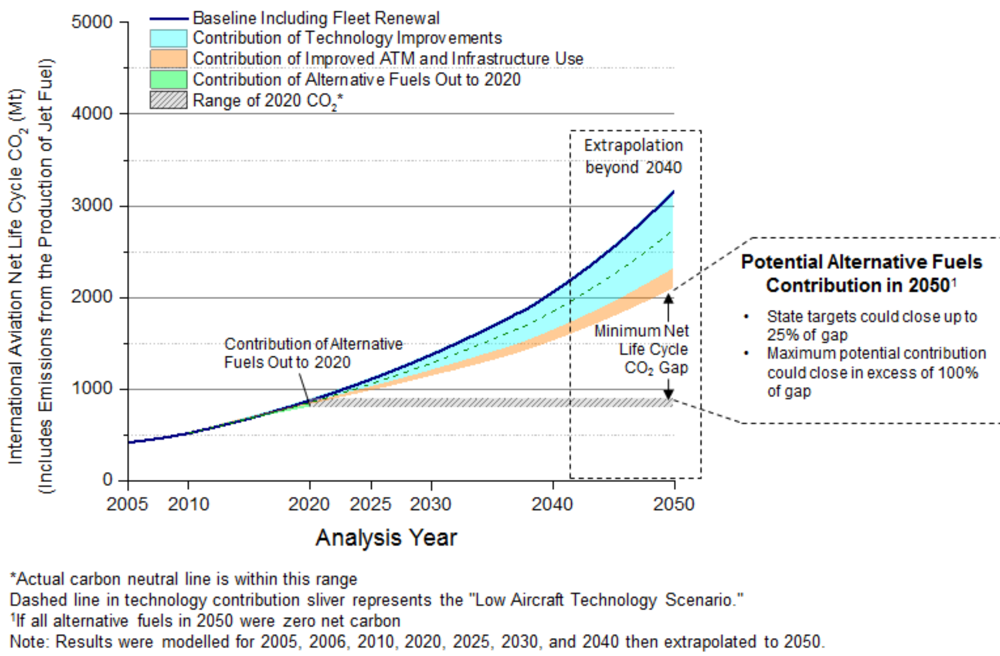


Figure 4: Contribution of Alternative Fuels Shown as International Aviation Net Life Cycle CO_2 Emissions, 2005 to 2050.

3.5 Interpretation of Trends

3.5.1 In 2010, international aviation consumed approximately 142 million metric tonnes of fuel, resulting in 448 million metric tonnes (Mt, 1kg x 10^9) of CO_2 emissions. Based on the assumptions described in paragraph 3.4.2, this equates to 522 Mt of net life cycle CO_2 emissions. By 2040, fuel consumption is projected to have increased 2.8 to 3.9 times the 2010 value, while revenue tonne kilometres are expected to increase 4.2 times under the central demand forecast. By extrapolating to 2050, fuel consumption is projected to have increased 4 to 6 times the 2010 value, while revenue tonne kilometres are expected to increase 7 times under the central demand forecast.

3.5.2 Under Scenario 9, aviation fuel efficiency is expected to improve at an average rate of 1.4 per cent per annum to 2040, and at 1.39 per cent per annum, if extrapolated to 2050. While in the near term (2010 to 2020), efficiency improvements from technology and improved ATM and infrastructure use are expected to be moderate, they are projected to accelerate in the mid-term (2020 to 2030). During the 2020 to 2030 period, fuel efficiency is expected to improve at an average rate of 1.76 per cent per annum under Scenario 9. This analysis shows that additional technological and operational improvements beyond even those described in Scenario 9 will be required to achieve the global aspirational goal of 2 per cent per annum fuel efficiency.

3.5.3 In 2020, it is expected that international aviation will consume between 216 and 239 Mt of fuel, resulting in 682 to 755 Mt of CO_2 emissions. Using the assumptions in paragraph 3.4.2, this translates to 794 to 879 Mt of net life cycle CO_2 emissions. Under the most likely scenario, it is estimated that approximately 3 per cent of this fuel consumption could consist of sustainable alternative fuels in 2020. Based on the maximum anticipated fuel consumption in 2020 (Scenario 1) and the anticipated Scenario 9 fuel consumption in 2040, a minimum CO_2 emissions gap of 523 Mt is projected in 2040. Extrapolating Scenario 9 to 2050, results in a 1,039 Mt gap. Using the assumptions in paragraph 3.4.2, a net life cycle CO_2 emissions gap of 607 Mt in 2040 and of 1,210 Mt in 2050 are projected. Significant uncertainties exist in predicting the contribution of sustainable alternative fuels in 2050. Based on targets established by Member States, it is possible that 25 per cent of the gap could be closed with sustainable alternative fuels in 2050. Considering the maximum evaluated contribution from sustainable alternative fuels (based on potentially available feedstocks and land areas) with assumed net zero-carbon emissions relative to conventional jet fuel, it is possible that more than 100 per cent of the gap could be closed.

4. MEASURING PROGRESS ACHIEVED TOWARD GLOBAL ASPIRATIONAL CLIMATE CHANGE GOALS

4.1 Assembly Resolution A37-19 "resolves that States and relevant Organizations will work through ICAO to achieve a global annual fuel efficiency improvement of 2 per cent until 2020 and an aspirational global fuel efficiency improvement of 2 per cent per annum from 2021 to 2050, calculated on the basis of volume of fuel used per revenue tonne kilometre performed". It also "requests the Council to regularly report CO_2 emissions from international aviation to the UNFCCC, as part of its contribution to assessing progress made in the implementation actions in the sector based on information approved by its member states." The Secretariat is developing a capability, known as the ICAO CO_2 Reporting and Analysis System (ICORAS), that will allow the Organization to report to the UNFCCC and measure progress achieved toward the global aspirational environmental goals.

4.2 ICORAS aims to facilitate the measurement of international aviation fuel consumption and RTK data by integrating fuel burn and traffic data reported by Member States through the ICAO Air Transport Statistics Reporting Forms and complementing missing data with appropriate estimates. The key to success for the ICORAS project is the timely receipt of accurate fuel consumption data from States through ICAO Form M – Fuel Consumption and Traffic – International and Total Services, Commercial Air Carriers (ICAO Fuel Form). This form is a unique data source since it contains measured fuel burn by aircraft type for each reporting air carrier covering both scheduled and non-scheduled international operations. ICAO has currently received valid data through Form M from 55 States, whose air traffic represents approximately 50 per cent of global international RTK, 80 per cent of which has been validated. With an improvement in reporting on Form M, ICORAS will allow ICAO to report more accurately international aviation CO_2 emissions to the UNFCCC and to measure more precisely progress toward the global aspirational environmental goals.

5. CONCLUSIONS

5.1 In absolute terms, the total global population exposed to aircraft noise, total global aircraft emissions that affect LAQ and CO_2 emissions that affect the global climate are expected to increase throughout the analysis period, but generally at a rate slower than aviation demand. It is important to consider the substantial uncertainty associated with future demand in the aviation sector. International aviation fuel efficiency is expected to improve to 2050, however measures in addition to those considered in this analysis will be required to achieve the 2 per cent annual fuel efficiency improvement aspirational goal. Similarly, when considering only aircraft technology and operational improvements, additional measures will be needed to achieve carbon neutral growth relative to 2020. Sustainable alternative fuels have the potential to make a significant contribution, however insufficient data are available to confidently predict their availability or life cycle CO_2 emissions.

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APPENDIX A

NOISE AND LOCAL AIR QUALITY TRENDS

1. INTRODUCTION

1.1 For the 37th Session of the Assembly, a range of scenarios were developed for the assessment of aircraft noise and emissions that affect local air quality (LAQ). Scenario 1 is the sensitivity case that assumes the operational improvements necessary to maintain current operational efficiency levels, but does not include any aircraft technology improvements beyond those available in 2006 production aircraft. Since Scenario 1 is not considered a likely outcome, it is purposely depicted in all graphics with no line connecting the modelled results in 2006, 2016, 2026 and 2036. The other scenarios assume increased implementation of both operational and technological improvements. Scenarios 2, 3 and 4 are assumed to represent the range of most likely outcomes.

1.2 Operational data for 2006, the baseline year, includes global commercial aviation operations under Instrument Flight Rules (IFR). Detailed aircraft movement data were available for North America, Central America, and most of Europe, while aircraft manufactured in the Commonwealth of Independent States (CIS) were not included due to lack of data.

2. TRENDS IN POPULATION EXPOSED TO AIRCRAFT NOISE

2.1 Figure 1 provides results for the total global population exposed to aircraft noise above 55 DNL for 2006, 2016, 2026 and 2036. The 2006 baseline value is about 21.2 million people. In 2036, total population exposed ranges from about 26.6 million people with Scenario 4, to about 34.1 million people with Scenario 2.

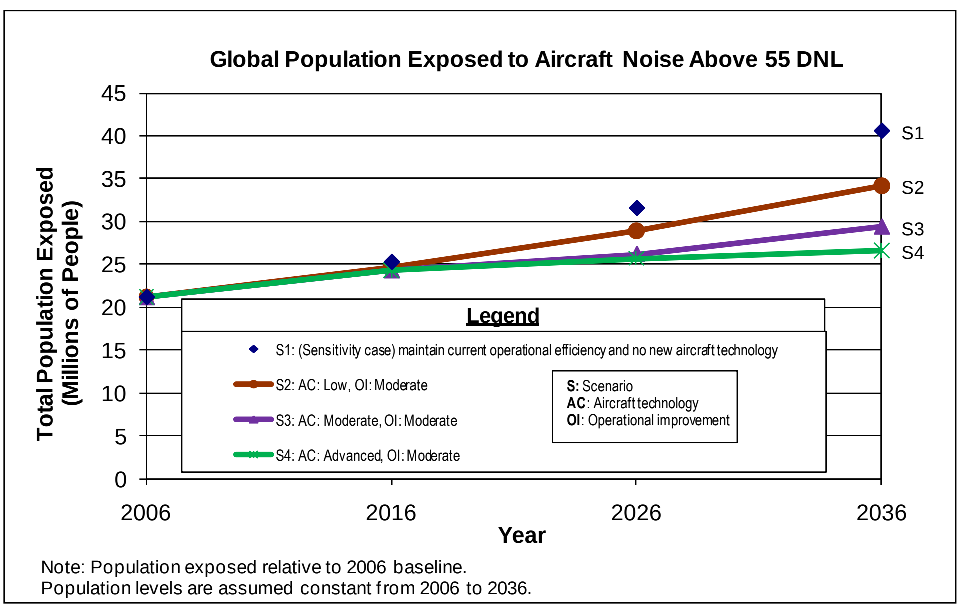

Figure 1. Total Global Population Exposed to Aircraft Noise Above 55 DNL.

<u>Noise (Scenarios 2 – 4)</u>

- **Scenario 2** is the low aircraft technology and moderate operational improvement case that assumes noise improvements of 0.1 decibels of effective perceived noise level (EPNdB) per annum for all aircraft entering the fleet from 2013 to 2036.
- **Scenario 3** is the moderate aircraft technology and operational improvement case that assumes a 0.3 EPNdB per annum for all aircraft entering the fleet from 2013 to 2020, 0.1 EPNdB from 2020 to 2036.
- **Scenario 4** is the advanced aircraft technology and moderate operational improvement case that assumes a 0.3 EPNdB per annum for all aircraft entering the fleet from 2013 to 2036.

3. TRENDS IN AIRCRAFT NOX AND PARTICULATE MATTER (PM) EMISSIONS BELOW 3,000 FT

3.1 Figure 2 provides results for global NOx emissions below 3 000 feet above ground level (AGL) for 2006, 2016, 2026 and 2036. The 2006 baseline value is about 0.25 million metric tonnes (Mt, 1kg x 109). In 2036, total NOx ranges from 0.52Mt, with Scenario 3, to 0.72 Mt with Scenario 2.

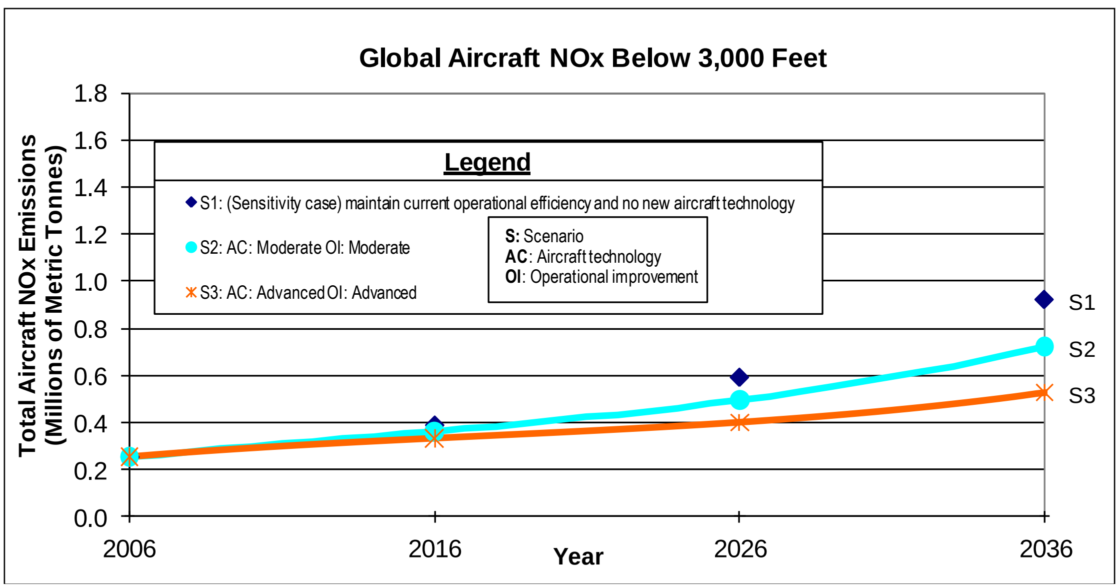

Figure 2. Total Global Aircraft NOx Below 3,000 Feet AGL.

<u>NOx (Scenarios 2 and 3, Below and Above 3,000 ft)</u>

- **Scenario 2** is the moderate aircraft technology and operational improvement case that assumes aircraft NOx improvements based upon achieving 50 per cent of the reduction from the current NOx emission levels to the NOx emissions levels by CAEP/7 NOx Independent Expert goals review (-60 per cent +/-5 per cent of current CAEP/6 NOx Standard) for 2026, with no further improvement thereafter. This scenario also includes fleet-wide moderate operational improvements by region.

- **Scenario 3** is the advanced aircraft technology and operational improvement case that assumes aircraft NOx improvements based upon achieving 100 per cent of the reduction from the current NOx emission levels to the NOx emissions levels by CAEP/7 NOx Independent Expert goals review for 2026, with no further improvement thereafter. This scenario also includes fleet-wide advanced operational improvements by region that are considered to be an upper bound of those improvements.

3.2 The results for PM emissions below 3 000 feet follow the same trends as those for NOx. The 2006 baseline value is 2 200 metric tonnes. In 2036, total global PM is projected to be about 5 800 metric tonnes with Scenario 2.

3.3 The relative contribution of an airport's emissions to overall regional emissions is dependent upon the airport's location. For example, for an airport located in a typical urban environment, its emissions may represent as little as 10 per cent of total regional emissions, whereas in more rural environments an airport's emissions would tend to represent a comparatively higher percentage.

3.4 Mass emissions, measured in units such as total tonnes of NOx or total tonnes of PM, from airport sources are only a metric for comparison purposes. To understand the influence on ambient air quality, airport mass emissions must be converted to ambient concentrations, measured in units such as micrograms per cubic meter ($\mu g/m^3$) or parts per million (PPM) of NOx or PM. The incremental contribution in ambient pollutant concentrations from airport emissions decreases the further one travels from the airport. Each airport's contribution is unique, given the surrounding urbanization/industrialization and meteorological conditions within the vicinity of the airport.

4. TRENDS IN AIRCRAFT NOX EMISSIONS ABOVE 3 000 FT

4.1 The scenarios assessed for NOx above 3 000 ft are identical to those for NOx below 3 000 ft. As shown in Figure 3, the 2006 baseline value is about 2.5 Mt. In 2036, total NOx ranges from about 4.6 Mt with Scenario 3, to about 6.3 Mt with Scenario 2.

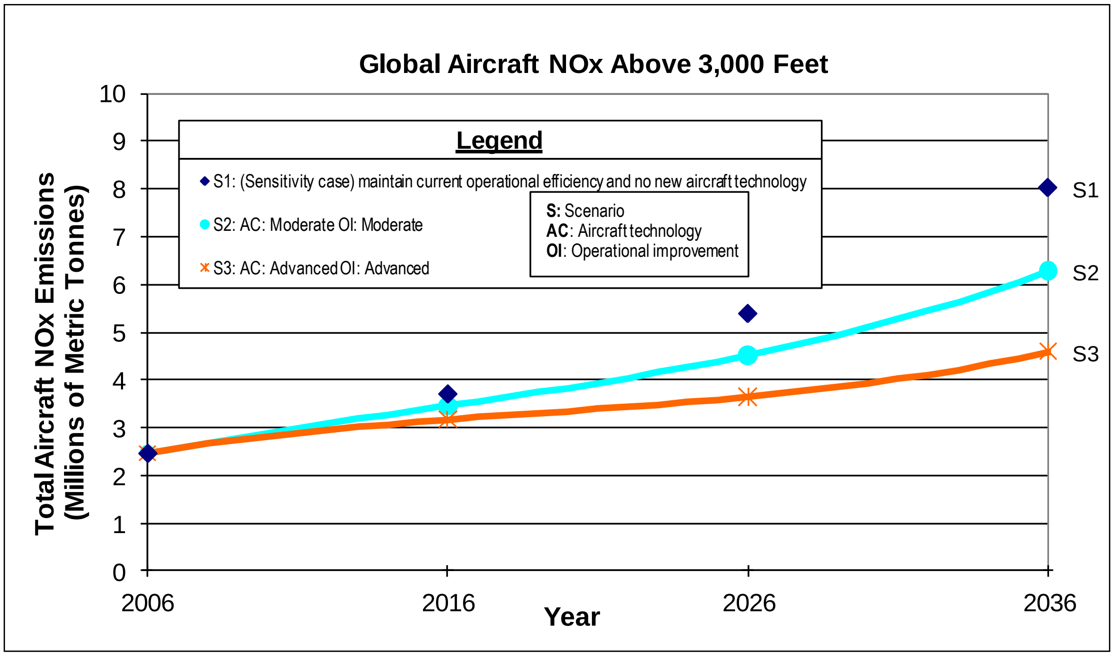

Figure 3. Total Global Aircraft NOx Above 3,000 Feet AGL.

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APPENDIX B

FULL-FLIGHT FUEL BURN AND CO_2 SCENARIO DESCRIPTIONS

Scenario 1 (*CAEP7 Baseline*): This scenario includes the operational improvements necessary to maintain current operational efficiency levels, but does not include any technology improvements beyond those available in current (2010) production aircraft.

Scenario 2 (*Low Aircraft Technology and Moderate Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes fuel burn improvements of 0.96 per cent per annum for all aircraft entering the fleet after 2010 and prior to 2015, and 0.57 per cent per annum for all aircraft entering the fleet beginning in 2015 out to 2050. It also includes additional fleet-wide moderate operational improvements by region, as provided in Table 1, under "lower bound".

Scenario 3 (*Moderate Aircraft Technology and Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes fuel burn improvements of 0.96 per cent per annum for all aircraft entering the fleet after 2010 out to 2050. It also includes additional fleet-wide moderate operational improvements by region, as provided in Table 1, under "lower bound".

Scenario 4 (*Advanced Aircraft Technology and Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes fuel burn improvements of 1.16 per cent per annum for all aircraft entering the fleet after 2010 out to 2050. It also includes additional fleet-wide advanced operational improvements by region, as provided in Table 1, under "upper bound".

Scenario 5 (*Optimistic Aircraft Technology and Advanced Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes an optimistic fuel burn improvement of 1.5 per cent per annum for all aircraft entering the fleet after 2010 out to 2050. It also includes additional fleet-wide advanced operational improvements by region, as provided in Table 1, under "upper bound". This scenario goes beyond the improvements based on industry-based recommendations.

Scenario 6 (*Low Aircraft Technology and CAEP/9 Independent Expert (IE) Operational Improvement*): This scenario includes fuel burn improvements of 0.96 per cent per annum for all aircraft entering the fleet after 2010 and prior to 2015, and 0.57 per cent per annum for all aircraft entering the fleet beginning in 2015 out to 2050. It also includes additional fleet-wide CAEP/9 independent expert (IE) Operational Improvements by route group, as provided in Table 2.

Scenario 7 (*Moderate Aircraft Technology and CAEP/9 IE Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes fuel burn improvements of 0.96 per cent per annum for all aircraft entering the fleet after 2010 out to 2050.

It also includes additional fleet-wide CAEP/9 IE Operational Improvements by route group, as provided in Table 2.

Scenario 8 (*Advanced Aircraft Technology and CAEP/9 IE Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes fuel burn improvements of 1.16 per cent per annum for all aircraft entering the fleet after 2010 out to 2050. It also includes additional fleet-wide CAEP/9 IE Operational Improvements by route group, as provided in Table 2.

Scenario 9 (*Optimistic Aircraft Technology and CAEP/9 IE Operational Improvement*): In addition to including the improvements associated with the migration to the latest operational initiatives, e.g., those planned in NextGen and SESAR, this scenario includes an optimistic fuel burn improvement of 1.5 per cent per annum for all aircraft entering the fleet after 2010 out to 2050. It also includes additional fleet-wide CAEP/9 IE Operational Improvements by route group, as provided in Table 2. This scenario goes beyond the improvements based on industry-based recommendations.

Table 1: Per Cent Change in gate-to-gate fuel burn relative to 2010, by Region

	2020		2030/2040/2050	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
North America	0	-2	0	-4
Europe	-2	-6	-3	-7
Central America	-1	-4	-2	-5
South America	-1	-4	-2	-5
Middle East	-2	-5	-3	-6
Africa	-4	-7	-5	-8
Asia/Pacific	-3	-6	-4	-7

Table 2: Per Cent Change in gate-to-gate fuel burn relative to 2010, by Route Group

Route Group	**2020 Goal**	**2030 Goal**	**2040 Goal**
Domestic Africa	3.13%	6.59%	9.95%
Domestic Asia/Pacific	4.01%	8.70%	11.53%
Domestic Europe	4.35%	8.28%	11.30%
Domestic Latin America	3.33%	7.46%	10.38%
Domestic Middle East	4.00%	8.98%	11.71%
Domestic North America	4.73%	8.98%	11.41%
Europe – Africa	2.38%	5.26%	7.55%
Europe - Asia/Pacific	2.27%	4.94%	6.26%
Europe - Middle East	1.67%	4.46%	6.86%
Intra Africa	2.50%	5.24%	8.09%
Intra Asia/Pacific	2.82%	6.12%	7.82%
Intra Europe	3.41%	6.63%	9.23%
Intra Latin America	2.96%	6.83%	9.39%
Intra Middle East	3.50%	7.88%	10.26%
Intra North America	4.73%	9.27%	12.05%
Mid Atlantic	2.30%	4.90%	6.08%
Middle East - Asia/Pacific	2.46%	5.35%	6.72%
N America – Cen America/Caribbean	3.19%	6.73%	9.01%
North America - South America	2.24%	5.31%	7.15%
North Atlantic	2.33%	4.93%	6.11%
Other International Routes	2.63%	6.18%	8.42%
South Atlantic	2.12%	4.64%	5.78%
Transpacific	2.10%	4.61%	5.76%

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