



ICAO

Doc 9988

Guidance on the Development of States' Action Plans on CO₂ Emissions Reduction Activities

Third Edition, 2019



Approved by and published under the authority of the Secretary General

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AMENDMENTS

Amendments are announced in the supplements to the *Products and Services Catalogue*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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ACRONYMS

ACI	Airports Council International
A-CDM	Airport collaborative decision-making
AEDT	Aviation Environmental Design Tool (United States FAA)
AES	Aviation Environmental System
AEM	Advanced Emissions Model
ANSP	Air navigation services provider
APER	Action Plan for Emissions Reduction
APU	Auxiliary power unit
A-SMGCS	Advanced surface movement guidance and control system
ASPIRE	Asia and South Pacific Initiative to Reduce Emissions
ASTM	American Society for Testing and Materials
ASUR	Alternative surveillance
ATAG	Air Transport Action Group
CAA	Civil Aviation Authority
CAEP	Committee on Aviation Environmental Protection
CANSO	Civil Air Navigation Services Organisation
CCO	Continuous climb operation
CDM	Clean Development Mechanism
CDO	Continuous descent operation
CNS/ATM	Communications, Navigation and Surveillance/Air Traffic Management
CO	Carbon monoxide
CO ₂	Carbon dioxide
CO _{2e}	Carbon dioxide equivalent
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
EBT	Environmental Benefits Tool
EEA	European Environment Agency
EMEP	European Monitoring and Evaluation Programme
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
FAST	Future Aviation Scenario Tool (Manchester Metropolitan University)
FB	Fuel burn
FEGP	Fixed electrical ground power
FT	Fischer Tropsch
GANP	Global Air Navigation Plan
GATMOC	Global Air Traffic Management Operational Concept
GFAAF	Global Framework for Aviation Alternative Fuels
GHG	Greenhouse gas
GIACC	Group on International Aviation and Climate Change
GPU	Ground power unit
GSE	Ground support equipment
HEFA-SPK	Hydroprocessed Esters and Fatty Acids
IATA	International Air Transport Association
IFSET	ICAO Fuel Savings Estimation Tool
IPCC	Intergovernmental Panel on Climate Change
LED	Light emitting diode
LTO	Landing and take-off

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LVP	Low visibility procedures
MAC	Marginal abatement cost
MBM	Market-based measure
MRV	Monitoring, Reporting and Verification
PBN	Performance-based navigation
PCA	Pre-conditioned air
PIRG	Planning and Implementation Regional Group
RNP	Required Navigation Performance
RTK	Revenue Tonne Kilometre
SAF	Sustainable Aviation Fuel
SARP	Standard and Recommended Practice
SID	Standard instrument departure
SKA	Synthetic kerosene with aromatics
SPK	Synthetic paraffinic kerosene
STAR	Standard instrument arrival
SURF	Surface operations
UNFCCC	United Nations Framework Convention on Climate Change

PUBLICATIONS

(referred to in this document)

1. ICAO PUBLICATIONS

Manuals

Africa-Indian Ocean Regional Traffic Forecasts 2008–2028 (Doc 9939)

Asia/Pacific Area Traffic Forecasts 2010–2030 (Doc 9961)

Caribbean/South American Regional Traffic Forecasts 2009–2030 (Doc 9940)

Global Air Navigation Plan (Doc 9750)

Global Air Traffic Management Operational Concept (Doc 9854)

Guidance on the Use of Emissions Trading for Aviation (Doc 9885)

ICAO's Policies on Charges for Airports and Air Navigation Services (Doc 9082)

ICAO's Policies on Taxation in the Field of International Air Transport (Doc 8632)

Manual on Air Traffic Forecasting (Doc 8991)

Manual on Air Traffic Management System Requirements (Doc 9882)

Manual on Global Performance of the Air Navigation System (Doc 9883)

Offsetting Emissions from the Aviation Sector (Doc 9951)

Operational Opportunities to Reduce Fuel Burn and Emissions (Doc 10013)

Procedures for Air Navigation Services — Aircraft Operations (Doc 8168)

Report of the Tenth Meeting of the Committee on Aviation Environmental Protection (CAEP/10) (Doc 10069)

Report on Voluntary Emissions Trading for Aviation (VETS Report) (Doc 9950)

Circulars

Global Air Transport Outlook to 2030 and trends to 2040 (Circular 333)

Others

ICAO-EU project: *Feasibility Study on the Use of Sustainable Aviation Fuels — Dominican Republic*

(https://www.icao.int/environmental-protection/Documents/FeasabilityStudy_DomRep_ENG_Web.pdf)

ICAO-EU project: *Feasibility Study on the Use of Sustainable Aviation Fuels — Trinidad and Tobago*

(https://www.icao.int/environmental-protection/Documents/FeasabilityStudies_TrinidadTobago_Report_Web.pdf)

ICAO-EU project: *Feasibility Study on the Use of Sustainable Aviation Fuels — Burkina Faso*

(https://www.icao.int/environmental-protection/Documents/FeasabilityStudy_BurkinaFaso_Report-Web.pdf)

ICAO-EU project: *Feasibility Study on the Use of Sustainable Aviation Fuels — Kenya*

(https://www.icao.int/environmental-protection/Documents/FeasabilityStudy_Kenya_Report-Web.pdf)

ICAO-UNDP-GEF project: *Transforming Global Aviation Collection — Financing Aviation Emissions Reductions*

(https://www.icao.int/environmental-protection/Pages/ICAO_UNDP_Guidancedocs.aspx)

ICAO-UNDP-GEF project: *Transforming Global Aviation Collection — Regulatory and Organizational Framework to Address Aviation Emissions*

(https://www.icao.int/environmental-protection/Pages/ICAO_UNDP_Guidancedocs.aspx)

ICAO-UNDP-GEF project: *Transforming Global Aviation Collection — Renewable Energy for Aviation: Practical Applications to Achieve Carbon Reductions and Cost Savings*

(https://www.icao.int/environmental-protection/Pages/ICAO_UNDP_Guidancedocs.aspx)

ICAO-UNDP-GEF project: *Transforming Global Aviation Collection — Sustainable Aviation Fuels Guide*

(https://www.icao.int/environmental-protection/Pages/ICAO_UNDP_Guidancedocs.aspx)

Forms

ICAO Form M — *Fuel Consumption and Traffic — International and Total Services, Commercial Air Carriers* (ICAO Fuel Form)

Websites

ICAO CORSIA (www.icao.int/corsia)

ICAO Global Framework for Aviation Alternative Fuels (GFAAF)

(<https://www.icao.int/environmental-protection/GFAAF/Pages/default.aspx>)

ICAO-UNDP-GEF project: Environment Knowledge Sharing Platform (KSP)

(<https://www.icao.int/environmental-protection/knowledge-sharing/Pages/default.aspx>)

ICAO-EU project on-line course on State Action Plans developed in cooperation with UNITAR

(<https://www.unitar.org/event/full-catalog/international-aviation-intro-states-action-plans-reduce-co2-0>)

2. PUBLICATIONS OF OTHER ORGANIZATIONS

Alternative fuels

Air Transport Action Group (ATAG)

Beginner's Guide to Sustainable Aviation Fuel (https://aviationbenefits.org/media/166152/beginners-guide-to-saf_web.pdf)

International Air Transport Association (IATA)

IATA 2015 Report on Alternative Fuels (<http://www.iata.org/publications/Pages/alternative-fuels.aspx>)

IATA Guidance Material for Sustainable Aviation Fuel Management
(<https://www.iata.org/whatwedo/environment/Documents/IATA%20Guidance%20Material%20for%20SAF.pdf>)

Partnership for Air Transportation Noise and Emissions Reduction. An FAA/NASA/Transport Canada-sponsored Center of Excellence.

Life Cycle Greenhouse Gas Emissions from Alternative Jet Fuels
(<http://web.mit.edu/aeroastro/partner/reports/proj28/partner-proj28-2010-001.pdf>)

Fuel efficiency/emissions reduction

Airbus

Getting to Grips With Fuel Economy
(<https://www.scribd.com/doc/74091544/Getting-to-Grips-With-Fuel-Economy>)

Airports Council International (ACI)

Guidance Manual: Airport Greenhouse Gas Emissions Management
(<http://www.aci.aero/Publications/Full-Publications-Listing/Guidance-Manual-Airport-Greenhouse-Gas-Emissions-Management>)

Boeing

Fuel Conservation Strategies (http://www.boeing.com/commercial/aeromagazine/articles/2015_q1/archive.html)

Civil Air Navigation Services Organisation (CANSO)

Introduction to Environmental Management Systems for ANSPs
(<https://www.canso.org/introduction-environmental-management-systems>)

International Air Transport Association (IATA)

Guidance Material and Best Practices for Fuel and Environmental Management
(https://store.iata.org/IEC_ProductDetails?id=9796-05)

Sustainable Aviation

Aircraft on the Ground CO₂ Reduction Programme
(<https://www.sustainableaviation.co.uk/wp-content/uploads/2018/06/Aircraft-On-the-Ground-CO2-Reduction-Programme-Best-Practice-Guidance.pdf>)

Emissions inventory preparation

United States (U.S.) Federal Aviation Administration

Aviation Environmental Design Tool (AEDT) (<https://aedt.faa.gov>)

European Monitoring and Evaluation Programme (EMEP)/European Environment Agency (EEA)

EMEP/EEA air pollutant emission inventory guidebook 2016
(<http://www.eea.europa.eu/themes/air/emep-eea-air-pollutant-emission-inventory-guidebook>)

Intergovernmental Panel on Climate Change (IPCC)

Guidelines for National Greenhouse Gas Inventories (<http://www.ipcc-nggip.iges.or.jp/public/2006gl/>)

U.S. Air Force Research Laboratory

Propulsion and Power Rapid Response Research and Development (R&D) Support — Delivery Order 0011: Advanced Propulsion Fuels Research and Development-Subtask: Framework and Guidance for Estimating Greenhouse Gas Footprints of Aviation Fuels
(<http://caafi.org/information/pdf/AFRL-RZ-WP-TR-2009-2206.pdf>)

Argonne National Laboratory

Greenhouse Gases, Regulated Emissions and Energy Use in Transportation (GREET)
(<http://greet.es.anl.gov/>)

Implementation of measures

Air Transport Action Group (ATAG)

Aviation Climate Solutions (https://aviationbenefits.org/media/125796/Aviation-Climate-Solutions_WEB.pdf)

United Kingdom Committee on Climate Change

Meeting the UK aviation target — Options for reducing emissions to 2050
(<http://www.theccc.org.uk/publication/meeting-the-uk-aviation-target-options-for-reducing-emissions-to-2050/>)

U.S. Federal Aviation Administration

Continuous Lower Energy, Emissions, and Noise (CLEEN) Program
(https://www.faa.gov/about/office_org/headquarters_offices/apl/research/aircraft_technology/cleen/)

NextGen Priorities Joint Implementation Plan 2017-2019
(https://www.faa.gov/nextgen/media/NG_Priorities_Joint_Implementation_Plan.pdf)

3. MISCELLANEOUS

Learmount, David

"Lean, Mean Flying," *Flight International* (June 2010)

Chapter 1

INTRODUCTION

1.1 BACKGROUND

1.1.1 The 39th Session of the ICAO Assembly, held from 27 September to 7 October 2016, adopted Resolution A39-2: *Consolidated statement of continuing ICAO policies and practices related to environmental protection — Climate change*. Resolution A39-2 reflects the determination of ICAO's Member States to provide continuous leadership to international civil aviation in limiting or reducing its emissions that contribute to global climate change.

1.1.2 The Assembly recognized ICAO's tremendous progress during the 2013 to 2016 triennium, and reaffirmed the collective aspirational goals that were established by the 37th Session of the ICAO Assembly. It agreed on a comprehensive strategy to progress all elements of its "basket of measures", namely: technology and standards, sustainable aviation fuels, operational improvements and market-based measures.

1.1.3 A central element of Resolution A39-2 is for States to voluntarily prepare and submit action plans to ICAO. It also laid out an ambitious work programme for capacity building and assistance to States in the development and implementation of their action plans to reduce emissions, which States were initially invited to submit by the 37th Session of the ICAO Assembly in October 2010. Specifically, Resolution A39-2:

- a) "*Further encourages* States to submit voluntary action plans outlining respective policies and actions, and annual reporting on international aviation CO₂ emissions to ICAO" (operative clause 10);
- b) "*Invites* those States that choose to prepare or update action plans to submit them to ICAO as soon as possible preferably by the end of June 2018 and once every three years thereafter, in order that ICAO can continue to compile the quantified information in relation to achieving the global aspirational goals, and the action plans should include information on the basket of measures considered by States, reflecting respective national capacities and circumstances, quantified information on the expected environmental benefits from the implementation of the measures chosen from the basket, and information on any specific assistance needs" (operative clause 11); and
- c) "*Encourages* States that already submitted action plans to share information contained in action plans and build partnerships with other Member States in order to support those States that have not prepared action plans, and to make the submitted action plans available to the public, taking into account the commercial sensitivity of information contained in States' action plans" (operative clause 12).

1.1.4 Furthermore, operative clause 13 of Resolution A39-2 "*Requests* the Council to ... continue to provide guidance and other technical assistance for the preparation and update of States' action plans prior to the end of June 2018, in order for States to conduct necessary studies and to voluntarily submit their action plans to ICAO".

1.1.5 Additionally, operative clause 17 b) of Resolution A39-2 requested the Council to:

Build further partnerships with other international organizations to meet the assistance needs of ICAO's Member States, including through the ICAO Action Plan Buddy Programme, and facilitate access to existing and new financial resources, technology transfer and capacity building, to developing countries and report on results achieved as well as further recommendations, preliminarily by the end of 2018 and at the 40th Session of the Assembly.

1.1.6 In short, action plans give ICAO Member States the ability to establish partnerships, promote cooperation and capacity building, facilitate technology transfer and obtain assistance.

1.2 ABOUT THIS GUIDANCE DOCUMENT

1.2.1 This guidance document has been prepared in response to the request referred to in 1.1.4 above. It provides guidance for States to help them prepare or update their action plans and is designed for use by those responsible for the preparation of an action plan.

1.2.2 Specifically, this guidance document aims to:

- a) describe how to prepare or update an action plan by providing an overview of the action plan preparation process (i.e. tasks, activities and outputs);
- b) help States better understand the objectives and expected outcomes of the action plan preparation process;
- c) highlight the need for cooperation and collaboration between and among various stakeholders in the preparation of action plans; and
- d) assist States in considering the basket of measures from which they might select their actions.

1.2.3 This document is divided into five chapters, each focusing on a different aspect of an action plan. ICAO has developed an interactive Action Plan on Emissions Reduction (APER) website to facilitate the preparation or update of action plans and their submission to ICAO. Users are encouraged to submit their action plans through the website. Chapter 2, 2.6, provides detailed instructions on accessing the APER website.

1.2.4 This guidance document has been developed with the goal of accommodating the various levels of experience among States in the development of similar national reports. It is expected that in addition to facilitating the preparation or update of an action plan, this guidance document will contribute to improving the reporting of CO₂ emissions and the implementation of mitigation projects for international aviation.

1.2.5 Although not specifically mentioned here, there are interrelated issues, such as financial needs, research activities, transfer of technology, capacity building (including education, training and public awareness), and information and networking, which form integral elements of an action plan. These issues will be addressed in the relevant chapters of this guidance document.

1.3 CONVENTIONS USED IN THIS DOCUMENT

Recognizing that different conventions for referring to numbers are used throughout the world, this document has been standardized in the North American (English) form. That is, thousands are separated by a comma and the period is used to represent a decimal point (1,500.22 = one thousand five hundred and twenty-two hundredths). In addition, throughout the document reference is made to quantifying fuel consumption and traffic. When required, units for these will be explicitly stated. Furthermore, methods for converting fuel consumption data into CO₂ emissions are provided in the relevant sections of this document.

1.4 WHAT'S NEW IN THE THIRD EDITION OF DOC 9988

1.4.1 Following the initial invitation by the 37th Session of the ICAO Assembly for States to submit action plans for reducing emissions from international aviation, the Secretariat has worked closely with States to support the development of those plans. The Second Edition of Doc 9988 reflected both the feedback received from States which developed plans based on the First Edition of this document and the feedback from the ICAO Council, as well as observations from the action plans that were submitted to ICAO.

1.4.2 The Third Edition of Doc 9988 aims to accurately reflect the latest changes in ICAO Standards and Recommended Practices applicable to the State Action Plan initiative and to integrate the deliverables and lessons learned from the assistance and capacity-building initiatives undertaken by ICAO. The document has been reorganized to reflect the expected flow of information within each State and contains updated case studies. To this end, the Third Edition should be the reference document for the development or update of State Action Plans.

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Chapter 2

ACTION PLANS

2.1 PURPOSE

2.1.1 In many respects, the development of an action plan resembles the execution of any project, potentially involving activities such as securing resources, assembling a team, and planning and implementing various tasks. This chapter provides generic guidance on some of the key aspects of the development process. It does not prescribe any specific activities, since it is up to individual States to decide upon any arrangements (organizational, legal, procedural, etc.) that they may need to put in place in accordance with their national conditions and circumstances.

2.1.2 The aviation sector often plays a central role in the national economy of a State, affecting numerous economic sectors and contributing to the State's further development. As such, any measures to limit or reduce the impact of international aviation on the environment, pursuant to the global aspirational goals agreed by the 37th Session of the ICAO Assembly, and reaffirmed by the 38th and 39th Sessions of the Assembly, should be an integral part of the broader sustainable development priorities and objectives of a State. This would promote sustainable growth of international aviation while ensuring consistency with any overarching greenhouse gas (GHG) emissions limitation or reduction efforts in the State.

2.1.3 In accordance with operative clauses 10 and 11 of Resolution A39-2: *Consolidated statement of continuing ICAO policies and practices related to environmental protection — Climate change*, an action plan can help:

a) States:

- 1) to report international aviation CO₂ emissions to ICAO;
- 2) to outline to ICAO their respective policies and actions;
- 3) to provide information to ICAO on the basket of measures considered, reflecting their respective national capacities and circumstances, and on any specific assistance needs; and

b) ICAO:

- 1) to compile information in relation to the achievement of the global aspirational goals;
- 2) to facilitate the dissemination of economic and technical studies and best practices related to aspirational goals;
- 3) to provide guidance and other technical assistance for the preparation of States' action plans; and
- 4) to identify and respond to States' needs for technical and financial assistance, with a view to responding appropriately through the development of a process and mechanism for the provision of assistance to States.

2.1.4 It is clear from the above that an action plan is a tool that a State can use to showcase and communicate both at the national and international level, its efforts to address their CO₂ emissions from international aviation. In addition, through the development of an action plan, a State could:

- a) better understand the share and projections of international aviation CO₂ emissions;
- b) experience enhanced cooperation between all aviation stakeholders that can positively reflect on their operational areas;
- c) identify the most relevant mitigation actions;
- d) streamline policies;
- e) enhance stakeholders' support and understanding for policy decisions;
- f) establish cross-sectoral partnerships;
- g) promote capacity building;
- h) multiply the environmental effects of mitigation measures;
- i) facilitate technology transfer; and
- j) identify assistance needs.

2.2 SCOPE

2.2.1 In accordance with Resolution A39-2, action plans should incorporate information on activities that aim to address CO₂ emissions from international aviation, including national actions, as well as activities implemented regionally or on a global scale as the result of bilateral and regional/multilateral agreements.

2.2.2 It should be noted that most aviation-related mitigation measures affect both domestic and international operations. To the extent possible, States should distinguish between domestic and international aviation data within their State Action Plan. The action plan should focus on international data, however, if a State wishes to highlight the impact of selected measures on domestic aviation, those impacts may be considered a supplemental benefit of ICAO's global aspirational goals.

2.2.3 Examples of supplemental benefits could include emissions from ground support equipment operations and airport-related ground transportation. These are considered domestic emissions and are beyond the scope of Resolution A39-2. However, if a State wishes to consider the aviation sector as a whole, these measures could be listed as relevant supplemental information to help explain their strategies.

2.3 CONTENTS: WHAT SHOULD BE INCLUDED IN AN ACTION PLAN?

2.3.1 Every action plan submitted to ICAO should contain, at a minimum, the information described in Box 1. This base set of information will allow States to clearly and consistently communicate their intended actions and the expected results from those actions, and allow ICAO to compile the information into a global picture as requested by the 37th Session of the Assembly, and reaffirmed at the 38th and 39th Sessions of the Assembly. This document describes how to obtain the information necessary to prepare a complete action plan. For a template of a complete action plan, please refer to Appendix B.

Box 1. Five basic elements of an Action Plan (minimum requirements)

For action plans to fulfil their purpose in accordance with the provisions of Resolution A39-2, they should contain the following five elements:

1. *Contact information.* The focal point and any other person(s) responsible for the compilation and submission of the action plan should be identified.
2. *Baseline (without action) fuel consumption CO₂ emissions and traffic (from the latest available year to 2050).* Annual historic fuel consumption and traffic from international aviation from the latest available year(s) should be submitted. In addition, projected future fuel consumption and traffic to 2030, 2040 and 2050, in the absence of action (i.e. implementation of mitigation measures) should be submitted. Although any available data would be welcome, in order to assess progress towards the global goals, baseline data for the years 2030, 2040 and 2050 should be provided.
3. *Measures to mitigate CO₂ emissions.* The measures being proposed to address CO₂ emissions from international aviation, distinguishing between those that are already in place and those that are being considered for future implementation, should be listed.
4. *Expected results (fuel consumption, CO₂ emissions and traffic with the actions in 3 being taken from the latest available year to 2050).* Similar to 2, in order for ICAO to understand the global effect of the actions being proposed by States, projected fuel consumption and traffic for the same future years provided in 2 that quantify the effect of the actions listed in 3 should be submitted.
5. *Assistance needs.* A description of any specific needs (for example, financial, technological or capacity building) for the implementation of future actions should be described, if applicable.

States are invited to submit this information directly through the Action Plan on Emissions Reduction (APER) website. This website also enables the direct submission of supporting documentation, if desired.

2.3.2 It is recognized that, where the implementation of mitigation measures requires a high level of integration between various national authorities and when the respective CO₂ emissions impact of these mitigation measures cannot be attributed to individual States, States may wish to include the supranational measures in their States' Action Plans. These will be considered as quantified data by ICAO, provided that the supranational part of the action plans is adopted by all contributing Member States and that this supranational part can be considered *in lieu* of action plans for those States that would not have directly submitted an action plan to ICAO, until they effectively do so. In this respect, it is of utmost importance that all States are encouraged to provide information on the national implementation of supranational measures or the impact of any additional national measure that would not have been taken into account in the supranational part.

2.3.3 States may provide more detail in their action plans in order to showcase their activities and/or solicit assistance for the future implementation of specific actions. In providing information on ongoing and future actions, a State may indicate which actions are the direct result of policy-making at the government level and which are being driven by other stakeholders (solely or in cooperation with State authorities), such as engine and aircraft manufacturers, air carriers, airport/local authorities and non-governmental organizations. Other action-specific information that may be provided includes:

- a) an indication of the type of action (operational, technological, market-based, etc.);
- b) time horizon (start date and date of full implementation);
- c) anticipated change in fuel consumption and/or CO₂ emissions;
- d) economic cost and how it may be covered (domestic sources, regional funding, international assistance, etc.);
- e) expected supplemental benefits (those benefits that do not directly influence international aviation fuel consumption and/or CO₂ emissions, which include domestic aviation, airport-level emissions reduction, air quality improvements, noise reduction, etc.);
- f) references to any relevant legislation; and
- g) a description of the process used for selecting the mitigation actions.

2.3.4 Furthermore, States may provide additional explanatory information which may highlight the specific conditions of the State (e.g. a general introduction on the role of international aviation in the State).

2.3.5 While States are encouraged to make their action plans available to the public, ICAO will consider all plans submitted as confidential unless otherwise notified by the originating State. To protect confidentiality, the State may elect not to make certain data publicly available, or may aggregate/de-identify the data before including it in the action plan. In the event that confidential data is collected in the development of the action plan (for example, from individual air carriers or on specific international routes), appropriate procedures should be followed by the State for the designation and treatment of such information in accordance with the applicable national legislation and regulations. A State could improve transparency by explaining in its action plan how confidential information has been treated.

2.3.6 Every effort is being made to ensure that the process of reporting action plans to ICAO is as simple and flexible as possible. Once the basic five elements described in Box 1 have been submitted through the APER website, States are encouraged to submit additional information in support of their action plans on assumptions, methods used, etc. in any format they wish. This information will assist ICAO in aggregating the data from different State action plans and could be used by a State to request assistance from ICAO. To ease the process of collecting additional information to be included in the action plan, a template is provided in Appendix B which reflects the format of the APER website.

2.4 PROCESS: WHAT ARE THE STEPS TO DEVELOP AN ACTION PLAN?

2.4.1 As described in operative clause 11 of Resolution A39-2, action plans should be prepared and submitted to ICAO by the end of June 2018 and once every three years thereafter. This provides a time horizon against which a plan for the preparation of an action plan can be formulated. However, it is recognized that the work of ICAO Member States might be bound to different timelines, not allowing the completion and submission of their action plan by June every three years. In such cases, it is accepted that a different submission date be defined.

2.4.2 The key steps in the planning process include:

- a) establishing the team that will contribute to the development of the action plan;
- b) estimating the baseline (without action) international aviation fuel consumption and traffic;
- c) selecting the measures to mitigate CO₂ emissions and improve fuel efficiency;

- d) estimating the expected results from the actions (mitigation measures) selected; and
- e) identifying any assistance needed to develop and/or implement the plan.

2.4.3 *Establishing the team.* The first step in developing an action plan is to secure the commitment of all stakeholders involved with civil aviation matters in the State. All relevant stakeholders (from the public and private sectors) should be involved taking into consideration their specific expertise. Depending on the complexity of the aviation sector in a State, small working teams may be established to carry out specific technical tasks or hold discussions on one specific category of mitigation measures. Most States have already employed such a State team approach for the preparation of other national reports in the context of various multilateral agreements under the United Nations (for example, national communications under the United Nations Framework Convention on Climate Change (UNFCCC), national reports in the context of Agenda 21¹, reporting under ICAO Statistical Air Transport Reporting Forms, etc.). It is advised to convene the State Action Plan stakeholders group formally and to develop and share terms of reference for the work of the group and an associated timeline.

2.4.4 One of the key prerequisites for the successful development of an action plan is the establishment of clear roles and responsibilities for each of the stakeholders involved. One of the principal stakeholders at the national level would be an executing body with the overall responsibility (often as mandated by national legislation) to deal with, and coordinate actions on, international aviation and climate change in the State. Examples include, but are not limited to, national authorities (such as the civil aviation authority), departments or ministries (such as the transport or environment ministry) and specialized national agencies. It is important that the appropriate executing body be identified at an early stage of the process because it will make it easier for personnel to be appointed and for specific roles and responsibilities to be allocated. Within this organization, a single person should be identified to serve as the focal point for the action plan. This is the only person who would be authorized to submit the action plan to ICAO through the APER website on behalf of the State and is the primary point of contact between ICAO and the State, including on information related to the organization of training seminars.

2.4.5 In addition, depending on the measures to be included in the action plan, many activities may not be under direct control of the State, and/or may require cooperation with others in order to secure reliable data, including: air carriers, air navigation service providers, airports, fuel providers, airframe/engine manufacturers, etc. States can incorporate information on a point or points of contact in their action plans. Such information would help ICAO clarify any issues that may arise during the compilation of the reported information.

2.4.6 In cases where expertise in specific areas of an action plan is missing or lacking, capacity building and training should be arranged early in the process. This would ensure that all experts have the necessary know-how to carry out their respective tasks in an efficient and timely manner. States that have identified specific capacity-building needs are encouraged to inform ICAO in order for the Organization to explore options for facilitating technical training, as appropriate. The focus of such training would be on the use of available resources (such as GHG inventory guidelines, mitigation models and tools) and would be conducted, preferably, at the national level.

2.4.7 Another equally important element is for all information generated or collected during the action plan process to be documented and archived for future use. Having such a system in place facilitates regular future updates and periodic reporting as suggested in ICAO Assembly Resolution A39-1: *Consolidated statement of continuing ICAO policies and practices related to environmental protection — General provisions, noise and local air quality*.

2.4.8 *Estimating the baseline.* This is a key part of an action plan because it provides the opportunity to determine the historical levels of international aviation fuel consumption and traffic and to project into the future the growth in fuel consumption and traffic in the absence of the actions described in the plan. It provides a reference point against which the State can understand the expected progress of their actions, i.e. implementation of mitigation

1. <https://sustainabledevelopment.un.org/outcomedocuments/agenda21>

measures, and monitor progress in the future. This information will also assist ICAO in assessing the overall emissions trends and tracking progress towards the achievement of the global aspirational environmental goals. Information about how to develop the baseline is provided in Chapter 3.

2.4.9 *Measures to mitigate CO₂ emissions.* An integral element of an action plan is the identification of measures that will be implemented in order to achieve CO₂ emissions reductions and/or improve fuel efficiency. Chapter 4 provides more information on how to put together a basket of measures that is suited to a State's circumstances.

2.4.10 *Estimation of expected results.* Along with the selection of measures, Chapter 4 also provides information on how to quantify their effects on CO₂ emissions and fuel efficiency. As with the baseline, this information will allow the State to understand the impact that their proposed actions will have on their fuel consumption and CO₂ emissions. It also allows ICAO to assess the collective global contribution of States' individual plans toward the achievement of the global aspirational goals.

2.4.11 *Identification of assistance needs.* An often overlooked element of an action plan is the identification of assistance that would further enable the plan's development and implementation. A clearly communicated plan provides a solid basis for requesting assistance from a broad range of sources (see Chapter 5 for more information).

2.5 UPDATING AN EXISTING ACTION PLAN

2.5.1 Once action plans have been prepared, States are invited to submit them and subsequently update them every three years preferably on the year prior to the Assembly year. The guidance in this document is equally relevant for updating an existing action plan as for creating a new one. In each of the steps described in this document, recommendations are included for what to consider if a plan is being updated.

2.5.2 Regular updates of the State Action Plan are essential to fully deliver the benefits of the initiative at the national level. Indeed, such updates increase the robustness of the data collection process, the understanding of stakeholders operating needs and constraints, the ownership of the content of the document, the preparedness for the implementation of mitigation measures and the ability to demonstrate progress.

2.5.3 When a State Action Plan is submitted to ICAO, it is reviewed and feedback on the submission is provided to the State Action Plan Focal Point. In order to facilitate this process, ICAO developed a Feedback Form, which is used to provide each State Action Plan Focal Point with an informal analysis of their submitted State Action Plan.

2.5.4 This Feedback Form is only shared with the State Action Plan Focal Point. This Feedback Form is not used to any other end, is not intended to be a formal document, and is not intended to provide a "grade" or rank of submitted State Action Plans.

2.5.5 The Feedback Form:

- a) provides tailored points for consideration when developing future updates of a State Action Plan;
- b) ensures that ICAO provides feedback to each State Action Plan Focal Point in a consistent format;
- c) encourages States to continue communications with stakeholders following the submission of a State Action Plan; and
- d) emphasizes that ICAO is always available for questions related to State Action Plans.

2.5.6 An example of the current version of the Feedback Form is provided in Appendix G. Please note that the Feedback Form may be periodically adjusted in order to reflect comments received by ICAO.

2.6 THE APER WEBSITE: HOW TO SUBMIT AN ACTION PLAN

2.6.1 To facilitate the submission of action plans and minimize the burden on States, ICAO has developed an interactive website that can be used to upload and submit action plans electronically. The template in Appendix B will help States to organize the information in the same order that it will be requested on the website. Instructions for online submission, as well as training materials, including a step-by-step guide and examples, can be downloaded from the APER website.

2.6.2 In order to obtain access to the APER website, States' Action Plan Focal Point(s) must create an account on the ICAO Secure Portal. To create a new user account:

- a) access the ICAO Portal at the following link: <http://portal.icao.int>;
- b) if you do not have a pre-existing portal username/password, click the **Request an account** option;
- c) click the **OK** button on the pop-up message to indicate that this is your first portal account;
- d) in the pop-up window **Please enter a group name you wish to subscribe**, enter the group name **APER** (all caps and no spaces);
- e) click the **OK** button;
- f) enter the necessary information in the **New User Account Application Form**; and
- g) click the **Submit Request** button.

When these steps have been completed, you will receive confirmation that you have been granted or denied access (if granted access, the e-mail will include your username and password).

2.6.3 Should the State Action Plan Focal Point(s) already have an ICAO Secure Portal account, instructions for accessing the APER website are as follows:

- a) log on to <http://portal.icao.int> with your secure site login credentials;
- b) click on the **PROFILE** link in the top, left-hand corner;
- c) in the next window on the left-hand side, click on **Group Subscribe**;
- d) under **To Subscribe** enter the group name **APER** (all caps and no spaces) and the **Justification** for your request; and
- e) click the **Submit Changes** button.

When these steps have been completed, you will receive an e-mail confirmation that you have been granted or denied access to the group in question.

2.6.4 The APER website allows States to upload their action plans and/or additional supporting documentation as electronic documents. Action plans or supporting documentation submitted in a language other than one of the six official languages of ICAO (Arabic, Chinese, English, French, Russian and Spanish) will not be translated by the ICAO Secretariat. Furthermore, it is emphasized that if a State submits its action plan in a language other than one of the six ICAO official languages, it should use the APER website to provide (at least) the minimum information described above in English. If the State does not do so, the submitted information will not be processed by the ICAO Secretariat.

2.6.5 In addition to providing a secure location to upload a State Action Plan, the APER provides access to resources developed by ICAO in support to States, including this guidance document. Additional resources include the ICAO Environmental Benefits Tool (EBT), the Marginal abatement cost (MAC) curves tool, ICAO Carbon Emissions Calculator for States, additional ICAO guidance documents, useful links, and PowerPoint presentations from past ICAO States' Action Plans Regional Seminars.

2.7 HOW ICAO CAN HELP

2.7.1 ICAO generally provides States with assistance related to aviation and the environment on a regular basis under its work programme, including through the organization of meetings at ICAO Headquarters and the regional offices; correspondence with States on specific environmental questions; publication of documents, such as the ICAO Environmental Reports or technical documentation, including the ICAO guidance material; and the development and dissemination of tools to assist States in accounting for aviation related CO₂ emissions. These tools support calculating CO₂ emissions from air travel (ICAO Carbon Emissions Calculator), estimating fuel and CO₂ emissions savings from operational measures (ICAO Fuel Savings Estimation Tool (IFSET)), support the development of the baseline for the action plan (Environmental Benefits Tool (EBT)) and support decision-making in prioritizing mitigation measures (MAC curve tool) and in minimizing CO₂ emissions from air travel to attend meetings (ICAO Green Meetings Calculator).

2.7.2 Specific technical assistance was requested by Assembly Resolution A39-2 (operative clause 13) for the preparation and submission of States' action plans on CO₂ emissions reduction activities. Significant resources are available to ensure that all States are able to prepare, submit and implement an action plan that reflects their circumstances. In addition to this guidance document, the interactive APER website and regional seminars, the ICAO Secretariat has developed a team for the action plan initiative. This team includes experts at ICAO Headquarters and one focal point in each of the ICAO regional offices who are available to assist States in developing their action plans by providing them with the necessary data and specific technical support; work with States in the development and implementation of their action plans; and answer any questions related to the action plan initiative. The ICAO Secretariat action plan team can be identified at: <https://www.icao.int/environmental-protection/Pages/ActionPlan-Questions.aspx>.

2.7.3 Since the Second Edition of ICAO Document 9988 was published, the ICAO Secretariat has developed a State Action Plan Feedback Form, based on Box 1 of this chapter. This form provides a streamlined method for the ICAO Secretariat to communicate possible areas of improvements for States in their action plans. This form is an important communication tool to encourage States to continue discussions with their stakeholders, even after the submission of the State Action Plan.

2.7.4 To further support States in the development of their action plans and to encourage cooperation amongst ICAO Member States, ICAO has initiated the ICAO Action Plan Buddy Programme. This programme was given reaffirmed support by Assembly Resolution A39-2 and is in line with the No Country Left Behind initiative. This programme encourages the building of partnerships between States that have already submitted an action plan (Buddy State) and States that wish to develop their action plan, but have not yet done so. The programme is intended as an informal agreement and the level of collaboration is entirely decided upon by the two States. In this context, ICAO can

facilitate initial communication between the two States, if desired. Examples of successful Buddy Programme partnerships can be found on the ICAO Environmental Protection (ENV) webpage².

2.7.5 ICAO has also engaged in two capacity-building and assistance projects that have delivered guidance material and tools of significant importance for States and their stakeholders in the process of developing or updating a State Action Plan.

2.7.6 ICAO's partnership with the European Union "Capacity Building for CO₂ Mitigation from International Aviation", has allowed for support to 14 selected States in the Africa and Caribbean regions in the development of their State Action Plan, the installation of tailor-made CO₂ emissions reporting software, the Aviation Environmental System (AES) and the implementation of pilot mitigation measures and feasibility studies. An essential component of the ICAO-EU project is the design and development of guidance material and tools to benefit all ICAO Member States. Thus, ICAO cooperated with the United Nations Institute for Training and Research (UNITAR) to develop an online training course accessible to the State Action Plan Focal Points designated by ICAO Member States. The feasibility studies and case studies from the project are also useful resources that are referenced in the relevant sections of this guidance document and can be found on the ICAO ENV webpage³.

2.7.7 ICAO has also concluded a partnership with the United Nations Development Programme (UNDP) with financing from the Global Environment Facility (GEF) *Transforming the Global Aviation Sector: Emissions Reduction from International Aviation* in order to support developing States and Small Island Developing States (SIDS) with the implementation of low carbon aviation measures. The key characteristic of all project deliverables is their contribution to the replication of CO₂ mitigation measures by States that have limited human and financial resources and that are the most vulnerable to the impacts of climate change. The project is structured around four main objectives:

- a) developing guidance documents to facilitate approaches to reduce aviation emissions in developing States and SIDS;
- b) setting up a Low-Carbon Knowledge Sharing Platform;
- c) devising an analytical tool for States' use in comparing the cost and effectiveness of emission mitigation initiatives; and
- d) demonstrating an easily replicable, low emission installation by way of a pilot project which would serve as an example to replicate for developing States and SIDS.

The project deliverables are also referenced in the relevant sections of this guidance document and can be found on the ICAO ENV webpage⁴.

2.7.8 Moreover, additional support for States beyond the provision of data or a few days' support may be obtained from the ICAO Technical Cooperation Bureau (TCB) which provides further assistance through consultants/experts selected and hired by TCB.

2. <https://www.icao.int/environmental-protection/Pages/ActionPlan-Questions.aspx>

3. https://www.icao.int/environmental-protection/Pages/ICAO_EU.aspx

4. https://www.icao.int/environmental-protection/Pages/ICAO_UNDP.aspx

Chapter 3

BASELINE SCENARIO — ACCOUNTING FOR CURRENT AND FUTURE TRAFFIC, FUEL CONSUMPTION AND CO₂ EMISSIONS DATA

(SITUATION WITHOUT ACTION)

3.1 INTRODUCTION

In order to understand the benefits that can be expected from the implementation of a basket of measures, it is useful to quantify both the historic fuel consumption and traffic, as well as to project into the future what would happen in the absence of the measures contained in the action plan. This chapter is intended to help States establish a baseline scenario for their international aviation fuel consumption and traffic. It provides general guidance for the estimation, reporting and verification of CO₂ emissions from international aviation.

3.2 DIFFERENTIATING BETWEEN INTERNATIONAL AND DOMESTIC EMISSIONS

3.2.1 Multiple definitions exist for differentiating between international and domestic aviation operations. In order to properly interpret the information provided by States, it is important that the definition used is clearly articulated in the action plan. For the purpose of Annex 16 — *Environmental Protection*, Volume IV — *Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)*, international flights are defined (paragraph 1.1.2 refers). To ensure consistency with the mandatory requirements of Annex 16, Volume IV, States that voluntarily develop and submit their action plan to ICAO shall use the following definition of international flight:

An international flight is defined as the operation of an aircraft from take-off at an aerodrome of a State or its territories, and landing at an aerodrome of another State or its territories. In addition, a domestic flight is defined as the operation of an aircraft from take-off at an aerodrome of a State or its territories, and landing at an aerodrome of the same State or its territories.

3.2.2 Various methodologies exist to account for the CO₂ emissions attributed to international flights:

- a) ICAO: each State reports the CO₂ emissions from the international flights operated by aircraft registered in the State (State of Registry); and
- b) IPCC: each State reports the CO₂ emissions from the international flights departing from all aerodromes located in the State or its territories (State of Origin).

3.2.3 In light of the Monitoring, Reporting and Verification (MRV) requirements mandated by Annex 16, Volume IV, all States with a registered operator are encouraged follow the ICAO methodology for the accounting of CO₂ emissions from international aviation for the purpose of their State Action Plan. However, States that already use the IPCC methodology, or States with no registered air carrier should also be enabled to voluntarily develop and submit an action plan to ICAO, where they could lay down their national strategy for dealing with international aviation CO₂ emissions. In those cases, the IPCC methodology for the accounting of international aviation CO₂ emissions would be applicable.

3.3 COLLECTING OR ESTIMATING HISTORIC AIR TRANSPORT ACTIVITY AND FUEL CONSUMPTION DATA

3.3.1 ICAO requires that States report fuel consumption and traffic through Statistical Air Transport Reporting Form M — *Fuel Consumption and Traffic — International and Total Services, Commercial Air Carriers* on an annual basis. Reporting instructions for this and other forms is provided at <http://www.icao.int/staforms>. States may wish to leverage this data in creating their historical baseline as it has already been collected.

3.3.2 As indicated in Appendix B, only total fuel consumption and traffic (including of aircraft leased) are required in an action plan. Therefore, the data collected from the various air carriers in the State for the purpose of Form M can be aggregated.

3.3.3 For the purposes of developing a State Action Plan, States are encouraged to aggregate the fuel burn and emissions data submitted by all of their international aeroplane operators for each year. Using this aggregated data, the State Action Plan Focal Point can forecast the future fuel burn and emissions data in order to develop the State Action Plan Baseline Scenario.

3.3.4 The baseline scenario included in the State Action Plan is understood to be an estimation only. The baseline scenario established by each State in their State Action Plan is unrelated to the CORSIA baseline (see Section 4.2). However, the information reported to the State through the CORSIA MRV system (see Box 2) can serve as a basis for collecting fuel consumption and CO₂ emissions data in the State.

Box 2. CORSIA Monitoring, Reporting and Verification (MRV) system

The first edition of Annex 16, Volume IV was adopted by the ICAO Council at its 214th Session in June 2018. Annex 16, Volume IV contains the Standards and Recommended Practices for the implementation of CORSIA, including CORSIA's MRV system, and is applicable on 1 January 2019.

CORSIA's MRV system consists of three components:

1. **Monitoring** of fuel use on each international flight and calculation of the related CO₂ emissions will be either based on a Fuel Use Monitoring Method, or the on use of the simplified ICAO CORSIA CO₂ Estimation and Reporting Tool (CERT), which has been made available to aeroplane operators through the ICAO CORSIA website to support the monitoring and reporting of their CO₂ emissions. An aeroplane operator is required to describe its approach to CO₂ emissions monitoring in an Emissions Monitoring Plan, which the operator will submit for approval by the State. A conversion factor of 3.16 kg of CO₂ per 1 kg of Jet-A fuel will be used to convert fuel use into CO₂ emissions.
2. **Reporting** of CO₂ emissions information between aeroplane operators, States and ICAO through the use of harmonized templates and procedures. ICAO will then consolidate this CO₂ emissions data, calculate the Sector's Growth Factor, and then communicate the Growth Factor to States.
3. **Verification** of reported CO₂ emissions data to ensure that the data reported by aeroplane operators is accurate and free of errors. A very basic idea of the verification under CORSIA's MRV system is that an accredited third party verification body checks that everything has been done correctly. This is similar to the accounting practices that are performed in the financial world.

As per Annex 16, Volume IV, all aeroplane operators conducting international flights are required to monitor, report, and verify CO₂ emissions from these flights from 1 January 2019 until 31 December 2035, unless exempted. It should be noted that the requirement for the MRV of CO₂ emissions is independent from participation in CORSIA offsetting.

Annex 16, Volume IV provides exemptions to the applicability of the MRV requirements to the following:

- a) An aeroplane operator that produces annual CO₂ emissions from international flights less than or equal to 10,000 tonnes;
- b) Aeroplane(s) with a maximum certificated take-off mass less than or equal to 5,700 kg; and
- c) Humanitarian, medical and firefighting flights, as well as flights preceding or following a humanitarian, medical or firefighting flight, provided that such flights were conducted with the same aeroplane, and were required to accomplish the related humanitarian, medical or firefighting activities or to reposition thereafter the aeroplane for its next activity.

As a part of the CORSIA MRV system, an aeroplane operator is required to submit to the State a verified Emissions Report on an annual basis. The Emissions Report will include information on the previous calendar year's CO₂ emissions, and it shall be accompanied by a Verification Report that will be prepared by an accredited third-party verification body. The operator and the verification body shall both independently submit the verified Emissions Report and associated Verification Report to the State Authority.

For example, the CO₂ emissions from the calendar year of 2019 shall be reported to the State by 31 May 2020. CO₂ emissions from the calendar year of 2020 shall be reported by 31 May 2021. Regarding the CO₂ emissions for the period of 2021-2035, the reporting deadline of the previous calendar year's CO₂ emissions is 30 April.

After the State has received Emissions Reports from all of its aeroplane operators, the State shall perform an order of magnitude check to the Emissions Report, and submit the required information regarding CO₂ emissions to ICAO. Reporting by States will take place by 31 August 2020 for 2019 emissions and by 31 August 2021 for 2020 emissions. Regarding CO₂ emissions from 2021-2035, the annual reporting deadline from States to ICAO is 31 July following the calendar year for which the CO₂ emissions are being reported.

For CORSIA eligible fuels, an aeroplane operator can report on CORSIA eligible fuels in 2019-2020 as part of its annual Emissions Report. However, the CO₂ benefits associated with the use of those fuels will not be claimed from 2021 onwards. In order to claim emissions reductions from the use of such fuels from 2021, the operator will provide supplementary information to the Emissions Report, which includes the details of the CORSIA eligible fuels and associated emissions reductions. The aeroplane operator that intends to claim for emissions reductions from the use of CORSIA eligible fuels during the compliance periods of CORSIA shall use a CORSIA eligible fuel that meets the CORSIA Sustainability Criteria as defined within the ICAO document entitled *CORSIA Sustainability Criteria for CORSIA Eligible Fuels* that is available on the ICAO CORSIA website.

The aeroplane operator that intends to claim for emissions reductions from the use of CORSIA eligible fuels shall only use CORSIA eligible fuels from fuel producers that are certified by an approved Sustainability Certification Scheme included in the ICAO document entitled *CORSIA Approved Sustainability Certification Schemes*, which will become available on the ICAO CORSIA website following approval by the ICAO Council. Such certification schemes meet the requirements included in the ICAO document entitled *CORSIA Eligibility Framework and Requirements for Sustainability Certification Schemes*, also available on the ICAO CORSIA website.

More information on CORSIA is available on the ICAO CORSIA website:
<https://www.icao.int/environmental-protection/CORSIA/Pages/default.aspx>

3.3.5 *Converting fuel consumption to CO₂.* In order to convert from fuel consumption in litres to CO₂ emissions in kilograms, the fuel consumed must first be converted from volume (litres) to mass (kg). If the average fuel density is known, it should be used; otherwise a conversion factor of 0.8 kg/litre should be assumed. Then, to convert from the mass of fuel to mass of CO₂ emissions, a conversion of 3.16 kg CO₂/kg fuel should be used for jet fuel. Depending on the methodology used, sustainable aviation fuels may be treated separately (see Section 4.2).

3.4 FORECASTING FUTURE BASELINE TRAFFIC AND FUEL CONSUMPTION

3.4.1 The baseline scenario is intended to reasonably represent the fuel consumption and traffic that would occur in the absence of action. This corresponds to the “business as usual” or “do-nothing additional” scenario. States will need to carefully consider how to define their baseline with regard to which elements are and are not included. For example, States may decide to exclude from their baseline any actions or measures already taken, but which will limit or reduce emissions in the future. Alternatively, they may wish to include such actions in the baseline so that the baseline will be used to assess the impacts only of new, additional actions or measures. Whichever approach is chosen, it will be important that States make explicit the assumptions behind the baseline they establish. The time horizon of a baseline scenario is not limited to the present and should correspond to the time horizon (to be) set for the goals.

3.4.2 The establishment of a baseline involves the following steps (see Figure 3-1):

- a) *Define the time horizon and intermediate years.* These should include the time horizon and intermediate years set by ICAO for its goals (ideally to 2050, with any other years).
- b) *Estimate historical activity data and emissions inventory.* Historical air transport activity data are normally readily available from operators and airport and civil aviation authorities, as described in Section 3.3.
- c) *Develop forecasts for air transport activity and for related emissions in the baseline scenario.* Forecasts for air transport activity may be readily available since many States develop such forecasts on a regular basis, while others may have prepared them for other planning purposes. Forecasting emissions may be done using techniques of various levels of complexity. ICAO's *Manual on Air Traffic Forecasting* (Doc 8991) provides guidance on air traffic forecasting techniques and includes some case studies. However, States have the option to select the technique that is suitable to them.



Figure 3-1. Steps for the establishment of a baseline

3.4.3 Global and regional (Africa, Asia/Pacific, Europe, Latin America and Caribbean, Middle East, North America) long-term forecasts for passenger and freight traffic are prepared by ICAO on a regular basis. The latest set of these forecasts is contained in Circular 333 — *Global Air Transport Outlook to 2030 and trends to 2040*.

3.4.4 More detailed long-term regional air traffic forecasts are also available: *Asia/Pacific Area Traffic Forecasts 2010–2030* (Doc 9961), *Africa-Indian Ocean Regional Traffic Forecasts 2008–2028* (Doc 9939) and *Caribbean/South American Regional Traffic Forecasts 2009–2030* (Doc 9940).

3.4.5 Fuel consumption and emissions are related to air traffic, but also depend on the fleet in service, air carriers and airport operations, as well as the provision of air navigation services. Consequently, forecasting emissions from civil aviation requires taking these factors into consideration. The three tiers for the estimation of emissions from civil aviation, described in the IPCC 2006 Guidelines, can be used to project emissions based on the available air traffic forecasts.

3.4.6 The approaches to developing a baseline scenario described in this section are all based on the extrapolation of past trend data in order to determine future levels of fuel consumption and traffic. The main assumption made is that past (historic) data on both fuel consumption and traffic are available.

3.4.7 Depending on the availability of historical data, three different methods (depending on the size of the fleet) can be applied for generating a baseline scenario:

- a) *Method A.* The State has a current fleet size of no more than ten aircraft.
- b) *Method B.* The State has a current fleet size of more than ten aircraft, and has access to data for at least two years.
- c) *Method C.* The State has a current fleet size of more than ten aircraft, and has access to data for a single year only.

3.4.8 The Environmental Benefits Tool (EBT) available on the Action Plan for Emissions Reduction (APER) website has been developed to assist in developing the baseline using the methods described above.

3.4.9 Method A (fleet size of no more than ten aircraft)

3.4.9.1 Due to the small size of the fleet, this method for calculating the baseline scenario results in step-change increases in traffic, in Revenue Tonne Kilometres (RTKs), and fuel burn (FB) to more realistically reflect the effect of adding aircraft to the fleet when demand exceeds the available capacity.

Note.— A State can use this method to develop the baseline scenario when the fleet has no more than ten aircraft and then once the fleet size expands beyond ten aircraft, the State can select another method (most likely Method B) to update the baseline scenario.

Step 1: Estimate fuel burn based on the single year of data

Note.— In the event that a State has data for multiple years, the fuel burn can be averaged across all of the data available for the period when the fleet size and composition was the same as the most recent year.

- a) obtain historical annual data for fuel consumption (volume of fuel) and RTK for the latest available year (FB_i);

- b) determine how the RTK will evolve in the future by considering national forecasts (or projections) or by using default regional growth rates (available in ICAO Circular 333); and
- c) determine the forecasted (or projected) fuel consumption for the near future assuming the same growth rate as for the RTK as follows:

$$FB_n = FB_{n-1} * (1 + CAGR) \text{ where } n \in \{j + 1, \dots, N\}$$

where FB is the fuel burn, n is the current year, $CAGR$ is the RTK compound annual growth rate.

Step 2: Estimate average fuel burn per aircraft

- a) provide the number of aircraft within the fleet (between one and ten); and
- b) estimate average fuel burn per aircraft for the latest available year:

$$\overline{FB} = \frac{FB_j}{k_j}$$

where $\overline{FB}$ is the average fuel burn, j is the latest available year (i.e. reference year) and k is the number of aircraft in the fleet.

Step 3: Allocate the change in fuel burn to individual aircraft (known as corrected fuel burn (CFB))

- a) estimate the CFB for the latest available year (j):

$$CFB_j = FB_j$$

and

- b) estimate the CFB for each year (n):

$$CFB_n = \overline{FB} * k_n$$

corrected fuel burn (current year) = average fuel burn × number of aircraft (current year)

where $n \in \{j + 1, \dots, N\}$

where $k_n = k_{n-1}$ if $FB_n - CFB_{n-1} < \overline{FB}$ (Case 1)

or $k_{n-1} + 1$ if $FB_n - CFB_{n-1} \geq \overline{FB}$ (Case 2)

3.4.9.2 The CFB is calculated for each year from the year after the reference year (i.e. when $n = j+1$) to the last year of the period (i.e. when $n = N$). We assume a constant average fuel burn across the fleet over the entire period. Up to this point, this is the same technique that is used for operators with larger fleets.

3.4.9.3 In order to more realistically reflect the effects of adding an aircraft to the fleet, the fuel burn needs to be adjusted for each projected year based on one of the two cases that follow:

- a) **Case 1** (demand in the given year can be accommodated with the existing fleet). If the amount of fuel burn of the current year minus the amount of corrected fuel burn of the previous year is less than the amount of the average fuel burn, then the number of aircraft within the fleet remains constant ($k_n = k_{n-1}$). The next step is to calculate the corrected fuel burn of the current year by multiplying the number of aircraft (unchanged from the number of aircraft from the previous year) with the average fuel burn.
- b) **Case 2** (demand in the given year can only be met with the addition of another aircraft). If the amount of fuel burn of the current year minus the amount of corrected fuel burn of the previous year is greater than or equal to the amount of the average fuel burn, then the number of aircraft within the fleet increases by one ($k_n = k_{n-1} + 1$). The next step is to calculate the corrected fuel burn of the current year by multiplying the number of aircraft (number of aircraft in the previous year + 1) with the average fuel burn.

3.4.9.4 *Example.* An operator in the State has the following characteristics for the year of 2014:

- a) international fuel burn (tonnes) = 16,000
- b) number of aircraft in 2014: 4
- c) annual RTK growth rate = 5.8%
- d) baseline period for the example: from 2014 to 2025

This translates to the following parameters for the equations described on the previous page:

- a) $j = 2014$ and $N = 2025$
- b) $n = \{2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025\}$
- c) $k_j = 4$
- d) $FB_j = CFB_j = 16,000.00$
- e) $CAGR = 5.8\%$ or 0.058

Step 1: Estimate fuel burn (in tonnes) based on the single year of data from 2014 to 2025

**Table 3-1. Example of outcome of Step 1 of Method A —
Estimate of fuel burn (in tonnes) based on the single year of data from 2014 to 2025**

<i>Year</i>	<i>Fuel burn</i>	<i>Details on calculation</i>
2014	16,000	Fuel burn for the latest available year (FB _j)
2015	16,928	16,000 * (1+ 0.058)
2016	17,910	16,928 * (1+ 0.058)
2017	18,949	17,910 * (1+ 0.058)
2018	20,048	18,949 * (1+ 0.058)
2019	21,210	20,048 * (1+ 0.058)
2020	22,441	21,210 * (1+ 0.058)
2021	23,742	22,441 * (1+ 0.058)
2022	25,119	23,742 * (1+ 0.058)
2023	26,576	25,119 * (1+ 0.058)
2024	28,117	26,576 * (1+ 0.058)
2025	29,748	28,117 * (1+ 0.058)

Step 2: Estimate average fuel burn per aircraft for the year 2014

$$\overline{FB} = \frac{FB_j}{k_j} = \frac{FB_{2014}}{k_{2014}} = \frac{16,000}{4} = 4,000$$

Step 3: Allocate the change in fuel burn (in tonnes) to individual aircraft

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Table 3-2. Example of outcome of Step 3 of Method A — Fuel burn versus corrected fuel burn for the period 2014 to 2025

Year	Fuel burn	Corrected fuel burn (annual tonnes)	Number of aircraft (k)	Details on calculation
2014	16,000	16,000	4	2014 is the reference year (j) Corrected fuel burn in 2014 = fuel burn in 2014
2015	16,928	16,000	4	Fuel burn in 2015 — Corrected fuel burn in 2014 is less than average fuel burn (16,928 – 16,000 < 4,000) The fleet size remains at 4 Corrected fuel burn in 2015 = 4,000 * 4
2016	17,910	16,000	4	Fuel burn in 2016 — Corrected fuel burn in 2015 is less than average fuel burn (17,910 – 16,000 < 4,000) The fleet size remains at 4 Corrected fuel burn in 2016 = 4,000 * 4
2017	18,949	16,000	4	Fuel burn in 2017 — Corrected fuel burn in 2016 is less than average fuel burn (18,949 – 16,000 < 4,000) The fleet size remains at 4 Corrected fuel burn in 2017 = 4,000 * 4
2018	20,048	20,000	5	Fuel burn in 2018 — Corrected fuel burn in 2017 is greater than average fuel burn (20,048 – 16,000 ≥ 4,000) The fleet size increases to 5 Corrected fuel burn in 2018 = 4,000 * 5
2019	21,210	20,000	5	Fuel burn in 2019 — Corrected fuel burn in 2018 is less than average fuel burn (21,210 – 20,000 < 4,000) The fleet size remains at 5 Corrected fuel burn in 2019 = 4,000 * 5
2020	22,441	20,000	5	Fuel burn in 2020 — Corrected fuel burn in 2019 is less than average fuel burn (22,441 – 20,000 < 4,000) The fleet size remains at 5 Corrected fuel burn in 2020 = 4,000 * 5
2021	23,742	20,000	5	Fuel burn in 2021 — Corrected fuel burn in 2020 is less than average fuel burn (23,742 – 20,000 < 4,000) The fleet size remains at 5 Corrected fuel burn in 2021 = 4,000 * 5

Year	Fuel burn	Corrected fuel burn (annual tonnes)	Number of aircraft (k)	Details on calculation
2022	25,119	24,000	6	Fuel burn in 2022 — Corrected fuel burn in 2021 is greater than average fuel burn (25,119 – 20,000 ≥ 4,000) The fleet size increases to 6 Corrected fuel burn in 2022 = 4,000 * 6
2023	26,576	24,000	6	Fuel burn in 2023 — Corrected fuel burn in 2022 is less than average fuel burn (26,576 – 24,000 < 4,000) The fleet size remains at 6 Corrected fuel burn in 2023 = 4,000 * 6
2024	28,117	28,000	7	Fuel burn in 2024 — Corrected fuel burn in 2023 is greater than average fuel burn (28,117 – 24,000 ≥ 4,000) The fleet size increases to 7 Corrected fuel burn in 2024 = 4,000 * 7
2025	29,748	28,000	7	Fuel burn in 2025 — Corrected fuel burn in 2024 is less than average fuel burn (29,748 – 28,000 < 4,000) The fleet size remains at 7 Corrected fuel burn in 2025 = 4,000 * 7

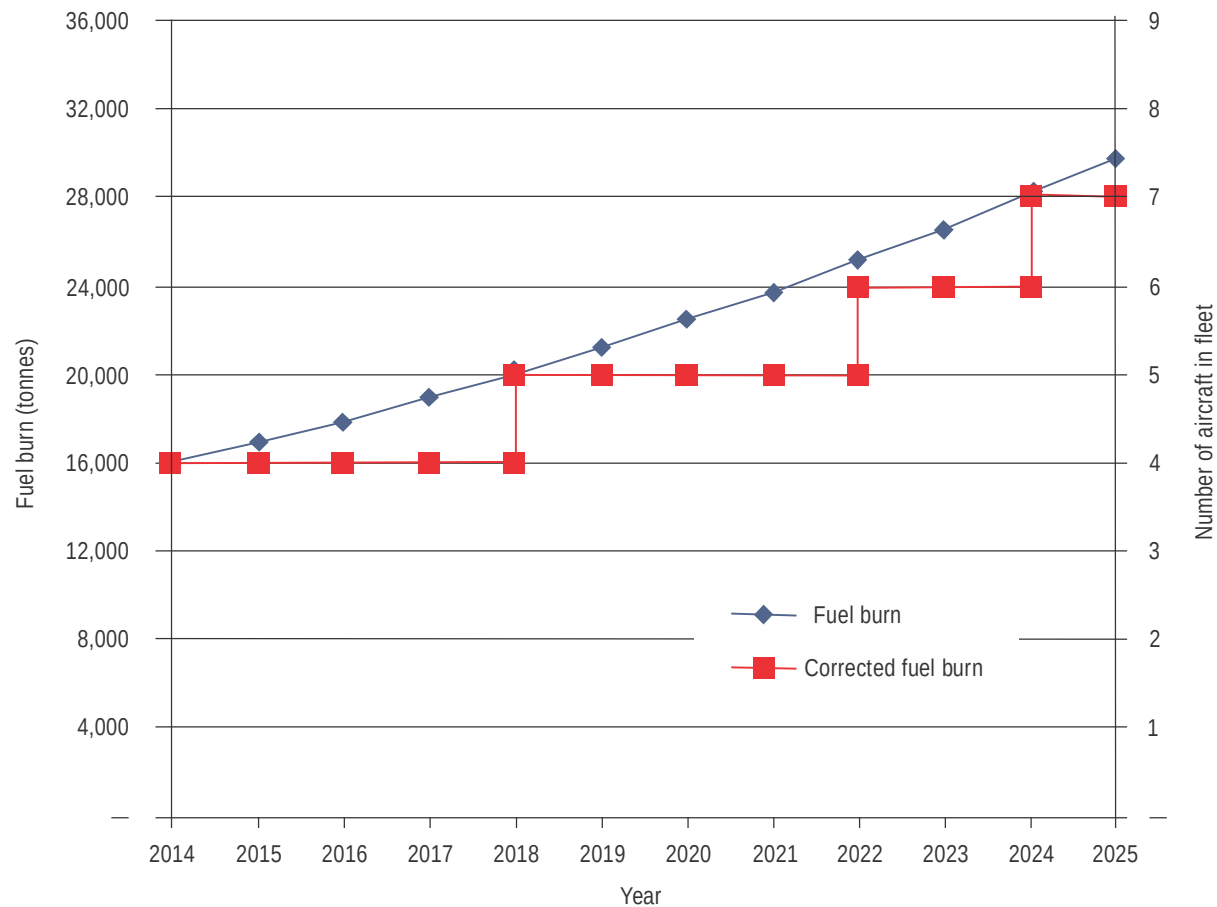


Figure 3-2. Graphical representation of Table 3-2

3.4.10 Method B (fleet size of more than ten aircraft and data available for at least two years)

3.4.10.1 This method allows the State to consider the past trend in fuel efficiency improvement in their baseline. The specific steps for developing a baseline using Method B are as follows:

- Step 1: Obtain historical annual data for fuel consumption (volume of fuel) and RTK.
- Step 2: Divide the fuel consumption data by the traffic data to obtain the fuel efficiency (expressed as volume of fuel per RTK) for each past year.
- Step 3: Determine the past trend of fuel efficiency.
- Step 4: Use the past trend as an approximation of future development of fuel efficiency (in the absence of any additional mitigation measures).
- Step 5: Determine how the RTK will evolve in the future either by considering national forecasts (or projections) or by using default regional growth rates (available in ICAO Circular 333).