Doc 10031

Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes

Approved by the Secretary General
and published under his authority

First Edition — 2014

International Civil Aviation Organization

Doc 10031

Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes

Approved by the Secretary General and published under his authority

First Edition — 2014

International Civil Aviation Organization

Published in separate English, Arabic, Chinese, French, Russian
and Spanish editions by the
INTERNATIONAL CIVIL AVIATION ORGANIZATION
999 University Street, Montréal, Quebec, Canada H3C 5H7

For ordering information and for a complete listing of sales agents
and booksellers, please go to the ICAO website at www.icao.int

Doc 10031, *Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes*
Order Number: 10031
ISBN 978-92-9249-470-4

AMENDMENTS

Amendments are announced in the supplements to the *Publications 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, CORRIGENDA AND ADDENDA

AMENDMENTS		
No.	Date	Entered by

CORRIGENDA/ADDENDA		
No.	Date	Entered by

FOREWORD

This manual covers an evolving area of knowledge and represents currently available information that is sufficiently well-established to warrant inclusion in international guidance. This first edition of the guidance manual includes chapters on purpose, context, scope and approach.

It is intended that the manual be kept up to date. Future editions will most likely be improved on the basis of experience gained and of comments and suggestions received from users of this manual. Therefore readers are invited to send their views, comments and suggestions on this edition, in writing to:

The Secretary General
International Civil Aviation Organization
999 University Street
Montréal, Quebec
Canada H3C 5H7

or by email to: env@icao.int.

TABLE OF CONTENTS

Page

____

GLOSSARY

SYMBOLS AND UNITS

Distance:

ft	foot, or feet
nm	nautical mile
m	metre
µm	micrometre (1/1 000 000 of a metre)

Noise:

dB	decibel – see Appendix B for additional examples

Mass:

g	gramme
kg	kilogramme (1 000 g)
t	tonne (1 000 000 g)

Volume:

l	litre

Concentration:

ppb	parts per billion
ppm	parts per million
$\mu g/m^3$	microgramme per cubic metre

ABBREVIATIONS

AAL	Above Aerodrome Level
ACC	Area Control Centre
AEDT	Aviation Environmental Design Tool
AEM	Advanced Emissions Model
AGL	Above Ground Level
AIRE	Atlantic Interoperability Initiative to Reduce Emissions
ANAC	National Administration of Civil Aviation of Argentina
ANCON2	Aircraft Noise CONtour model, version 2 (UK CAA)
ANSP	Air Navigation Service Provider
ASPIRE	Asia & Pacific Initiative to Reduce Emissions
ATC	Air Traffic Control
ATM	Air Traffic Management
ATFM	Air Traffic Flow Management
CAA	Civil Aviation Authority
CAEP	Committee on Aviation Environmental Protection
CATEX	Categorical Exclusion

CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
CONOPS	Concept of Operations
DAP	Directorate of Airspace Policy (UK)
DGAC	Direction Générale de l'Aviation Civile (France)
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DfT	Department for Transport (UK)
DME	Distance Measuring Equipment
EA	Environmental Assessment
EASA	European Aviation Safety Agency (Europe)
EC	European Commission
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration (USA)
FAB	Functional Airspace Block
GDP	Gross Domestic Product
GHG	Greenhouse gas
GSA	Geographic Study Area
H_2O	Water vapour
HAP	Hazardous Air Pollutant
HC	hydrocarbons or unburned hydrocarbons
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IFSET	ICAO Fuel Savings Estimation Tool
ILS	Instrument Landing System
INM	Integrated Noise Model (USA FAA)
INSPIRE	Indian Oceanic Strategic Partnership to Reduce Emissions
IPCC	Intergovernmental Panel on Climate Change
MASE	Midwest Airspace Enhancement
MCDM	Multi-Criteria Decision Making
NADP	Noise Abatement Departure Procedure
NEPA	National Environmental Policy Act
N_2O	Nitrous oxide
NO	Nitrogen oxide
NO_2	Nitrogen dioxide
NOx	Oxides of nitrogen (NO plus NO_2)
NMHC	Non-methane hydrocarbons
NPR	Noise Preferential Route, or Routeing
PM	ultra-fine Particulate Matter (e.g. PM10 – ultra-fine particulate matter with mean aerodynamic diameter less than 10 µm; PM2.5 – mean aerodynamic diameter less than 2.5 µm)
RNAV	Area navigation
RTS	Real-time Simulation
SAAM	System for traffic Assignment and Analysis at a Macroscopic level
SAE	Society of Automotive Engineers
SES	Single European Sky
SESAR	Single European Sky ATM Research programme
SID	Standard Instrument Departure
SOx	Oxides of sulphur
STAPES	SysTem for AirPort noise Exposure Studies (Europe)
STAR	Standard Terminal Arrival
SVFR	Special Visual Flight Rules
TMA	Terminal Control Area

VFR	Visual Flight Rules
VOC	Volatile Organic Compounds
VOR	Very High Frequency Omnidirectional Range

DEFINITIONS

Action Plans:

Action Plans — Action plans are a practical means for States to communicate to ICAO information on their activities to address CO_2 emissions from international civil aviation. The level of detail of the information contained in an action plan demonstrates the effectiveness of actions and will ultimately enable ICAO to measure global progress towards meeting the goals set by Assembly Resolution A37-19.

Airspace:

Class A — Restricted airspace where all operations must be conducted under IFR or SVFR. All aircraft are subject to ATC clearance. All flights are separated from each other by ATC.

Class B — Airspace where operations may be conducted under IFR or SVFR or VFR. All aircraft are subject to ATC clearance. All flights are separated from each other by ATC.

Class C — Airspace where operations may be conducted under IFR or SVFR or VFR. Entering Class C airspace only requires radio contact with the controlling air traffic authority, though an ATC clearance will ultimately be required.

Assessments:

Absolute — An assessment that evaluates all environmental parameters across all phases of flight and then compares the output to predefined acceptability criteria.

Relative — An assessment that evaluates all environmental parameters across applicable phases of flight and then compares the output to the environmental parameters for an operation that is performed without the proposed change.

Fit for purpose — In the context of this document, this relates to the fact that any assessment should be suitable for its intended purpose, i.e. it does what it was designed to do.

Emissions certification:

EI — Emissions Index. Determined during the emissions certification of aircraft engines to ICAO Annex 16 — *Environmental Protection*, Volume II — *Aircraft Engine Emissions*, and expressed in terms of grammes of pollutant emitted per kilogramme of fuel burnt.

LTO — Landing-Take-Off cycle. For emissions certification purposes, ICAO has defined a specific reference LTO cycle below a height of 3 000 ft (915 m) AGL, in conjunction with its internationally agreed certification test, measurement procedures and limits (see Annex 16, Volume II, for additional information). The departure and arrival phases of an actual operational flight cycle for a commercial aircraft are more complex than the four modal phases (i.e. approach, taxi/idle, take-off and climb) used for ICAO certification purposes. Actual cycles employ various aircraft engine thrust settings, and the times at those settings are affected by factors such as aircraft type, airport and runway layout characteristics, and local meteorological conditions.

Heights:

Height	The distance above a defined datum, normally ground level.
Altitude	The height above a datum defined by an atmospheric pressure of 1 013.25 mB.

REFERENCES

ERCD — *Metrics for Aircraft Noise*, ERCD Report 0904, United Kingdom CAA, 2009.

Eurocontrol — "The Aircraft Noise and Performance (ANP) database", http://www.aircraftnoisemodel.org/

ICAO —

"Assessing Current Scientific Knowledge, Uncertainties and Gaps in Quantifying Climate Change, Noise and Air Quality Aviation Impacts — Final Report of the International Civil Aviation Organization (ICAO) Committee on Aviation and Environmental Protection (CAEP) Workshop", ICAO, 2007.

Doc 9829, *Guidance on the Balanced Approach to Aircraft Noise Management*, 2nd edition, ICAO, 2008.

Doc 9883, *Manual on Global Performance of the Air Navigation System*, 1st edition, ICAO, 2009.

Doc 9888, *Noise Abatement Procedures: Review of Research, Development and Implementation Projects — Discussion of Survey Results*, 1st edition, ICAO, 2010.

Doc 9889, *Airport Air Quality Manual*, 1st edition, ICAO, 2011.

Doc 9911, *Recommended Method for Computing Noise Contours Around Airports*, 1st edition, ICAO 2008.

Doc 9931, *Continuous Descent Operations (CDO) Manual*, 1st edition, ICAO, 2010.

Doc 9938, CAEP — Committee on Aviation Environmental Protection, *Report of the Eighth Meeting*, Montréal, 1-12 February 2010, ICAO, 2010.

ICAO Aircraft Engine Emissions DataBank, http://easa.europa.eu/environment/edb/aircraft-engine-emissions.php

IPCC — "2006 IPCC Guidelines for National Greenhouse Gas Inventories", http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html, IPCC 2006.

SAE — "Procedure for the Calculation of Aircraft Emissions", AIR5715, SAE 2009.

Chapter 1

INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide States, airport operators, air navigation service providers (ANSPs) and other stakeholders with environmental assessment guidance to support sound and informed decision making when analysing proposed air traffic management (ATM) operational changes. High-level principles related to the quantification of changes in aviation-related environmental impacts associated with air navigation service changes are collected in order to ensure a consistent approach to the analysis of the changes, while minimizing the risk of common assessment errors. This provides a framework within which specific, detailed assessment methodologies can be developed that meet local requirements, while facilitating global compatibility of results. It is also intended to assist with recognizing any environmental benefits associated with operational changes. While the guidance is intended to be applied broadly, it also highlights areas of priority that may need to be considered at the local level.

1.2 CONTEXT

This guidance manual was requested by ICAO Member States through the Committee on Aviation Environmental Protection (CAEP) in response to a growing need to measure in a globally harmonized and compatible way the environmental impacts associated with ATM operational changes. The high-level principles described in this document were extracted from the environmental assessment best practices of air navigation service providers, State governments and other advisory bodies. These high-level principles are not intended to override existing or future State-specific guidance, but can be used to support their development, or evolution.

1.3 SCOPE OF THE DOCUMENT

1.3.1 This guidance identifies high-level principles that facilitate the robust definition and application of specific assessment approaches, methodologies and their respective metrics. The focus of these principles is on changes that relate to aircraft and ATM operational initiatives and may involve all phases of flight (e.g. Gate-to-Gate). The general principles of this guidance can be applicable to air navigation aspects arising from infrastructure proposals and major changes to airspace capacity or throughput, as well as operational changes. While the boundaries of an air navigation services environmental analysis are based on the needs of the study, for the purposes of this guidance material “air navigation services environmental assessment” is to be interpreted in the broadest possible sense and refers to impacts arising from changes to where, when, and how aircraft are operated.

1.3.2 These principles could support the development of environmental “Action Plans”, which can be used to report the environmental benefits expected from the implementation of the elements or modules outlined: in the ICAO Global Air Navigation Plan, States action plans on emissions reduction, or be used to further support changes that allow aviation to become more sustainable. They can also apply to the assessment of specific operational changes.

1.3.3 This guidance material has been developed to be applicable worldwide with no specific geographic restrictions. It is focused on assessments of environmental impacts related to operational procedural changes, airspace redesigns and other similar operational aspects. Therefore, additional guidance should be consulted for the assessment of other types of changes that do not deliver operational change, such as those related to aircraft technologies and fuels. Similarly, these principles do not cover the direct environmental impacts from facility development or operation (e.g. terminal buildings, airport access). This material is applicable for the assessment of aircraft emissions, fuel consumption and noise.

1.3.4 The principles in this document are high level and intended to be flexible enough to account for State-specific requirements with respect to methodologies and metrics. The information in this document can be used to populate metrics and to support the validation and application of assessment methodologies. This includes helping to determine the types of changes that could be subject to an environmental assessment, criteria for triggering an assessment, and the environmental parameters to be assessed. The principles can also guide the definition of the geographical boundaries of an assessment and the prioritization of environmental aspects that should be assessed based on geographic area and the relative significance of the impacts being considered. The main types of environmental effects of air navigation service changes are listed, and their assessment is described at a high level.

1.3.5 The consideration of trade-offs between various environmental impacts and non-environmental effects is a typical analysis and policy challenge. This high-level material provides guidance on how to recognize these trade-offs, but does not provide detailed recommendations on the in-depth assessment of interdependencies.

1.3.6 This assessment guidance is intended to be used in the planning phase of air navigation service or other operational changes. While many of the principles described could be useful for performance measurement or environmental steering after implementation of changes, these activities are outside the scope of this document.

1.3.7 Many States and organizations have developed detailed descriptions of environmental assessment methods and issues. As this document is limited to the identification of high-level principles, Appendix D provides some examples of related, detailed, assessments.

____

Chapter 2

PREPARATION FOR CONDUCTING AN ENVIRONMENTAL ASSESSMENT

2.1 INTRODUCTION

2.1.1 When beginning to formulate an environmental assessment plan for a proposal, one of the first important tasks is to determine what environmental regulations apply both in terms of the assessment itself (e.g. consultation obligations) and in terms of the impacts to be assessed (e.g. limit values). In cases where environmental regulations may apply, one should become familiar with their application and compliance requirements. The regulations could range from broad overarching regional/national regulation to very specific city/county/municipal requirements. These regulations may also have specific criteria for the types of documentation required and for the review period for information submitted. These requirements need to be included in planning to avoid the risk of regulation breach or project delay. This initial regulation review may need to be revisited once the scope of the environmental assessment is determined to check for new regulation risks and requirements.

2.1.2 In addition to the above, in many circumstances it may be good practice to conduct an environmental assessment where there is no legislative or regulatory requirement to do so. In particular, while formal legislated triggers may indicate the impacts from a proposal will not be significant, it may be prudent to be conservative and engage with stakeholders even when apparently small impacts are expected. Note that in doing so, it should be recognized that "stakeholders" are not only represented by official bodies or organizations but potentially by environmental groups and political opposition as well.

2.1.3 Assessment preparation typically begins by gathering information on the present situation and the proposal itself, addressing core information such as the following non-exhaustive list of examples:

- a description of the proposal including any options/alternatives to be assessed, with suitable information on any aspects that may change environmental impacts;

- a description of the "do nothing" scenario, which usually provides the "base case" against which the proposal will be compared in order to derive the net[1] impacts of the proposal;

- the core context assumptions for the proposal such as:

  – the proposed date of implementation;

  – the estimated life expectancy for the proposal;

  – the agreed milestone dates at which assessments are required;

1. In the context of this document, "net" refers to the difference in system performance in the base case and the performance of the system after the change has taken effect.

- a description of the key impact influences for the milestone years (movement forecasts, predicted fleet mixes, operational assumptions, etc.) as these will apply to both the base case and proposal case(s); and

- what legislation, regulations or agreements apply.

2.1.4 The scope of the environmental assessment may cover a known geographical area for anticipated local impacts and may also include issues with a wider scope (e.g. comparison to national policy or global greenhouse gas emissions). Typically for the local impacts, surveys of the area of potential impact would be conducted to identify important assets and sites that are relevant to the impacts being assessed including, but not limited, to:

- population distribution;
- tranquil areas;
- schools and hospitals;
- touristic or leisure areas;
- areas of special ecological or historical value; and
- coastal zones.

2.1.5 It will be important to assess the present baseline situation (e.g. level of pre-proposal impacts) for any such areas of interest that are considered to be important for the assessment (e.g. where a significant positive or negative change to impact may be expected). These present-day baseline assessments will often form the basis for the predictive modelling or extrapolation of any "future do-nothing" base cases, against which the proposal may be assessed to determine its net impact.

2.1.6 It is also important to note any existing environmental conditions in order to avoid double counting and to identify areas of special interest, for example, where noise and/or pollution levels are already close to breach of regulation. It is also a good idea at this stage in planning to determine if there are other projects occurring in the same timeframe and geographical or project area. The environmental impacts of other actions may need to be considered, especially if there is a regulatory requirement to look at all actions in a specific area from a cumulative perspective. Some airspace projects may give rise to cross-border impacts (e.g. a proposal in a State may have impacts on a neighbouring State). These projects may require special handling, such as initiating early consultation with affected parties or responsible State authorities.

2.1.7 Gathering this baseline information is beneficial in several different ways. The first is that it aids in planning. For example, if the project area contains a noise-sensitive area, then planning can take that into consideration and it may be possible to avoid the noise-sensitive area during the design of the project. Ultimately determining the net impact of a proposal may require a combination of comparisons, for example:

- where impacts will arise in areas that would otherwise remain free of such impacts, the comparison to the present case will be important. This can allow risk analysis of the likelihood of any possible breaches of environmental regulations or limits;

- where environmental impacts are expected to change significantly with or without the proposal (for example, where growth in movements will be accommodated in the base case), then the true comparison to derive the impact may be between a "*future do-nothing case"* which represents the base case and a "*future with the proposal case";*

- sometimes the comparison of impacts between the base case and the proposal case will be required for a number of milestone years to show the change in the impact differential over time;

- sometimes a combination of the above comparisons will be needed to accurately describe the proposal's change to impacts.

2.1.8 All of this information (assumptions, methodologies used, etc.) should be adequately documented so that it can be substantiated and reproduced by another party, if necessary, to confirm the findings.

2.1.9 Not all environmental assessments are driven by legal requirements. For example, an operationally driven proposal may reduce environmental impacts, enhancing its business case. In addition, some environmental assessments may be performed based on agreements set up with local bodies or neighbourhoods, or as part of flight trials, etc.

2.2 CRITERIA FOR TRIGGERING A FORMAL ASSESSMENT

2.2.1 Operational changes that are expected to result in significant or long-term impacts may be subject to a formal environmental assessment. If the proposed change is likely to result in modification to how, where, when or how many aircraft transit the airspace or airport surface, then an environmental assessment may be required.

2.2.2 The list below contains some examples of significant or long-term changes (which affect the routine practice of operations) that may require environmental assessment:

- new or changed standard instrument departures or arrivals;

- new or changed existing flight paths or routes or use of them due to, for example, implementation of operational assistance tools or equipment that affect the way routes or flight paths are used;

- reclassification of airspace (e.g. from class A to class C);

- a change in normal use of runways (e.g. preferred usage);

- change to aircraft movements by time of day (e.g. changes to curfews or other changes based on ATM service);

- changes to airport infrastructure (e.g. new runways or changes to taxiway configurations);

- development of new airports and associated airspace infrastructure;

- changes that allow different aircraft types or operators to use current procedures/routes/processes.

2.2.3 In addition to specific operational changes that affect the way aircraft are operated, significant changes to traffic numbers will generally also require an environmental assessment.

2.2.4 Short-term changes resulting in temporary modifications to the way aircraft fly or move around may not require a formal environmental assessment. However, consultation with affected parties normally proves to be extremely beneficial in the long term and should include the reasons for the changes and the options for managing the changes. Examples of short-term changes may include runway closures for maintenance, emergency response actions, special single-day events or demonstration flights.

2.2.5 Where applicable, environmental assessments may also be used to demonstrate environmental benefits that accrue due to a change. The results of such an assessment can be used in a business case to support the arguments for a change.

2.2.6 The level of environmental assessment that addresses these operational changes will vary depending on the magnitude of the change and can range from simple qualitative evaluations to in-depth quantitative environmental impact assessments that require public review. National or local criteria will generally define the level of environmental assessment effort required when making a change. These criteria can be defined in terms of:

- altitude minima and maxima;
- numbers of inhabitants exposed to the change;
- significance criteria relating to changes in exposure (for instance, an increase in noise level or a specific increase in air quality emissions relative to a local threshold value);
- changes in where, when and how many aircraft fly or move around on the ground, and the magnitude of the changes;
- classification of the areas affected by the change (e.g. in terms of noise sensitivity);
- potential changes to existing ambient conditions (such as noise contour areas or ambient air quality).

2.2.7 States and relevant authorities are encouraged to define criteria to guide those conducting operational change analyses in the appropriate level and scope of environmental assessment. In establishing these criteria it is important that they are not presented in a way that suggests that there is a level below which there is no impact. In this respect, any criterion should broaden, rather than constrain, the extent of any assessment.

2.3 REGULATORY COMPLIANCE

2.3.1 The assessment of proposed operational changes may be regulated, especially for larger projects (e.g. new runways or major airspace changes). It is vital therefore that at the earliest stage of a project's development the regulations concerning assessment and the potentially affected environmental impact areas are identified and considered. It should be borne in mind that regulation may not always be aviation specific but instead may be specific to the type of resource or impact.

2.3.2 As the applicability, scope and nature of national regulations vary globally, Appendix A provides a few specific examples of national requirements, in order to help indicate the different elements that may need to be addressed during the different steps. This appendix includes a non-exhaustive list of examples of such regulations and guidance.

2.4 ENVIRONMENTAL PARAMETERS AND ASSESSMENT METHODOLOGIES

2.4.1 The most common environmental impacts arising from operational changes are noise, air quality, fuel consumption and greenhouse gas emissions, though there may be other effects that need to be assessed by State or local regulation as well.

2.4.2 Some States have predetermined parameters that need to be used for an environmental assessment, and a review of these is a useful first step to ensure that all appropriate required parameters are included in the study. The purpose of the change being proposed may also lead to the parameters that should be addressed, especially where the proposal is designed to address an existing environmental issue. Care should be exercised in trying to identify both the environmental and non-environmental interdependencies, to ensure that any trade-offs that are made are adequately identified by the study. This section provides a review of possible parameters to be considered.

a) *Noise*

2.4.3 Aircraft noise is the most significant cause of adverse community reaction related to airspace changes and the operation and expansion of airports and is expected to remain the case in most regions of the world for the foreseeable future.

2.4.4 The noise impacts from aircraft operations in and around an airport depend upon a number of factors including:

- the types of aircraft using the airport;
- the number of daily take-offs and landings, both overall and during specific periods;
- the time of day that the aircraft operations occur;
- the runways that are used;
- the flight-paths that are used (including Noise Preferential Routes (NPR));
- the prevailing weather conditions;
- the topography of the airport and surrounding area;
- the position and extent of local conurbations;
- the operating procedures used ; and
- the general operating conditions.

2.4.5 In addition, the way that individuals respond to noise is highly subjective and can depend on a number of factors related to the individual listener's cultural, socio-economic, psychological and physical situation. The response can also be driven by contextual issues such as the extent to which the individual has been involved in decisions; whether the reason for change is seen as reasonable; whether alternatives have been examined; and whether the outcome is perceived as being fair.

b) *Air quality*

2.4.6 There are a variety of air pollutants present as gaseous and particulate emissions that arise from the combustion of aviation fuel that can potentially impact air quality and human health. Generally, the following common species could be considered as primary species in air quality assessment:

- NOx — oxides of nitrogen, a mixture of nitrogen dioxide (NO_2) and nitrogen monoxide (NO);
- VOC — volatile organic compounds (including non-methane hydrocarbons (NMHC));
- CO — carbon monoxide;
- PM — particulate matter, the most common concern is for those with a mean aerodynamic diameter less than 10 µm (PM10) and 2.5 µm (PM2.5)[2]; and
- SOx – oxides of sulphur.

2.4.7 These emissions species can in turn become involved in the broader environmental issues related to ground level ozone, photochemical smog, formation of secondary volatile particles and other atmospheric chemical processes that can lead to potential health impacts.

2.4.8 Additional emission species of potential health and environmental concern may also need to be considered in emission inventories including so-called hazardous air pollutants (HAP), known organic gases that have an acute health effect at low concentrations. As of the date of publication of this document, HAP research is still at a relatively early stage, though some research has identified 15 known HAP in aircraft engine exhausts.[3] It should be noted that knowledge of emission factors is, however, very limited for many of these species.

c) *Fuel consumption and greenhouse gases*

2.4.9 Aircraft emissions are the result of the combustion of aviation kerosene or gasoline, the products of which are emissions that are comprised of approximately 70 per cent carbon dioxide (CO_2), slightly less than 30 per cent water vapour (H_2O), and less than 1 per cent of a number of other emissions, which include oxides of nitrogen (NOx), carbon monoxide (CO), oxides of sulphur (SOx), hydrocarbons, volatile and non-volatile particulates and other trace components. A number of these components are classed as greenhouse gases (GHG), with carbon dioxide being the most significant.

2.4.10 The effects of GHG emissions last for vastly different lengths of time with carbon dioxide being a very long-lived gas in the atmosphere and water vapour having a relatively short-term effect. Little or no nitrous oxide (N_2O) emissions occur from modern gas turbines and, although a modest quantity of methane (CH_4) may be emitted when engines are at their lowest efficiency, no methane is emitted during other operational phases.

d) *Other impacts*

2.4.11 Additionally, when analysing airport-related environmental impacts, attention may also be given to effects on water quality, ecology, etc., where these may be adversely affected by operational changes.

2.4.12 Appendix B gives more detailed information for noise, air quality and fuel consumption/greenhouse gases, along with a description of some common metrics in use to describe these environmental impacts.

---

2. Note that 100 per cent of direct particle emissions from the combustion of fuel in commercial gas turbine engines are less than 2.5 µm (PM2.5).
3. *Recommended Best Practice for Quantifying Speciated Organic Gas Emissions from Aircraft Equipped with Turbofan, Turbojet, and Turboprop Engines,* version 1.0, 27 May 2009. *http://www.epa.gov/nonroad/**aviation**/420r09901.pdf*

2.5 DOCUMENTATION, COMMUNICATION AND REPORTING

2.5.1 A vital part of any assessment is the effective documentation, communication and reporting of the process and the results. An important part of any process is to ensure that local communities are adequately engaged, right from the start, on changes that will, or might, affect them. It is also useful to carry out a stakeholder mapping exercise from an early stage to ensure that all appropriate stakeholders are aware of the proposed changes, can be adequately consulted, and that their views are taken into account. Engagement throughout the assessment with these groups will normally prove to be very beneficial in the long term, helping to address misconceptions and presenting a reasoned and balanced view of impacts and helping to avoid problems after any changes have been implemented.

2.5.2 While conducting an assessment, it is important to document and communicate appropriately the process followed and the decisions taken. More than simply recording the negative and positive impacts of an action, the documentation may need to convey which processes, considerations and decisions resulted in an airspace/operational change, and can be used to help facilitate communications with stakeholders. This documentation and communication can also take various forms but ought to be appropriate to the specific changes proposed and to the local situation.

2.5.3 There may be international, national and/or local requirements for what to document and/or communicate, and when this should be done. For any stage of documentation, it is useful to include decisions and recommendations on measures to mitigate environmental impacts, and identify and engage with the interested parties involved. This may take a number of forms and should be appropriate to the individual circumstances. However the use of workshops, seminars, briefing sessions, etc., with stakeholder groups and, where appropriate, individual stakeholders, may be adopted.

2.5.4 Also it is important to consider at an early stage whether it is applicable to conduct follow-up performance assessment after the proposal has been implemented and what communication and reporting may be relevant for this.

———————————

Chapter 3

ENVIRONMENTAL ASSESSMENT STEPS

3.1 INTRODUCTION

3.1.1 It is important to be aware of the steps involved in carrying out a proper environmental assessment of a proposed operational change. The basic process involved is outlined in Figure 3-1, and each one of the four key steps is described in more detail later.

3.1.2 The advice in this chapter assumes that the guidance given in the preliminary steps described in Chapter 2 has already been followed. It also assumes that, where appropriate, the baseline information has been identified, gathered and is ready for use in the assessment process outlined in this chapter.

3.1.3 An essential part of any successful environmental change process is to document, communicate and involve, and keep informed, all appropriate stakeholder groups throughout the whole of the process. An appropriate stakeholder engagement programme should therefore be developed as far in advance as possible to the start of the process.

3.2 DESCRIBE PROPOSED CHANGE, PURPOSE AND ALTERNATIVES

Before starting to carry out an environmental assessment of any proposed changes, it is important to be able to understand the answers to a number of key questions. In this case the first actions should be to describe the proposal, based on the preparatory work noted in the previous section. The description should include the objectives of the exercise in order to be able to fully understand what the proposals are trying to achieve. As part of this task, it is important that the following points are covered:

- What is the proposed change?

  This should be a detailed description of the changes being proposed including what they are meant to achieve and how they will do this.

- Are alternatives being considered?

  Particularly in the case of regulatory impact assessments, other reasonable and plausible options may be under consideration. Any alternatives should be described in addition to the proposed change, together with the reasoning why the proposed version has been selected over all alternatives.

- What are the applicable environmental regulations and/or agreements?

  Are there any regulations/agreements that would determine the way that an environmental assessment has to be carried out, including metrics, thresholds, significance levels, consultation requirements, etc? These will need to be satisfied in the environmental assessments to be carried out, to ensure compliance.

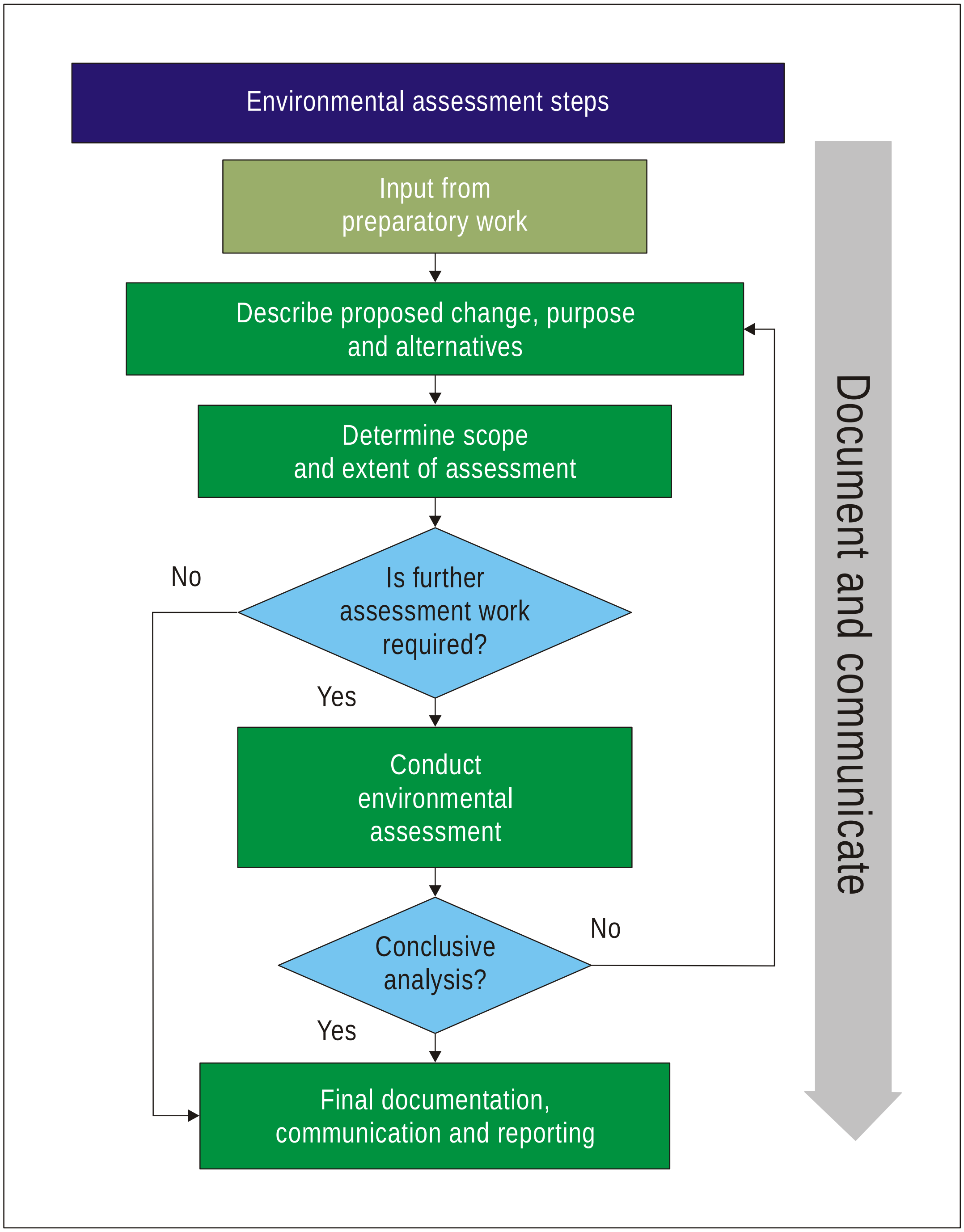

Figure 3-1. Environmental review process

- What is the operational context for the calculations?

  For the point in the future when the proposals would be completely implemented, it is important to determine the operation context for both the "do-nothing" case and the proposal case. This allows for a true comparison of what the environmental consequences of the proposals would be at that time. Future baselines may be developed by using current airport surface infrastructure and runway use with fleet and operations forecasting, or by use of simulation modelling. Future proposals for larger projects are usually analysed with the use of simulation modelling.

3.3 DETERMINE SCOPE AND EXTENT OF ASSESSMENT REQUIRED

3.3.1 Careful consideration of the appropriate scope and extent of the environmental assessment will ensure that it is suitable for the scale of the operational changes and complies with applicable regulatory requirements without creating undue additional work. From the previous section, the environmental assessment requirements that apply to the operational changes and what is new in the proposed changes from existing conditions should already be understood. The following considerations describe a preliminary evaluation and screening that will help refine the scope and extent of the environmental assessment effort:

- What scope and extent of environmental assessment is typically required for this type of change?

  It is useful to identify other environmental assessments of similar operational changes, where available, that could be used as a preliminary basis for determining the scope and extent. This is because similar operational changes generally require similar levels of assessments. However, it is important to note that differences may exist due to specific geographic environmental impacts or other special considerations. As a result, additional factors outlined below may also need to be evaluated before finalizing the scope and extent of the environmental assessment.

- What types of environmental impacts are expected, and how substantial are they likely to be?

  One should also identify the likely environmental impacts of the proposed change. Again, this may be possible by considering the environmental impacts that were evaluated in the assessments from other similar changes and then applying them to the proposal. Scientific assessment and testing can be conducted at many levels. To help with the analysis, it would be useful to make a preliminary appraisal of the intensity of any environmental impacts and to decide the scope and extent of the environmental analysis that needs to be performed.

- Can a preliminary review help?

  If there are no environmental impacts, or there is uncertainty about the extent of any impact, then basic technical assessments or screening tools can provide information to support decisions. Screening may reveal that no impacts are expected and therefore no further assessment is necessary. However, if there is uncertainty, or if screening indicates significant impacts, then a decision will have to be made on the extent of the analyses to include in an assessment.

- What study area should be used for the environmental assessment?

  The study area of an environmental assessment should be carefully defined early in the assessment to ensure it is appropriate for the type of change being proposed. It needs to be large enough in both geographic area and height to take into account a representative set of updated aircraft trajectories, but focused on the relevant area to keep the complexity of the assessment manageable. The boundaries of the geographic study area (GSA) should be established to encompass the geographic areas where existing or future (i.e. post action) aircraft routes could have environmental impacts. In addition, different GSA boundaries may be required for evaluating different types of environmental impact. For example, the GSA for the noise analysis may be different than the GSA for greenhouse gas emission analysis due to differences in the nature of the impacts.

3.3.2 In areas where the terrain varies, or is significantly higher than the airport, the GSA can extend over a very large area making assessments excessively onerous. In these instances, the geographic boundaries can be focussed on the areas underneath aircraft flight paths. This would then concentrate on areas of primary aircraft flows within the GSA and eliminate those areas where there would be little or no impact. So, for example, instead of identifying a large rectangular GSA that extends outwards to 100 NM, it may be possible to restrict the major portion of the rectangle to say 50 NM, with smaller areas focussed on zones under the aircraft flight-paths extending out to 100 NM (see Figure 3-2).

3.3.3 The necessary height above ground level (AGL) that the study should encompass depends upon the extent of the airspace actions, the type of environmental impact being evaluated, and any site-specific considerations. If the airspace action is in the immediate vicinity of a single airport, the study may need only encompass the immediate vicinity of that airport. However, when the actions take place over a larger area or may encompass more than one airport, the altitude chosen for the study may need to be higher to encompass all interaction of the proposed actions in the study. In addition, when there are special land uses where noise is very low and a quiet setting is a generally recognized purpose and attribute, it may be appropriate to extend the altitude of the study even higher to account for the low ambient noise and quiet settings in the special land use area. In addition, the ground terrain of the study area should be considered when determining the appropriate altitude that the study should encompass.

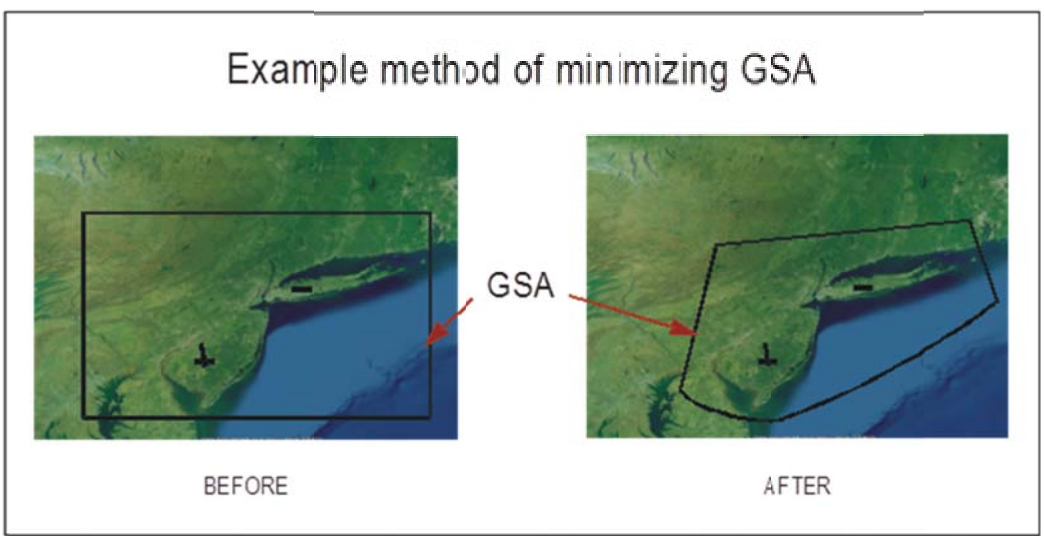

Figure 3-2. Example of GSA minimization

3.3.4 In general, Figure 3-3 and Table 3-1 may be used, in the absence of any specific instruction, to help focus on the most relevant impacts:

- Are there any cumulative effects that need to be considered in the assessment?

  The overall effects of some impacts may not be obvious. It is important to consider whether the proposal will have impacts that are individually small, but when added to other similar impacts, could be cumulatively significant. For example, some State regulations require a cumulative evaluation to determine if there are other projects in the area with similar environmental impacts which need to be considered together in the environmental assessment. These other projects could be recently completed, in progress, or planned.

- Are there any public concerns or extraordinary circumstances regarding environmental impacts that would influence your environmental assessment?

  Public interest, or concern with a particular change, may require more intense levels of analysis than would normally be accomplished. It might be useful to consider if there are other circumstances related to the location or change that will affect the scope of the assessment.

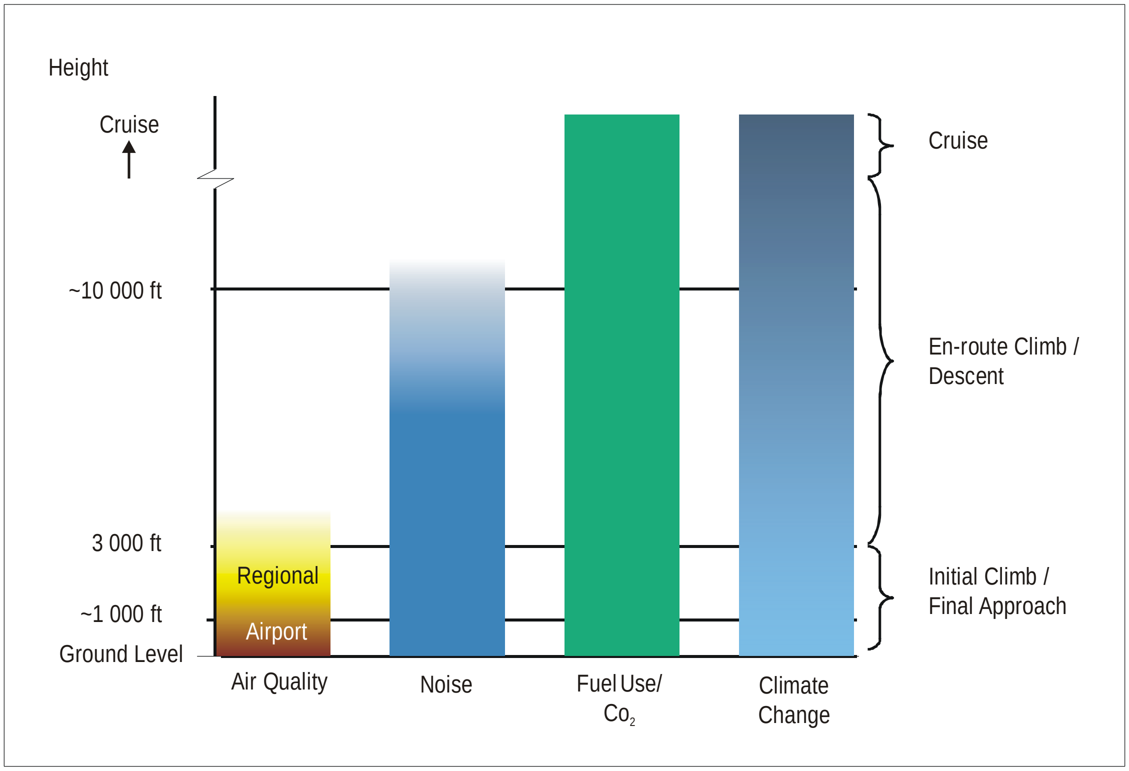

Figure 3-3. Environmental impacts and their most relevant heights AGL

Table 3-1. Environmental impacts and their most relevant heights

Impact / Height AGL	Below 1 000 ft (300 m)	1 000-3 000 ft (300-900 m)	3 000-10 000 ft (900-3 000 m)	Above 10 000 ft (3 000 m)
Air quality (e.g. NOx, PM, etc.)	Most relevant	Relevant (Note 1)	Less relevant	Less relevant
Noise	Potentially (Note 2)	Relevant	Relevant	Potentially (Note 3)
Fuel use / CO_2	Relevant	Relevant	Most relevant (Note 4)	Most relevant (Note 4)
Climate change	Relevant	Relevant	Most relevant (Note 5)	Most relevant (Note 5)

Notes:

1. Note, though, that differences to emissions above 1 000 ft (300 m) AGL will normally have little impact on changes in ground level concentrations (*Air Quality Guidance Manual* (ICAO Doc 9889) refers), but may need to be included in air quality assessments for other reasons.
2. Current legal constraints preclude Noise Abatement Departure Procedures from being applied below 800 ft (240 m) AAL (*Procedures for Air Navigations Services — Operations* (PANS-OPS), ICAO Doc 8168 refers).
3. Noise may need to be assessed for changes above 10 000 ft (3 000 m) in areas where the background noise levels are very low (for example, in some specific areas protected by law), in which case an upper limit of 18 000 ft (5 500 m), or higher, may be more appropriate in certain circumstances.
4. With regard to fuel burn/CO_2 emissions, although it is important to evaluate the changes to this parameter at all levels, they tend to dominate overall during the climb and cruise phases of flight, and therefore changes in low-level emissions may represent only a very small change when considering the whole flight.
5. Including the impacts of non-CO_2 emissions such as NOx and contrails, though the full impacts of these emissions are not yet certain.

3.3.5 When narrowing the scope and extent of environmental assessment, it is important to document the process(es) used, the organizations consulted, the members/organizations of the body that took the decisions on the level of assessment to be applied, the nature of the impacts (substantial or not), the cumulative effects and any public concerns. Good documentation regarding project parameters will help with communication and coordination as the project moves forward.

3.4 CONDUCT AN ENVIRONMENTAL ASSESSMENT

3.4.1 This step is usually made up of three parts: the preparation, the assessment itself and the analysis of the results.

a) *Preparation*

3.4.2 In preparing and conducting the assessment, a number of items need to be considered:

- Very often, the environmental assessment is part of a larger analysis where other factors, such as safety, capacity and cost are being assessed as well. In this case, an overall planning strategy and validation plan may be established. The methodology for combining the results from the different assessments into a business case will need to be clarified and may drive specific requirements for the environmental assessment.

- Care must be taken to consider potential risks and pitfalls that might arise from inadequate preparation or the actual execution of the assessment.

3.4.3 Appendix C gives more detailed information on how to avoid common mistakes made when conducting environmental assessments.

- Very often, it will be necessary to generate scenario data sets representing the existing case (baseline) and future case (solution scenario) together with any alternative scenarios being considered. These data sets may be generated using radar data (e.g. for existing case), or fast-time or real-time simulations. In some cases procedure design software may be used. Live flight trials may also be conducted in certain cases.

- If using simulators, computer modelling or information from live trials, the required data needed to support the environment model should be defined as early as possible in the planning phase. This way, any necessary interfaces can be developed.

- Before starting the assessment, data availability and quality versus the data required should first be verified. Some data may not be readily accessible or may have a resolution that is not suitable for the chosen assessment model. In these cases consideration should be given to obtaining required data in an indirect way, for example, deriving it from already known information, or running specific field surveys. If data coverage is determined to be too small to guarantee sufficient assessment accuracy levels, then a change of assessment model or perhaps a resizing of assessment scope should be considered.

- The choice of metrics or criteria by which the results of the assessment will be judged will likely have been determined in the first step. This may also influence the choice of model to be used.

- System boundaries for the assessment will need to be clearly defined within the modelling environment. This too may influence the choice of model to be used.

b) *Assessment*

- Environmental assessment models used should be “fit for purpose”. Ideally the choice of model should be guided by local, national or international guidance.

3.4.4 Appendix B provides more detailed information along with a description of some common metrics, used by some States, to describe these environmental impacts:

- Any gaps in or limitations of the models should be identified at the start. It should be determined if the tool is likely to be sensitive to the type of change that is being assessed. Some models cannot fully capture the full nature of the change. This should be well documented and understood before the analysis is undertaken.

- Expert judgement can also be used in certain cases. This solution would not require any modelling but simply some logical, reasoned arguments making the case to support either an increase or a decrease in environmental impact.

- Some consideration needs to be given to the type of assessment that will be conducted. Most usually, assessments will tend to be "relative" (i.e. the difference between the proposed change and current condition) but in certain situations, they may be "absolute" (i.e. consequence of proposed change).

Note.— Additional information on "absolute" and "relative" assessments is given in the Glossary section to this document.

c) *Analysis of results*

- The final part of the assessment is analysing the results. Results may need to be compared to the expected outcomes, or targets, defined using well-identified metrics. It is possible that during the assessment, certain constraints or limitations became apparent, either through lack of necessary data or limitations in the sensitivity or accuracy of the tools.

- Pertinent questions to lead the analysis might include:

  - Is there an impact?

  - Is the impact temporary, long term, or permanent?

  - Is the impact significant and by what criteria?

  - Can anything be done to lessen the severity of the impact and with what consequences?

- Whether the proposed change has a positive or negative environmental impact is a fundamental part of this analysis. Even if the change degrades one or more impact areas (i.e. environmental impact is worse), this outcome may still be an acceptable conclusion if the value of that degradation is within some predefined limits and/or there are benefits in other areas.

- A decision will need to be made as to whether there is an acceptable conclusion regarding the environmental implications identified in the assessment. Where no conclusion can be made, the process may need to return to the start.

3.5 FINAL DOCUMENTATION, COMMUNICATION AND REPORTING

3.5.1 Final results and recommendations from an assessment are useful for informing decisions about the project and how to proceed, as well as facilitating communication with stakeholder groups. The documentation resulting from the assessment generally focuses on environmental impacts, but frequently also conveys the logic of the decisions used in establishing the scope and extent of the assessment. The level of documentation needed is usually related to the complexity of the proposed airspace operational changes, and some States have requirements about the extent of documentation necessary. When an environmental analysis is performed to comply with environmental requirements, the final documentation will cite applicable requirements (local, national or international), the processes used to address the requirements, the environmental impacts (both positive and negative) and all consultations that contributed to important decisions. In cases where a quantitative environmental analysis is performed, the documentation will generally support the results by describing the analytical methods and models used, any applicable model guidance followed, choices of metrics, and gaps in or limitations of the analytical approach.

3.5.2 Note that assessment documents are often made public, and there may be laws regarding retention of records used during development of the assessment, depending on State requirements.

3.5.3 Communication with stakeholders is also an important aspect of finalizing the assessment process. Frequently, the final report will be provided to stakeholders consulted during the assessment to inform them of the outcome. Active engagement with stakeholders and public groups about airspace and operational decisions reduces the chance of questions and concerns later. Tools to facilitate discussion at public hearings can include a summary of impacts, enlarged graphics and charts, use of video and other presentation media.

Chapter 4

INTERDEPENDENCIES AND TRADE-OFFS

4.1 INTRODUCTION

4.1.1 Decisions relating to operational changes are often made on the basis of a wide range of strategic, economic, operational and impact-related information.[1] Often a compromise or balance is required to ensure that a disbenefit, or a combination of disbenefits, does not outweigh the value of the anticipated benefits. Thus when performing an environmental assessment and using the results to inform decision making, it is important to consider interdependencies or trade-offs of the proposed action and/or alternatives. It should be noted that, in the context of this document, the term “interdependency” refers to a situation where a change in Factor A results in a change to Factor B (and vice versa), whereas the term “trade-off” is used to describe interdependency where an improvement in Factor A results in a detrimental change to Factor B.

4.1.2 At a high level, issues of capacity, efficiency, safety and environmental impacts are intertwined and consistency of assumptions and basic facts across these areas (forecast dates, etc.) is important to avoid the risk of conflicting results, or an inability to compare positive and negative impacts, arising from a proposed change. It is also important to note that there may be significant interdependencies at this scale that will require careful consideration to ensure they are adequately covered. It is also important to consider the impacts within an assessment topic (e.g. within environmental impacts, with trade-offs between noise and atmospheric emissions) and to analyse, at least at high level, how and to what extent these different topics and impacts may interact.

4.1.3 Where there are potentially significant interdependencies, a more detailed interdependency assessment may be required. The significance of each different impact may be given by: comparison to strategy and policy; the contribution of the desired outcome; regulations or anticipated political and community responses, which will vary globally on a case-by-case basis. The analysis of interdependencies can show how the achievement of one desired outcome may trigger a supporting or antagonistic outcome and its significance against relevant and pre-agreed criteria.

4.1.4 It is important to note that there are currently no internationally agreed criteria for performing interdependency assessments since the relative value of potential impacts such as economic development, employment or aircraft noise are case dependent and can vary substantially. Often, public decision processes within a legislative framework will have been established at the State level to provide a mechanism to weigh these different impacts and thus perform the interdependency assessment. In this case, the value of different impacts may be decided outside of a proposal’s internal assessment process. It is good practice, however, for the proposer of an ATM change to understand the criteria of such external decisions and to ensure that any trade-offs that could be important to the decision-making process have been adequately anticipated, assessed and mitigated.

4.1.5 The relationships between different impacts are often complex. For example, a voluntary lesser environmental constraint, which curtails one type of operation, may secure a much larger increase in capacity with an overall beneficial impact for operations generally. Thus an apparent trade-off with operations may produce an operational benefit when viewed from a wider perspective. As a result, sometimes it is important to consider the

---

1. For example, the eleven ICAO ATM Key Performance Areas as listed in the *Manual on Global Performance of the Air Navigation System* (ICAO Doc 9883): safety, security, environmental impact, cost effectiveness, capacity, flight efficiency, flexibility, predictability, access and equity, participation and collaboration, and interoperability.

weighting of impact value in the context of a much wider strategic picture so that the correct emphasis can be given to each impact. The approach to this strategic assessment and the weighting of the impacts accordingly are matters for local decision making.

4.2 INTERDEPENDENCY EXAMPLES

Below are descriptions of several common environmental and non-environmental interdependencies that frequently will need to be considered as part of an environmental assessment.

- Fuel efficiency versus capacity: objectives related to providing flight trajectories closer to user preferred trajectories may have to be balanced against the objective of increasing airspace capacity.

- Noise versus fuel burn and CO_2: routeings that benefit noise-sensitive areas (i.e. NPR) should reduce noise impacts to local communities, but may increase fuel burn and CO_2 emissions due to the additional track-miles travelled.

- Flexibility versus capacity: airspace users' ability to modify flight trajectories or arrival and departure times may come at the expense of the capacity of the air navigation system.

- Complex noise and emissions trade-offs: significant low-level turns may help reduce track-miles (and hence fuel burn and CO_2 emissions) and the avoidance of flying over close-in residential areas, but may increase noise beneath the flight path and low-level emissions due to the reduction in the gradient of the climb due to the turn.

Note.— This list is far from exhaustive, and the preservation of safety is always the overriding priority for aviation and is an essential caveat when assessing trade-off options.

4.3 ENVIRONMENTAL INTERDEPENDENCIES

4.3.1 When optimizing aircraft operations, there is frequently a trade-off between noise and fuel burn emissions, whereby decreasing one may well lead to increases to the other.

4.3.2 For example, procedures or airspace designs that may reduce noise exposure levels for a community by routing aircraft around (rather than over) particular residential areas (either close-in or farther-out) may increase the aircraft's distance flown, thus increasing fuel burn and emissions. In addition, the use of noise abatement departure procedures (NADPs), that change take-off thrust levels or aircraft take-off and climb configurations, and procedures to change population noise exposure can increase, or change, emissions (e.g. NOx). They may also shift noise impacts from one area to another. For example, procedures to reduce close-in noise may increase noise further out and vice versa.

4.3.3 Similarly, procedures or airspace designs that shorten flight track miles may decrease fuel burn and emissions, but move flight paths, and hence noise, thus potentially increasing noise exposure levels for a community.

4.3.4 Advanced avionics have led to new operational procedures options by which aircraft can be more precisely routed. Depending on how this is applied, the result can be either a concentration of flight tracks, and thus a concentration in the noise impact area, or the ability to define a number of flight tracks, and hence spread noise exposure over a wider community or area. Some States and local authorities may have already established policies regarding concentrating versus dispersing flight tracks in order to manage noise exposure.

4.3.5 It is important to understand as far as possible the interdependences between the different impacts and plan to minimize any adverse effects. It is not within the scope of this document to list all of the interrelationships that do exist; however, reference may be made to sources such as Chapter 8 of the *Airport Air Quality Manual* (ICAO Doc 9889) and the Final Report of the ICAO CAEP Workshop 2007 for some examples that may be useful. It must be emphasized, though, that due to their very nature actual interrelationships are specific to individual situations and trade-offs for each situation will normally be different.

4.4 NON-ENVIRONMENTAL INTERDEPENDENCIES

4.4.1 Preferably, innovative solutions should be chosen which are able to overcome the need for some, or all, of the trade-offs. History is full of examples where trade-offs were once necessary due to certain technical or operational limitations, but have now largely been done away with as innovative solutions have been identified. As a result, the requirement for trade-offs to be made for non-environmental interdependencies has substantially reduced.

4.4.2 However, if trade-offs are unavoidable, there is a need to make informed decisions based on priorities between the objectives and targets. This approach to overall performance implies an aim to achieve some “optimum performance” across different performance areas, objectives, metrics, etc. Such an aim should be treated as an overall performance objective, with its own indicator. Typically, this indicator takes the form of a performance index, a weighted score, or the monetized cost and/or benefit of all other performance aspects.

4.4.3 Further information on potential approaches for dealing with non-environmental interdependences is given in Appendix B of the *Manual on Global Performance of the Air Navigation System* (ICAO Doc 9883). It is important to note that the requirement for the safe operation and control of an aircraft is always the overriding priority.

4.5 EXAMPLE APPROACHES FOR MANAGING TRADE-OFFS

4.5.1 Bearing in mind the points made in 4.1, the approaches for balancing interdependences will vary from case-to-case. For example, the stringency and scrutiny applied to a public legal assessment may be different to an assessment carried out for internal reasons. Regardless of the purposes of the assessment, the consideration of interdependencies should be approached in a careful, stepwise fashion. To improve overall performance when there are interdependencies, one should determine if there are conflicting impacts (trade-offs) that need to be balanced.

4.5.2 For the environmental interrelationships, there are potential “compromise” options for managing noise/emissions trade-offs which may merit consideration. Particular criteria could be used to decide on placing the priority on either noise or emissions. In this situation, reference to Chapter 3, section 3.3, and in particular Figure 3-3 and Table 3-1, may be of help in deciding which environmental impact could be prioritized.

4.5.3 In addition, there may be a trade-off for areas closer to the airport and outer areas. With regard to noise, for example, procedures to reduce close-in noise may increase noise further out and vice versa. In these cases, it should be understood that conventional average day noise assessment techniques may not assist in analysing environmental and non-environmental trade-off issues in outer areas. These impacts may require some form of additional assessment using time-sampling and single event analysis approaches to enable the communities and the aviation industry to have a fully informed and transparent discussion on the merits of any particular proposed course of action. This applies equally to both the urban and airspace restructure situations.

4.5.4 When conflicting objectives do emerge, and there is no obvious compromise solution, it is possible that techniques from multi-criteria decision making (MCDM) can be applied. A detailed treatment of methods in this area is beyond the scope of this manual. However, a number of groups have suggested ways (which can be found in public literature) in which MCDM can be used to manage trade-offs.

4.5.5 Where the simultaneous meeting of different targets is not possible, the balance between targets should be adjusted so that they reflect, as far as is achievable, an acceptable and feasible compromise. In this case, decision-makers must ultimately determine which choices represent acceptable solutions.

Chapter 5

CONCLUSION

5.1 The information presented in this document is intended to support sound and informed environmental assessment for proposed operational changes. The high-level principles presented provide a framework for assessment methodologies in a wide variety of scenarios and conditions. States, airport operators, air navigation service providers and other stakeholders should thoughtfully adapt such recommendations to their own circumstances, with consideration to pre-existing regulations, aspirational goals, community considerations and geographic constraints.

5.2 Examples of specific existing State-level legal requirements, assessment methodologies and key parameters, how to avoid potential pitfalls, and assessment examples that have been carried out are provided in the Appendices A through D for convenience. The examples given attempt to capture a wide range of regions and scales in order to provide a variety of perspectives.

5.3 The intention of this guidance is to provide a "living" document which could be updated as more experience is gained in carrying out environmental assessments. This would then provide a continually improving source of advice. In this respect, users of this manual are requested to relay their experiences to the address below, so that the document can be updated in the future. To help facilitate this, an example form has been added as Appendix E which indicates the sort of information that is likely to be of value for future users of this ICAO assessment guidance. Not all points are required, and some may not be applicable to your case study, however, forwarding as much information as possible to ICAO will help ensure users are able to develop the best possible procedures for carrying out environmental assessments for proposed operational changes. Please send completed forms or details to:

The Secretary General
International Civil Aviation Organization
999 University Street
Montréal, Quebec
Canada H3C 5H7

or by e-mail to env@icao.int .

Appendix A

EXAMPLES OF FORMAL REQUIREMENTS AND GUIDANCE FOR ENVIRONMENTAL ASSESSMENTS

1. INTRODUCTION

This appendix gives examples of existing formal requirements and guidance for conducting environmental assessments from States that have them already in place. It should be noted that the extracts are not exhaustive and have been taken from documents existing in early 2012. They are produced in this appendix to give examples of the type of formal requirements and guidance specified by some States.

2. EXAMPLES

a) Excerpt from: *Europe — SESAR (Single European Sky ATM Research programme)*
http://www.sesarju.eu/environment/sesar%E2%80%99s-environmental-objectives-994

The SESAR programme will:

- evaluate the current environmental performance of the European air transport system against that of 2005;
- validate technical and operational work packages addressing SESAR environmental issues;
- put in place a methodology and supporting applications to track the programme's environmental performance;
- define action plans for the deployment of technical and operational work packages providing environmental benefits;
- engage all SESAR partners and communicate to them the need to put environmental performance at the core of their projects and continuously seek to deliver safe, efficient and capacity-enhancing ATM solutions with environmental benefits;
- maintain a full and clear understanding of the evolving European legal and regulatory environmental requirements affecting aviation and ensure compliance with these;
- make available environmental training and awareness material to all SESAR members, tailored to their needs;
- implement a strategy to ensure that the programme's environmental activities are appropriately communicated to its stakeholders.

b) Excerpt from: *United Kingdom — CAP 725, CAA Guidance on the Application of the Airspace Change Process*

Appendix B — Airspace Change Proposal — Environmental Requirements
Section 1 — Introduction

1. The Civil Aviation Authority (Air Navigation) Directions 2001 (incorporating Variation Direction 2004) (HMG, 2001) requires the CAA to take into account "the need to reduce, control and mitigate as far as possible the environmental impacts of civil aircraft operations, and in particular the annoyance and disturbance caused to the general public arising from aircraft noise and vibration, and emissions from aircraft engines". In order to achieve this, DAP requires Change Sponsors to provide an environmental assessment. Every airspace change will be different and the extent of environmental assessment will vary from case to case. It is the function of this document to assist those preparing airspace change proposals in providing sufficient environmental information for public consultation and to inform the decision-making process.

2. In order to ensure that the various areas for environmental assessment by DAP are addressed, Change Sponsors **should** submit the documentation with the following clearly defined sections:

a) Description of the airspace change (refer to paragraphs 28 - 33);

b) Traffic forecasts (refer to paragraphs 34 - 38);

c) An assessment of the effects on noise (refer to Sections 4 and 5);

d) An assessment of the change in fuel burn/CO_2 (refer to Section 6);

e) An assessment of the effect on local air quality (refer to Section 7); and

f) An economic valuation of environmental impact, if appropriate (refer to Section 9).

3. This document gives a broad outline of relevant methodologies for use in environmental assessment. It is not a complete instruction manual on all aspects of the topic. Readers should consult the further reading Annex or seek expert assistance where relevant. The purpose of this document is to provide clarification of the requirements for environmental information in the submission of an Airspace Change Proposal. It does not place additional obligations on Change Sponsors over that contained in current legislation and guidance issued by the Department for Transport (DfT) and other Government departments.

4. Guidance to DAP from DfT (DTLR, 2002 - paragraph 36) specifies that changes to airspace arrangements (which includes procedures for the use of controlled airspace in addition to its design) "should be made after consultation, **only** where it is clear that an overall environmental benefit will accrue **or** where airspace management considerations and the overriding need for safety allow for no practical alternative".

5. The Government white paper "The Future of Aviation" (DfT, 2003) sets out a strategic framework for the next thirty years. It recognizes the benefits of the expansion in air travel. It states the case for development of further airport capacity including steps to provide a corresponding increase in airspace capacity but "requires that we do more to reduce and mitigate the environmental impacts of air transport and airport development".

6. In March 2005 the Government revised its sustainable development strategy (DEFRA, 2005) which replaces the sustainable strategy outlined in the guidance on environmental objectives (DTLR, 2002). The revised strategy takes account of new developments since 1999 and, in particular, the Energy white paper (DTI, 2003) and international initiatives. The aim of the new sustainable development strategy is to build upon the old one, not depart from it.

7. The guiding principles of the latest UK sustainable development strategy are:

a) Living within environmental limits;

b) Ensuring a strong, healthy and just society;

c) Achieving a sustainable economy;

d) Promoting good governance; and

e) Using sound science responsibly.

8. For a policy to be sustainable, it must respect all five of these principles though recognizing that some policies will place more emphasis on certain principles than others. Any trade-offs should be made in an explicit and transparent way.

9. The strategy discusses indicators for sustainable consumption and production although a definitive list of indicators has yet to be published. These indicators are being developed to demonstrate “decoupling”. That is, measuring success in breaking the link between economic growth and environmental damage. For aviation, greenhouse gases and gross domestic product (GDP) have been suggested, although exact details have yet to be published.

10. The environmental impact of an airspace change **must** be considered from the outset. The Change Sponsor **should** discuss their general intentions for environmental assessment with the DAP Project Leader and, if necessary, with ERCD staff who will provide expert advice. These discussions **should** take place before any form of external consultation. Each airspace change is specific and raises different issues, while the guidance in this document is, of necessity, quite general.

11. Environmental science is continually evolving and this document describes assessment methods applicable at the date of publication. New methodologies based on sound principles may well be developed. This document will therefore be subject to review and updating in order to ensure that it reflects “best practice”.

12. Airspace changes are increasingly the subject of public debate and it is important that environmental assessment and associated public consultation are carried out thoroughly. Incomplete consideration of environmental issues will cause delays to the handling of airspace change proposals.

13. It is extremely important for Change Sponsors to discuss the general nature of the change with the DAP Project Leader. This can prevent wasted effort. For example, it may be that the Change Sponsor can demonstrate by approximate calculations, that some effects of an option are relatively small. In such an instance, the DAP Project Leader could indicate that there would be little point in further refinements to the calculation. The message is that analysis should be proportionate to the utility of the information gained from it.

14. The following terms are used here to indicate the degree of compliance expected from Change Sponsors in following this guidance:

a) **Must** — Change Sponsors are to meet the requirements in full when this term is used;

b) **Should** — Change Sponsors are to meet these requirements unless there is sufficient reason which must be agreed in writing with the DAP Project Leader and the circumstances recorded in the formal airspace change documentation; and

c) **May** — Change Sponsors decide whether this guidance is appropriate to the circumstances of the airspace change.

15. Where these three words are used in relation to actions by Change Sponsors, the words have been emboldened in the text.

16. The following text is divided into eight sections:

a) Section 2 – Principles of Environmental Assessment;

b) Section 3 – Inputs to the Environmental Assessment;

c) Section 4 – Noise: Standard Techniques;

d) Section 5 – Noise: Supplementary Methods;

e) Section 6 – Climate Change;

f) Section 7 – Local Air Quality;

g) Section 8 – Tranquillity and Visual Intrusion; and

h) Section 9 – Economic Valuation of Environmental Impact.

The full document text, along with all the references, can be found at: http://www.caa.co.uk/docs/33/CAP725.pdf

c) Excerpt from: *United States — Formal requirements and Guidance for Environmental Assessments*

The National Environmental Policy Act (NEPA) is a national-level policy that federal agencies follow to evaluate environmental impacts.[1] Environmental assessment conducted in the United States for proposed air traffic management operational changes follow requirements of U.S. Federal Aviation Administration (FAA) Order 1050.1E *Environmental Impacts: Policies and Procedures,* and Order JO 7400.2J *Procedures for Handling Airspace Matters (Chapter 32)*.[2,3] These FAA policies provide specific details on assessment for aviation actions, while also meeting the requirements set forth in NEPA.

FAA Order 1050.1E provides FAA with three levels of environmental review documentation based on those required by NEPA – Categorical Exclusion (CATEX), Environmental Assessment (EA) and Environmental Impact Statement (EIS). A CATEX is the least intensive assessment option, while an EIS is the most intensive assessment option. The FAA has developed a list of actions that it has determined do not normally result in significant environmental effects (see FAA Order 1050.1E paragraphs 307-312). Those actions are eligible for a CATEX, which means they are excluded from additional environmental review provided no extraordinary circumstances apply to the proposed action.[4] For proposed actions that do not qualify for a CATEX, an EA or EIS is required. The purpose of an EA is to determine whether a proposed action or its alternatives has the potential to significantly affect the environment. If an EA indicates that the proposed action's impacts may be significant, FAA will prepare an EIS that analyses all project alternatives and potential impacts, as well as options for mitigating impacts.

1. 40 Code of Federal Regulations ((CFR) parts 1500-1508), available at: http://www.gpo.gov/fdsys/search/pagedetails.action?collectionCode=CFR&searchPath=Title+40%2FChapter+V&granuleId=CFR-2011-title40-vol33-part-id1102&packageId=CFR-2011-title40-vol33&oldPath=Title+40%2FChapter+I&fromPageDetails=true&collapse=true&ycord=156
2. http://www.faa.gov/documentLibrary/media/order/energy_orders/1050-1E.pdf .
3. http://www.faa.gov/documentLibrary/media/Order/AIR.pdf.
4. see FAA Order 1050.1E paragraph 304 for possible extraordinary circumstances.

FAA Order 1050.1E provides a summary of the requirements and procedures to be used during an environmental impact analysis for each resource category. NEPA requires that the extent of consideration and analysis be proportional to the extent of potential environmental impact, and therefore not every category of impact is applicable to every proposed aviation action. For air traffic operational procedures the impacts most often studied in detail are noise and, where applicable, fuel burn and CO_2 emissions. Chapter 32 of FAA Order JO 7400.2J provides detailed procedures conducting environmental reviews of proposed airspace procedures and management actions. In particular, this policy establishes the specific altitudes at which certain analyses must be conducted, thresholds for assessing when an impact such as noise is significant, and some of the extraordinary circumstances that should be considered in air traffic environmental assessment (see FAA Order JO 7400.2J Chapter 32, Section 2). Examples of FAA assessments for air traffic operational changes are provided in Appendix 5.

Within Order 1050.1E are eighteen environmental impact categories that must be addressed within an environmental assessment. The list of environmental impact categories is presented below and additional information regarding the requirements and procedures for analysis of each category can be found in Appendix A of FAA Order 1050.1E:

Environmental Impact Categories:

- Air Quality
- Coastal Resources
- Compatible Land Use
- Construction Impacts
- Department of Transportation Act: Section 4(f)
- Farmlands
- Fish, Wildlife, and Plants
- Floodplains
- Hazardous Materials, Pollution Prevention, and Solid Waste
- Historical, Architectural, Archaeological, and Cultural Resources
- Light Emissions and Visual Impacts
- Natural Resources, Energy Supply, and Sustainable Design
- Noise
- Secondary (Induced) Impacts
- Socioeconomic Impacts, Environmental Justice, and Children’s Environmental Health and Safety Risks
- Water Quality
- Wetlands
- Wild and Scenic Rivers

Appendix B

ASSESSMENT METHODOLOGIES AND KEY ENVIRONMENTAL PARAMETERS

1. INTRODUCTION

This appendix expands on Chapter 2, 2.4 and Chapter 3, 3.4 to provide specific details regarding assessment methods and metrics. Methodologies are described for evaluating noise exposure, air quality and fuel burn/greenhouse gases, along with examples of the various metrics that may be applied to these processes. As emphasized in this document, effective environmental assessment data must adequately support all modelling carried out and satisfy all applicable regulations. Careful consideration should be given to choices about baseline data, the extent and type of all assessments and the metrics chosen, as well as how the results may be used. ICAO resources can provide further information on aircraft noise and engine emissions as well as a number of other documents and are cited below, where appropriate.

2. NOISE

a) *Assessment*

The assessment of aircraft noise can be conducted through a variety of techniques, ranging from the direct measurement of noise through the placement of calibrated microphones, to time-based simulation, or at a screening level through the use of tools developed for that purpose. From time to time, CAEP determines noise models that are suitable for computing global trends. For example, at the eighth CAEP meeting (CAEP/8), held in 2010, the following models were identified: AEDT, ANCON2, and STAPES.[1]

Specific noise level data can be obtained from a number of authoritative sources such as the *Aircraft Noise and Performance (ANP) database*, which is an international online data resource for aircraft noise modellers, for use with ICAO Doc 9911, *Recommended Method for Computing Noise Contours Around Airports*. This database is maintained by Eurocontrol and is publicly available following registration at http://www.aircraftnoisemodel.org/. Care should be taken to ensure that the aircraft procedures that are modelled agree with those in use operationally, otherwise the modelling may produce results that are different from those found in practice.

ICAO Doc 9911contains additional information on computing noise contours around airports.

b) *Metrics*

There are many metrics that are commonly used to evaluate aircraft noise. The suitability of any particular metric depends on the intended use of the result. As the metrics in Table B-1 illustrate, some provide a direct indication of the sound pressure from a single event, while others provide average values.

1. *Report of the Eighth Meeting of the ICAO Committee on Aviation Environmental Protection* (ICAO Doc 9938).

Table B-1. Commonly-used aircraft noise metrics

Abbreviation	*Full Name*	*Definition*
Single Event Metrics		
L_{max} (L_{Amax}) (L_{Cmax})	Maximum Sound Pressure Level (A or C-Weighted)	Highest sound level recorded during a noise event. Normally a frequency weighting (e.g. ‘A’, ‘B’, ‘C’ or ‘D’ weighting) is also applied.
SEL or L_{AE} (SELC or L_{CE})	A-Weighted Single Event Exposure Level (C-Weighted)	The sound level that contains the same total noise energy produced during a single event but compressed into 1 second, usually with the ‘A’ or ‘C’ weighting applied.
EPNL	Effective Perceived Noise Level	Measure of the effective perceived noise level (EPNL) as computed during certification. EPNLs are computed from PNLT values in a similar way that SEL is from dBA values, but use a reference time of 10 seconds.
Cumulative Metrics		
L_{eq} (L_{Aeq})	Equivalent Sound Pressure Level (A-Weighted)	The hypothetical steady sound that contains the same sound energy as the actual time varying sound. The ‘A’ frequency weighting is also normally applied.
DNL or L_{dn}	Day-Night Average Sound Level	24-hour average sound level based on L_{eq}, where a decibel penalty (e.g. 10 dB) is assigned to noise generated during the night-time period.
DENL or L_{den}	Day, Evening, Night Average Sound Level	24-hour average sound level where a decibel penalty is added to noise generated between a defined evening period, and a higher decibel penalty is assigned to noise generated during the night-time.
NEF	Noise Exposure Forecast	Prediction of future noise based on the EPNL generated by a set of operations, with an additional weighting for night-time operations.
Time-Based Metrics		
TA	Time Above	The total time or percentage of the time that the noise exceeds a defined level.
TALA	Time Above Ambient Level	The total time or percentage of time that the noise exceeds the ambient level.
TAUD	Time Audible	The total time or percentage of time that aircraft noise is audible.
Noise threshold-based Metrics		
Nxx – where xx is the noise level threshold in dB	Number Above	The total number of events where the noise exceeds a defined threshold level, e.g. N70, the number of events exceeding a 70 dB(A) threshold is a commonly used version of this metric.

There are also a number of derived metrics based on those in Table B-1 that are in use in different countries. Further information on these and their characteristics and uses may be found in a number of sources, for example, ERCD Report 0904[2].

In addition to simply computing the metrics, the area of the noise contours (often measured in square kilometres or square miles) and the number of inhabitants within a noise contour are frequently used in an aircraft noise analysis to describe noise impacts.

3. AIR QUALITY

a) *Assessment*

The two main areas of an air quality assessment are:

a) emissions inventories; and

b) dispersion modelling of pollutant concentrations.

An emissions inventory gives the total mass of different species of emissions released into the environment and provides a basis for reporting, compliance and mitigation planning. An inventory can then be used as an input to pollution dispersion modelling.

Dispersion modelling enables emissions to be linked to pollutant concentrations by modelling the atmospheric transport of the emitted pollutants and their resulting spatial and temporal concentration and distribution. Depending on the pollutants being considered, the use of a model that can account for the chemical reactions of the pollutants in the atmosphere and/or the deposition of particles could be considered.

This combined approach of using emission inventories and dispersion modelling enables the assessment of historical, existing and/or future pollutant concentrations in the vicinity of airports or from individual emission sources. A dispersion model could be used, for example, to compute the impact of the modified emissions on air quality local to the airport.

Information on emissions indices (EI) for NOx, CO and HC for the majority of the world's current large jet engines have been collected into an ICAO Aircraft Engine Emissions Databank. The emissions indices were measured in accordance with the requirements of ICAO Annex 16, Volume II, for the purposes of engine emissions certification. This databank contains information on exhaust emissions of only those aircraft engines that have entered production. The information was provided by engine manufacturers, who are solely responsible for its accuracy. It was collected in the course of the work carried out by CAEP but has not been independently verified unless indicated. This databank is hosted by the European Aviation Safety Agency (EASA) on behalf of ICAO, and it is accessible on the Internet at http://easa.europa.eu/environment/edb/aircraft-engine-emissions.php . However, care should be taken in the application of the information in this database, as the levels given will normally not represent those produced in actual operations without additional analysis. Additional information on the use of information from the databank is available in the ICAO *Airport Air Quality Manual* (Doc 9889), including a first order approximation method for estimating Particulate Matter (PM) emissions.

2. ERCD Report 0904 *Metrics for Aircraft Noise*
http://www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=3384

b) *Metrics*

When an emissions inventory is being conducted, the typical metric is the total mass of emissions for the period of time being evaluated (often measured in kilograms or tonnes). For a dispersion analysis, the concentration (pollutant mass per volume or air) is measured in units such as $\mu g/m^3$, ppb or ppm. The evaluation is based on statistical quantities of the concentration, for example: annual, daily, and hourly means, percentiles and excess frequencies.

4. FUEL CONSUMPTION AND GREENHOUSE GASES

a) *Assessment*

In general, the amount of CO_2 that is emitted from the combustion of fuels can be calculated by multiplying the amount of fuel burned by an appropriate emission factor. Therefore, the assessment of CO_2 emissions follows the same process as that of fuel consumption. For the case of CO_2 emissions from the combustion of conventional aviation fuel, States are encouraged to use the emission factor of the ICAO Carbon Emissions Calculator methodology (3.157 $kgCO_2$/kg for jet fuel[3] or 3.05 $kgCO_2$/kg for AvGas). If the amount of fuel is available in volume units (for example, in litres) the density factor of the fuel should be used to convert it into mass units. If data are not available to determine a country-specific density factor value, in the absence of such a density factor, the global default of 0.8 kg/litre could be used.

Information on the calculation of emissions from aircraft operations may be found in the Society of Automotive Engineers (SAE)'s "Procedures for the Calculation of Aircraft Emissions", AIR5715, (http://standards.sae.org/air5715/) which brings together the different procedures that exist for estimating aircraft emissions during normal operations.

In addition, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories[4] provide three methodological tiers for estimating CO_2 emissions from international aviation. All tiers, listed below, distinguish between domestic and international flights, which are defined using criteria that apply irrespective of the nationality of the carrier.

The choice of methodology depends on the type of fuel, the data available and the relative importance of aircraft emissions. All tiers can be used for operations using jet fuel, as relevant emission factors are available for this fuel type. The data requirements for the different tiers are summarized below:

- Tier 1 is based on an aggregate quantity of fuel consumption data (no distinction is made between landing/take-off (LTO) cycles and cruise phase) multiplied by average emission factor;

- Tier 2 is based on the number of LTO cycles and fuel use. Distinction is made between emissions generated during the LTO and cruise phases of flight. Default or nationally-specific emission factors for CO_2 could be used;

- Tier 3 methods are based on actual flight movement data, either for Tier 3A origin and destination data or for Tier 3B full flight trajectory information.

The resource demand for the various tiers depends in part on the number of air traffic movements. Tier 1 should not be resource intensive. Tier 2, based on individual aircraft, and Tier 3A, based on origin and destination pairs, would use incrementally more resources. Tier 3B, which involves the use of sophisticated models, requires the most resources.

3. ICAO Carbon Emissions Calculator Methodology Version 3 (http://www2.icao.int/en/carbonoffset/).
4. http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html .

Emissions estimates for the cruise phase become more accurate when using Tier 3A methodology (such as with the ICAO Carbon Emissions Calculator) or Tier 3B models (such as the CAEP-approved models AEDT, AEM III, AERO2k, and FAST[5] or other national models).

In the event that these models are not available for the particular project being assessed, as a fall-back position, it may be appropriate to use the ICAO Fuel Savings Estimation Tool (IFSET). This has been developed by the Secretariat with support from States and international organizations to assist in estimating the change in fuel consumption from the implementation of operational measures. It should be noted, however, that IFSET will not be as accurate as the CAEP-approved models and these should be used in preference to IFSET where they are available.

b) *Metrics*

Presently, the most common metric for assessing aviation CO_2 emissions is the total net mass of CO_2 emitted. Similarly, the total fuel consumed is an equivalent metric for fuel consumption.

5. *Report of the Eighth Meeting of the ICAO Committee on Aviation Environmental Protection*, Doc 9938.

Appendix C

AVOIDING COMMON MISTAKES MADE IN ASSESSMENTS

Table C-1. Common mistakes made in assessments

Common mistakes	*Potential consequences*	*How to avoid*	*Additional Information*
Failure to present a cogent argument for the need for the proposed change.	Lack of support, or outright opposition to the change, from parties affected by the proposals.	Ensure early and detailed engagement with the affected parties, highlighting the reasons for the proposed changes.	Decision makers are unlikely to approve a change if there is no demonstrated need, so a clear, well thought-out and rational case should be presented at an early stage. Early engagement with affected parties may help with the understanding of the reasons for the proposal. This in turn may help decision makers to come to a more positive decision about the changes. If the proposals face strong opposition across a number of groups, they may be rejected or at best significantly modified.
Failure to correctly describe the base case against which the proposed case will be assessed.	Incorrect estimation of environmental impact, business case and/or technical evaluation. Refusal of authorization to implement proposal. Inconsistency with non-environmental assessments being undertaken for the proposal.	Ensure clarity and consistency of the base case selection and description. *Is the base case the present case with present throughput and present operational parameters?* *or* *Is the base case the future case with predicted levels of growth, a future fleet and present operational parameters?* Ensure consistency of assumptions and time horizons with any other non-environmental assessments being undertaken for the proposal (e.g. cost benefit, safety or capacity). Ensure adequate consultation and buy-in	This is most commonly found in an assessment-derived impact from a future scenario against the present situation. In reality, the present situation will often change in the future, even without the proposal to be assessed (for example, increase flights). Typically the objective of an assessment is to predict the impact of a proposed aviation change which will exist for some time. Because of growth in air transport demand, it is common practice to measure the impact of the change at specified future time horizons (e.g. at 5-, 10- and 20-year milestones). Because influences on the impacts (such as movement numbers or fleet mix) will change regardless of the decision to implement the proposal, it is important to consider assumptions for how these key influences will change for the "base case" for the proposal and any proposal alternatives being assessed. The impact of a proposal will often therefore be derived by assessing the differential between the changing base case and changing future cases at specified milestone years. It is important to consider what influences on the base case and the proposal/option cases may change before reaching the relevant milestone years for the assessment (e.g. air traffic throughout, fleet mix, ambient

Common mistakes	*Potential consequences*	*How to avoid*	*Additional Information*
		on the definition, description and assumptions for the base case and proposal cases.	conditions, planned changes that will happen regardless of the proposal). Very often the present is used to describe current conditions as a reference.
Failure to consider potentially viable options.	Late emergence of viable options requiring assessment and leading to delay. Refusal of authorization to implement on the grounds of a technicality.	Ensure that all options are considered and the decision whether to progress to an assessment is documented for audit purposes. The list of viable options can be reduced to a shortlist by simple evaluation or expert judgement. Ensure adequate consultation and buy-in on the options to be assessed.	The requirement to consider alternatives may be a legal requirement. The "'do nothing" case can usually be assumed to be one option that almost always needs to be assessed.
Failure to agree to and maintain common assumptions for all related assessments of a proposed initiative. (e.g. forecast demand, throughput, capacity, fleet mix, business, safety and other key influences).	Conflict and inconsistency between assessment outcomes. Results could be perceived as being unreliable or inadequate. Authorization to implement may be refused or a technical legal challenge may be triggered. Delay to implementation caused by revisiting assessments.	Produce and continue maintenance of a single suite of core assumptions with appropriate communication and document control. Topics can include, inter alia, movement trends, assessment year, fleet mix. This should be updated and circulated to all assessment teams when a change to these assumptions is agreed.	Failure to manage this risk is surprisingly common. Often it is only part way through a proposal's development that differences in basic assumptions come to light. It is possible (and may be a requirement) to use differing assumptions for different assessment topics, but these need to be agreed and documented to aid evaluation of each assessment. This risk can be triggered by the need to make a most challenging assessment for safety or capacity assessment purposes, whilst average conditions may be required for environmental assessment. The nature of the input parameters (e.g. busy day for noise) for environmental assessment may be specified in law.
Failure to be aware of relevant international guidance/best practice.	In certain circumstances, decisions resulting from analyses may face legal challenges and may lose credibility as a result. Refusal of authorization to implement.	Check with recognized sources whether international guidance or best practice exists. Seek independent expert advice of the assessment approach. In particular, understand the reasons for any differences between national and international guidance.	There may be cases where both international and national guidance exist, but are incompatible. Documenting the fact that this incompatibility exists together with the justification for a decision (usually to follow national guidance/requirements) will reduce the risk of later challenges to the validity of the assessment. Any international guidance used for the assessment must be applicable to the local situation otherwise there may be potential for a challenge to the assessment or resulting decisions.

Common mistakes	*Potential consequences*	*How to avoid*	*Additional Information*
Using unharmonized (or unendorsed) assessment methodologies, databases or models where these exist and are applicable.	Rejection of the assessment report. Poor decision making. Refusal of authorization to implement. More robust assessments being used by alternative proposals.	Check legal requirements and good practice guidance to identify widely used, legally compliant or commonly endorsed methodologies and models (that are applicable). Use the most robust methodologies and models. Seek independent verification of the assessment approach and outputs where commonly agreed models are not used.	It is not always appropriate or possible to use commonly agreed models. However documenting the fact that this was considered and the justification for such a decision will reduce the risk of later challenge to an assessment's validity. Sometimes the specific model or methodologies (including version number) may be specified by regulations (local, State or international).
Failure to consult on the assumptions' scope or method being used for an assessment.	Rejection of the assessment and associated proposed change. Lack of buy-in support for a proposal. Errors in assumptions. Omission of key impacts from the assessment.	Identify and comply with any legally mandated scoping or screening consultation processes. Identify interested parties and consult as appropriate. Research similar assessments elsewhere for intelligence.	This is also a basic error that is surprisingly common in assessments. It is not unheard of for detailed assessment to be undertaken on impacts that are of no relevance to decision making about a proposal.
For repetitive assessments: Changing to an upgraded model, database or method.	Sudden change of assessment results. Public concern about validity of models or honesty of impact reports. Doubt in decision making.	Employ expertise of a level to understand the technicalities of such changes to the extent that they can robustly explain differences in assessment. Run the old and new models, datasets or methods in parallel for a small number of assessments to offer transparency for the change.	The use of a new model, method or dataset may be mandated by law and may therefore be unavoidable.

Common mistakes	*Potential consequences*	*How to avoid*	*Additional Information*
Failure to adequately consider interdependencies (trade-offs).	Unintended consequences resulting in adverse impacts – both environmental and/or non-environmental. Public and/or stakeholder concern about validity of exercise and focusing on detrimental rather than improved impacts. Non-compliance with legal requirements.	Ensure all impacts are evaluated and methods chosen for trading-off any adverse impacts are open, transparent and if possible, agreed in principle before evaluation of the proposal is initiated.	Combining environmental metrics is complex and there are a number of methods available – see Chapter 4. Monetization as a rationale for comparing impacts, although simple and relatively straightforward to conduct, may not be acceptable to all stakeholders. It is difficult to monetize subjective impacts, e.g. as with noise.

____

Appendix D

ASSESSMENT EXAMPLES

1. INTRODUCTION

This appendix gives example overviews of existing assessments from States that have already carried them out. The examples have been taken from documents existing in early 2012. It should be noted that these examples are not exhaustive and may not be relevant to the type of assessment under consideration. They are provided in this appendix in order to give some initial help with conducting new environmental assessments for States and bodies that are attempting to do this for the first time.

2. EXAMPLES AT LOCAL LEVEL

a) *Argentina — Environment Care: new trends in Argentinean airspace design*

The National Administration of Civil Aviation of Argentina (ANAC) is making its best efforts to get all aviation-related areas involved in environmental care. All stakeholders including aviation authorities, service providers and the industry are undertaking different actions to reduce emissions and improve air quality.

As a part of this plan, the ANAC has intensified its participation in the ICAO CAEP and in other forums related to environmental protection. The next step will be working on ATM in domestic airspace to improve efficiency in fuel consumption.

Taking into account new airspace design concepts, the ANAC has developed an aggressive five-year plan that aims at optimizing the use of maximum aircraft performance in order to reduce distances, flight times, fuel consumption and thereby emissions of greenhouse gases.

The development of this plan particularly took into account the impact of civil aviation activity on the environment, focusing mainly in three areas:

- CO_2 and NOx emissions;
- Local air quality in the terminal areas; and
- Aircraft Noise.

The ANAC (through its Air Traffic Direction), is designing new flight patterns incorporating the concept of “mutual interference free” in the context of airspace, where conventional and area navigation (RNAV) coexist. Such new patterns are: Standard Arrivals (STAR), Standard Departures (SID) and approach procedures with minimum restrictions. These new procedures are designed to improve aircraft performance in the segments where greater fuel consumption occurs.

Implementation of this plan will substantially reduce engine emissions and aircraft noise in the terminal area, thereby improving the air quality of the airports located therein.

These new patterns will replace, in the short and medium term, the current instrument procedures, which had been developed isolated from each other and included some paths which, in many cases, limited aircraft operations.

This new design to be implemented by the ANAC includes requirements to the Air Traffic Control Service provider (Argentinean Air Force), relating the implementation of operational measures that optimize flight profiles (such as continuous ascent and descent procedures), improve the management of take-off slots and traffic coordination between different airspace control areas, etc.

Several simulations of these new procedures have been performed by the air navigation services provider, which was necessary to allow airspace designers to identify the adjustments required by the original conceptual model.

b) ***France***

For any modification or creation of an air navigation procedure, the French Direction Générale de l'Aviation Civile (DGAC) performs studies of impact on people exposed to noise above a threshold to be determined locally. Two examples of approach procedure modification, along with their environmental assessments, are described below.

- **Beauvais Tillé airport**

An ILS-based approach was implemented to replace a former L/VOR approach. The new procedure improves the aircraft vertical and lateral guidance and prevents multiple landing attempts possibly followed by missed approaches in case of adverse weather conditions. The increase of the track altitude also ensures an improvement in the trajectory's noise impact.

The LAmax 72dB contours were obtained using the INM (Integrated Noise Model) tool. The analysis was conducted with the B737-800 aircraft type, representing around 80 per cent of the airport total traffic.

The results of this study showed that, compared to the former procedure, the ILS-based procedure decreases the noise impact on people by 2-4dB between 8 and 15 km from the runway threshold and by 4-5dB beyond 15 km.

- **Caen Carpiquet airport**

In its effort to implement modern and more accurate technologies, while constantly enhancing flight safety, the DGAC has been developing satellite technology-based instrument approach procedures for many years.

Within this context, it was decided to implement an RNAV procedure at the Caen airport, in addition to the existing VOR/DME procedure, to increase the possibilities of using Runway 13 more efficiently while avoiding the high cost of an ILS.

The noise analysis was performed using the INM model with LAmax 65dB contours. The CRJ aircraft type was selected to reflect the air traffic at the airport.

From an environmental perspective, the study highlighted a significant decrease of around 23 per cent of the total number of people affected by the Runway 13 configuration approach, within an area covering a dozen small towns.

c) *United States*

The FAA completes an environmental assessment of all federal actions that require review under NEPA. Below are two examples of airspace-related assessments.

- **Midwest Airspace Enhancement (MASE) Project**

The Midwest Airspace Enhancement (MASE) project was developed to implement new en route and terminal airspace procedures that would increase efficiency and enhance safety of aircraft movements in the airspace overlying and beyond the Cleveland and Detroit Metropolitan Areas. The project consisted of changes to ingress and egress routes and fixes, altitude use, and holding patterns, as well as development of new procedures in both the high-altitude multi-centre en route and low-altitude terminal airspace environments. Analysis of Noise (see Sections 3.2.1, 4.1, Appendix H and I) for this study used the Noise Integrated Routing System (NIRS) model, and analysed the yearly Day-Night Average Sound Level (DNL) for the average annual daily operations. The use of DNL allows for the 10 dB penalty at night per flight to account for the greater annoyance caused by noise events at night. Noise modelling was conducted for 2004 and forecast conditions in 2006 and 2011. The noise analysis was conducted for the entire Environmental Study Area up to an altitude of 10 000 AGL. The Environmental Assessment also included detailed analysis of Land Use (see Sections 3.2.2, 4.2); Department of Transportation Act: Section 4(f) (see Sections 3.2.3, 4.7); Historical, Architectural, Archaeological, and Cultural Resources (see Sections 3.2.4, 4.8); Air Quality (see Sections 3.2.5, 4.11); and Wildlife (see Section 3.2.6, 4.9) environmental impact categories, which were analysed following the methodologies discussed in FAA Orders 1050.1E Appendix A, and 7400.2H, Chapter 32, Section 2. A range of reasonable alternatives were reviewed during the analysis (see Chapters 2 and 4) and coordination with the public and other agencies was accomplished (see Chapter 5, Appendix J). The environmental assessment resulted in a determination that there were no significant impacts to the quality of the human environment for any of the categories. A Finding of No Significant Impact (FONSI) was issued, followed by a Record of Decision (ROD) for the implementation of the MASE Project.

http://www.faa.gov/air_traffic/nas_redesign/mase/

- **New York/New Jersey/Philadelphia Airspace Redesign**

In its effort to continually maintain safety and increase efficiency of the airspace, the FAA proposed to redesign the airspace in the NY/NJ/PHL Metropolitan Area to more efficiently direct aircraft operating under Instrument Flight Rules (IFR). The FAA conducted a detailed noise analysis (see Sections 3.5, 4.1) that used the Day-Night Average Sound Level (DNL). The project calculated the numbers of people exposed to various noise levels by using census block data and centroid measurement, estimating total populations exposed to slight, moderate, or significant impacts. The NY/NJ/PHL study also included detailed analyses of Land Use (see Sections 3.3, 4.1); Population and Demographics (see Sections 3.4, 4.2); Weather and Climate (see Section 3.6); Department of Transportation Act Section 4(f), and Land and Water Conservation Fund Act Section 6(f) (see Sections 3.7, 4.5); Historical, Archaeological, Architectural, and Cultural Resources (see Section 3.8, 4.4); Air Quality (see Sections 3.9, 4.9); Energy Supply and Natural Resources (see Sections 3.10, 4.10); Light Emissions and Visual Impacts (see Section 3.11, 4.8); Coastal Resources (see Sections 3.12, 4.13); Wild and Scenic Rivers (see Section 3.13, 4.6); and Wildlife (see Sections 3.14, 4.7) environmental impact categories following the methodologies discussed in FAA Orders 1050.1E Appendix A, and 7400.2H, Chapter 32, Section 2. A range of five distinct alternatives, including a no action alternative, were quantitatively and qualitatively analysed and evaluated to determine their potential impacts. After extensive analysis and over 30 public hearings that spanned five states — New York, New Jersey, Pennsylvania, Delaware, and Connecticut — the Integrated Airspace Alternative Variation with Integrated Control Complex (ICC) was identified as the preferred alternative because it best met the purpose and need of the project, which was to improve the efficiency and reliability of the airspace structure and air traffic control system from southern Connecticut to eastern Delaware. Although it was determined that there were potentially significant impacts for Noise/Compatible Land Use, and Socioeconomic Impacts/ Environmental Justice, FAA moved forward because the preferred alternative best met the purpose and need of the project and the mitigation measures proposed minimized the potentially significant noise impacts without substantially diminishing its benefits. The Environmental Impact Statement was completed in July 2007 and a Record of Decision was published in September of that year.

http://www.faa.gov/air_traffic/nas_redesign/regional_guidance/eastern_reg/nynjphl_redesign/documentation/feis/

http://www.faa.gov/air_traffic/nas_redesign/regional_guidance/eastern_reg/nynjphl_redesign/documentation/media/Corrected_ROD_071005.pdf

3. EXAMPLES AT NON-LOCAL LEVEL

a) *Argentina — Five-year plan for airspace outside the BAIRES TMA*

The five-year plan designed by the ANAC for airspace outside the BAIRES TMA involves a number of different areas within the Argentinean airspace. All the actions to be carried out take into account the preservation of environmental conditions, the reduction of aeroplane greenhouse gas and other emissions, and the optimization of fuel consumption.

In this context, the ANAC has a wide range of projects including, but not limited to:

- development and implementation of Air Traffic Flow Management (ATFM), in the Argentinean airspace;
- installation of 23 secondary radar sensors, to address the need for full coverage across all the Argentinean airspace;
- flexible use of airspace;
- Area Control Centre (ACC)'s upgrade, utilizing INDRA technology, service radar implementation, etc.;
- AMHS MTA's interconnection with Peru, Brazil, Chile, Spain and Paraguay;
- reduction in the amount of restricted airspace devoted to military purposes; and
- incorporation of performance-based navigation (PBN) procedures in terminal areas.

In this development, an amendment to the Argentinean Aeronautical Information Publication (AIP) with a date of validity of August 2012 has been devised. This amendment includes, among other points, the incorporation of five domestic air traffic service (ATS) Routes RNAV5 (GNSS-INERCIAL), the incorporation of one conventional ATS Route, and a realigned one, which will allow flight distance reductions and direct trajectories.

In addition, the realignment of three ATS Routes and the design of a new route from El Calafate VOR to Ushuaia VOR are being evaluated at a Regional level.

It is estimated that Continuous Descent Operations could begin to be adequately applied by 2016/17 at specifically determined airports, selected according to their requirements.

b) *Europe — Environmental Assessment of a proposed European Functional Airspace Block*

Introduction

This example was carried out by EUROCONTROL on a Functional Airspace Block (FAB)[1,2] by applying the draft[3] ICAO Environmental Assessment Guidance methodology. The assessment was carried out in 2011 and comprises the airspace of two EUROCONTROL member states whose land and sea territory covers approximately 350 000 km^2.

Within any FAB, ATM interaction with the environment is subject to Single European Sky (SES) legislation, other relevant international and EU law and national or local legislation that may also cover trans-boundary effects.

The European Commission (EC) FAB implementation guidance material[4] requires that environmental implications are taken into account and that opportunities to improve environmental performance are taken. In particular, a cost benefit analysis must be undertaken, to demonstrate that "the FAB contributes to a reduction of the aviation environmental impact".

Preparatory Work

The FAB environmental assessment was part of the overall FAB project which consisted of seven work packages: Concept of Operations (CONOPS), Real-Time Simulation (RTS), system architecture, safety case, datalink, legal and institutional, and environment. As such, a cross work-package Project Management Plan (PMP) was created to ensure a coordination, reporting and performance framework between the different work packages.

For the environmental work package, two objectives were agreed prior to the study:

- OBJ-1: determine the real environmental benefits of FAB establishment

- OBJ-2: development of a FAB environmental study.

The FAB was proposed to be phased in by following a top-down approach, i.e. with the FAB implemented in the upper airspace first, followed by lower airspace/terminal areas and then airports.

Describe proposed change, purpose and alternative

The first requirement was to define the operational changes proposed by the study. One of the principal objectives of the FAB was to reduce emissions especially CO_2 in the upper airspace through reduction of distance, flight time and fuel burn by adoption of a new route system design. This would assist the FAB in achieving national, Europe-wide and international targets relating to flight efficiency[5] and CO_2 reduction[6,7].

---

1. http://ec.europa.eu/transport/modes/air/single_european_sky/fab/index_en.htm
2. European Commission regulation 550/2004 requires all member states to ensure the implementation of functional airspace blocks to achieve the required capacity and efficiency of the air traffic management network within the single European sky.
3. Environmental Assessment Guidance for Proposed Air Traffic Management Operational Changes, draft SG2 v1.5, ICAO, 14 December 2011.
4. http://www.skybrary.aero/index.php/Category:FAB_Guidance_Material
5. The EUROCONTROL 2010 performance review estimated that approximately 0.5 to 1.5 per cent of the extra distance flown compared to great circle was within the FAB States concerned.
6. The EUROCONTROL 2010 performance review reported that the share of ANS actionable CO_2 emission reductions relating to the horizontal flight path due to route inefficiency was 3.7 per cent.

Guidance material developed for FAB creation recommended that "*the assessment of alternative solutions*" was obligatory and that "*it is important to agree the operational and performance base case and proposed case (i.e. with the FAB) at an early stage*", a comparison between the two gave the environmental impact. The two cases agreed were "*the future case without the proposal*" (increased traffic, no FAB) and the "*future case with the proposal*" (increased traffic, with FAB). In the case of an ATM system, it is only by analysing the future "do-nothing" and "do-something" cases that the true future impact of a proposal can be correctly assessed. This step accords closely with the preliminary step of the ICAO guidance methodology.

Determine the scope and extent of assessment

The first task was to identify if there were any pertinent assessment methodologies that could be followed to undertake the ATM environmental assessment. It was agreed with the FAB representatives that the principles and general approach recommended in the emerging ICAO Environmental Assessment Guidance methodology would be used as the basis of the FAB environmental assessment — the ICAO method also accords closely with European Directives and European good practice. After this the geographical and environmental scope of the assessment needed to be identified. Although the base legislation relating to FABs had already been identified, it was necessary to create a database covering all possible national and international regulations that could impact upon the study. The State representatives were requested to complete this exercise.

Additionally, the State representatives were requested to collect noise contour data for the principal airports of their State together with air quality monitoring and measurement data in order to define the maximum general vertical and horizontal noise scope and the extent which air quality limits around the airports were currently breached or could be in the future. This helped to identify potential impacts and what level of assessment would be required.

Based upon the regulatory database created, the geographical scope of the assessment was identified. The decision to exclude airport operations at this stage of the FAB assessment was influenced by the timeframe of the assessment task which would be limited to the FAB implementation in the upper airspace. EC Regulation 551/2004 states that it would be *"desirable to reflect upon the extension of upper airspace concepts to the lower airspace, in accordance with a timetable and appropriate studies*". It was thus agreed that the study would need to provide guidance for the later assessment in the lower airspace, TMA and airports.

The State representatives compiled a database of regulations that could impact the study based on the assumption that the environmental impacts would be limited to:

- climate change (CO_2 and NOx);
- aircraft noise;
- local air quality (principally NOx); and
- visual intrusion/tranquillity.

Due to the lack of specific European regulations on visual intrusion or tranquillity, a request was made to the States to identify any such pertinent local material.

A final task was to identify robust methods and tools that could be used to carry out the environmental assessment. EUROCONTROL provided a list of methodologies for assessing changes to each of the four impact areas (where

7. At its 37th Assembly in October 2010, ICAO adopted the first global governmental agreement committing the aviation sector to reducing its greenhouse emissions (-2 per cent p.a. until 2020).

nothing was available, this was documented) together with possible models, methods and tools that could be used for assessment.

Based upon the information gained, a documented collaborative screening of the regulations, best practices and expert judgement was undertaken to determine the full scope of the assessment. As a result, it was decided that this would be undertaken for the upper airspace and assess climate change (CO_2)[8] only. Due to the lack of regulatory material and guidance available relating to visual intrusion or tranquillity, this was discounted from the assessment.

The tool proposed for the environmental assessment was the System for traffic Assignment and Analysis at a Macroscopic level (SAAM). This is a widely used and accepted European airspace design evaluation tool used to model, analyse and visualize route network and airspace developments at local, regional and European-wide levels. SAAM is composed of a fast-time computer simulator coupled to a fuel-use algorithm and aircraft dataset. Embedded in SAAM is the EUROCONTROL Advanced Emissions Model (AEM) used for calculating the emissions of aircraft in the en-route phase, and endorsed by ICAO.

Throughout the scoping process it was necessary to take a collaborative and transparent approach to the assessment, including the systematic documentation of decisions and their effective communication with all involved. Once this had been decided, a cross work-package workshop covering environmental impacts was organized to test the proposed approach and to identify how different work-packages could interface with the assessment process and its results. Representatives of operational stakeholders (e.g. airports, airlines, ANSP) and regulators together with representatives from other working groups (such as operational, legal, safety and business) were invited to the workshop with the aim to agree on common assumptions for the environmental assessment based upon shared needs.

A further objective was to identify any operational improvements that could be implemented in the FAB airspace to ensure that the full benefit of the FAB could be measured against what would have happened if the FAB was not progressed with. The exact date of implementation of any other operational improvement was not necessary to define as long as any improvements that were planned, accounted for, and the process for assessing them, could be documented. If there were no plans then that was also documented.

As part of the workshop, the list of key facts below was agreed by all working groups to ensure consistency across all work-packages.

– dates for the future scenarios (in common with the business case);

– the route networks for both cases;

– operational improvements and their timeframes; and

– traffic increase forecast methodology and scenario.

Environmental assessment and conclusive analysis

The environmental assessment was carried out as agreed with the various work-packages and work areas. The scenarios were analysed according to the tools proposed and agreed between the environmental working group members.

8. CO_2 is the principle focus of aviation-related climate change policy. Contrails and cirrus formation were not assessed as there was no scientific consensus on their significance. Oxides of nitrogen during en-route operations are assumed to be reduced by improvements in route efficiency, though their effects are not directly proportional to fuel use.

Final document and communication

Based upon the above, the following deliverables were agreed at the start of the study:

- applicable environmental legislation (draft and final);
- agreement on proposed cases to be assessed;
- review of existing assessment methodologies and tools;
- environmental statement;
- workshop agenda and lines of action;
- final environmental assessment report.

Communication was always maintained with all work-packages and areas in a transparent and collaborative manner.

Post-completion review

The assessment was only part completed for the first phase of the FAB (i.e. en-route). However it set the approach for the subsequent assessment plan for the other operational phases, and also the basis for a post-implementation review of the FAB once completed.

Analysis of the ICAO method

The approach to the FAB environmental assessment followed the principles of the draft ICAO Environment Assessment Guidance methodology. This proved to be useful in convincing other work-packages to support the environmental work-package and provided a useful checklist of stages against which to plan the overall approach. The draft ICAO Environment Assessment Guidance methodology offers a generic approach that is coherent and consistent with the assessment regulations that apply in the participating States and adds weight to the final outcome of the assessment.

4. EXAMPLES AT INTERCONTINENTAL LEVEL

Many international initiatives have been developed to address environmental issues that occur at the global level. Parties on both sides of the Atlantic, Pacific and Indian Oceans have created partnerships to evaluate and implement better trans-oceanic environmental practices.

a) AIRE

The Atlantic Interoperability Initiative to Reduce Emissions, or AIRE, is an international partnership established in 2007 by the FAA and the European Commission. Through this partnership FAA and the European Commission seek enhanced ATM interoperability, improved energy efficiency, reduced engine emissions, and lower aircraft noise through accelerated development and implementation of environmentally friendly procedures for all phases of flight, from gate to gate. An assessment of the 2009 AIRE Oceanic and AIRE Integrated Demonstration is available on the Internet http://www.sesarju.eu/environment/aire.

It illustrates procedures, methodology, and final assessment of over 100 actual flights by partner airlines demonstrating environmentally friendly procedures in transatlantic flights. The proposed procedures were supported by measured fuel savings as well as anecdotal evidence.

b) ***ASPIRE***

In the Pacific, the Asia and Pacific Initiative to Reduce Emissions (ASPIRE) is a partnership of air navigation service providers (ANSPs) dedicated to reducing emissions and increasing efficiency by identifying underutilized deployment-ready procedures and shepherding them into industry-wide adoption. ASPIRE was formed in 2008 and consists of FAA, Airservices Australia, Airways New Zealand, the Japan Civil Aviation Bureau (JCAB), the Civil Aviation Authority of Singapore (CAAS), and AeroThai. The 2011 Aspire Annual Report Performance Metrics Appendix is available on the Internet (http://www.aspire-green.com/mediapub/docs/metricsappendix.pdf). It includes an analysis of procedural changes made under ASPIRE (including trajectory-based air traffic management changes and reductions in aircraft separation) and quantifies their cumulative benefits in terms of fuel savings.

c) ***INSPIRE***

Building on the success of the ASPIRE partnership, the Indian Oceanic Strategic Partnership to Reduce Emissions (INSPIRE) was established in March 2011 between Airservices Australia, Air Traffic Navigation Services (ATNS) of South Africa, and Airports Authority of India. INSPIRE is a collaborative network of partners and peer organizations across the Arabian Sea and Indian Ocean region dedicated to improving fuel efficiency and sustainability of aviation. Airline partners include Emirates Airline, Etihad Airways, Virgin Australia, and South African Airways. The Inspire-green Strategic Plan can be found on the Internet.
(http://inspire-green.com/workProgram/docs/Inspire_Strategic_Plan_2011.pdf).

Appendix E

TEMPLATE FOR GOOD PRACTICE EXAMPLES OF ENVIRONMENTAL ASSESSMENT

<table>
<tr><td colspan="4" align="center">ICAO

Template for good practice examples of environmental assessment (Draft V1.0)

Note.— The italicized text is for guidance only and merely indicates the kind of information that is likely to be of value for users of the ICAO assessment guidance. You do not need to cover all points if some are not applicable to your case study.</td></tr>
<tr><td colspan="4">Organization/Company: (The name of the body that undertook or sponsored this assessment)</td></tr>
<tr><td colspan="3">Project Title: (The title of the project being assessed)</td><td>Date of Assessment:</td></tr>
<tr><td colspan="2">ASBU Module Code(s)[1]:</td><td colspan="2">State's Action Plan[2]:</td></tr>
<tr><td colspan="4">Project Description: (Briefly describe the project or proposed operational change to be assessed for its environmental implications. Please, when possible, use schematics for illustration.)</td></tr>
<tr><td colspan="4">Reason for the environmental assessment: (Explain why the environmental assessment was undertaken and, if applicable, include any specific regulation, policy or rule that requires the assessment to be undertaken)</td></tr>
</table>

[1] **APTA**–Approach procedures including vertical guidance; **WAKE**–Wake vortex; **RSEQ**–AMAN/DMAN; **SURF–**A-SMGCS, ASDE-X; **ACDM**–Airport CDM; **FICE**–Increased efficiency through ground–ground integration; **DAIM**–Digital AIM; **AMET**–Meteorological information supporting enhanced operational efficiency; **FRTO**–En-route Flexible Use of Airspace and Flexible Routes; **NOPS**–Air Traffic Flow Management; **ASUR**–ADS-B satellite-based and ground-based surveillance; **ASEP**–Air Traffic Situational Awareness; **OPFL**–In-Trail procedures (ADS-B); **ACAS**–ACAS improvements; **SNET**–Ground-based safety nets; **CDO**–Continuous Descent Operations, PBN STARs; **TBO**–Data link en-route; **CCO**–Continuous Climb Operations.

[2] http://www.icao.int/environmental-protection/Pages/action-plan.aspx

Client or competent Authority: *(Explain which body the assessment will be submitted to for their approval or decision making. Was the assessment internal or public? What audiences is it intended to inform?)*
Assessment Approach: *(This section asks for a brief description of your application of the ICAO guidance for each main assessment step. If a step was not undertaken, give a brief explanation of why the step was omitted or is not applicable to this assessment example. Please complete each section individually. In this box you can explain why the ICAO approach to assessment was chosen. If you did not apply the ICAO methodology, please explain how your methodology differed from the ICAO approach.)*
Preparatory Work: *(Briefly explain the <u>relevant</u> background activities that have been undertaken to prepare for the assessment. This may include decisions or processes such as, deciding that an environmental assessment is required, identifying the assessment client, gathering base data, deciding on years to be assessed, deciding on assessment methods or standards to be applied. There is no need to cover all possible information, simply provide a sufficient explanation of the reasons why the assessment steps and approach were selected. How did you establish which rules, regulations or standards applied to the assessment?)*
Describe the proposed [operational] change, its purpose and alternatives: *(Explain what will change as a result of the proposal to be assessed – this may repeat the information in the earlier project description. Explain why this project is required and what purpose it serves, and what alternatives have been considered. Information on why these alternatives were rejected is useful but not essential.)*
Describe the scope and extent of the assessment: *(How was it decided that this assessment was needed – "screening". Describe the impacts to be assessed, for example, aircraft noise, CO_2 or NOx emissions, climate impacts or air quality impacts. Explain the decision-making process that determined this scope and the level of detail to be used in the assessment – "scoping". Also describe any formal processes to consult upon or agree on the scope, for example, via a nominated competent authority if applicable. Explain, for example, if the scope was set using expert judgement or a pre-assessment check or information gathering. Also describe how the decision to undertake a more*

detailed assessment, or not, was taken. How were the base case and proposed case(s) determined, why were particular years chosen?)
Describe the assessment itself: *(Describe any standards or mandatory requirements for the assessment to be undertaken together with the methodology, monitoring or model used to determine the extent of the environmental impacts for the proposal. Give an indication of the extent or time-horizons that were chosen (if not already described earlier). Was quality management applied? For example, was there a process to ensure that the input data for the environmental assessment was consistent with other parallel assessments? Were interdependencies encountered and how did you address any trade-off issues[3]? Was the expertise for this assessment available from internal resources or procured externally?)*
Describe the results and how they were communicated: *(Explain in general terms what the results of the assessment were, how this was used, for example, to what extent it informed decision making or approval for the project. Was it produced as a draft for consultation or simply as a final report? Were the results validated or verified in any way – for example, were the assessment processes or quality management processes independently audited? Did the results feed into a wider process, for example, a business case assessment?*
Lessons learned: *(Explain here what worked well, what could be improved, what you would do differently next time. If applicable, please explain if you think the ICAO assessment guidance could be improved and in what way. If you did not use the ICAO methodology, can you identify aspects of your methodology that could provide benefits to future iterations of the ICAO guidance? What aspects of the ICAO guidance would you apply to your own methodology for future assessments?)*

[3] For definitions and examples of interdependencies and trade-offs, please refer to Chapter 4 of ICAO Document 10031, *Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes*.

Comments*: (Optional — Offer here any other advice or hints that may be of value to others using ICAO environmental assessment guidance.*)

Please send completed copies of this form to:

The Secretary General
International Civil Aviation Organization
999 University Street
Montréal, Quebec
Canada H3C 5H7

Or by e-mail at env@icao.int

— END —

ISBN 978-92-9249-470-4