

PRELIMINARY VERSION

ENVIRONMENTAL ASSESSMENT GUIDANCE FOR PROPOSED AIR TRAFFIC MANAGEMENT OPERATIONAL CHANGES

For the sole purpose of supporting States in developing their Action Plans on CO₂ emissions
reduction activities

PREFACE

This guidance 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 the purpose, context, scope, and approach. The guidance will be updated and amended periodically in the future, as new information becomes available.

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1. PURPOSE

The purpose of this document is to provide States, Airport Operators, Air Navigation Service Providers (ANSP's), and others with environmental assessment guidance to support sound and informed, decision making when analysing 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 captured in order to ensure a consistent approach to their analysis, 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 the recognition of realizing any environmental benefits associated with operational changes. While the guidance is intended to be applicable broadly, it also highlights areas of priority that may need to be considered at the local level.

2. CONTEXT

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

3. SCOPE OF THIS DOCUMENT

The 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 also 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 defined 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.

These principles could support the development of Environmental "Action Plans", which can be used to report on progress toward the implementation of 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.

This guidance material has been developed to be applicable worldwide with no specific geographic restrictions. It is focused on environmental impacts assessments 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 don't 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, etc.) This material is applicable for the assessment of aircraft emissions, fuel consumption and noise.

The principles in this document are high-level and intended to be flexible enough to account for State-specific requirements and needs 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 in the prioritisation 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.

The consideration of tradeoffs 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 tradeoffs, but does not provide detailed recommendations on the in-depth assessment of interdependencies.

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.

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, an appendix (Appendix 5) will be provided to give some examples of related, detailed, assessments.

4. APPROACH TO ENVIRONMENTAL ASSESSMENT

4.1 Preparation for Conducting an Environmental Assessment

When beginning to formulate an environmental assessment plan for a proposal, one of the first things that it is important to do is determine what environmental regulations apply both in terms of assessment itself (e.g. consultation obligations) and in terms of 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 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.

Irrespective of 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 recognised that “stakeholders” are not only represented by official bodies or organisations, but potentially by environmental groups and political opposition as well.

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:
 - proposed date of implementation;
 - the estimated life expectancy for the proposal;
 - the agreed milestone dates at which assessments are required
 - a description of the key impact influences for the milestone years (e.g. 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

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

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 etc). 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
- areas of special ecological or historical value; and
- coastal zones

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 +/- 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.

It may also be important to note any existing environmental conditions in order to avoid double counting and in order 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 and especially if there is a regulatory requirement to look at all actions in a specific area from a cumulative perspective. It may also be true that where a project can give rise to cross-border impacts (e.g. a proposal in one State impacting a neighbouring State) as these may require special handling such as obliging early consultation with affected parties or responsible State authorities.

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 that the noise sensitive area can be partly or generally avoided 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 for 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 change to impacts of the proposal

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

Not all environmental assessments are driven by legal requirements e.g. an operationally driven proposal may reduce environmental impact enhancing its business case. Other examples are flight trials, where even without a regulatory requirement the environmental impact areas of concern or interest could still be assessed; and following agreements set up with local bodies or neighbourhoods, etc.

4.1.1 Criteria for triggering a formal assessment

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 the quantity of aircraft that transit the airspace or airport surface then an environmental assessment may be required.

The list below gives some examples of significant or long-term changes (which affect the routine operating 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
- Re-classification 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

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.

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.

Where applicable, environmental assessments may also be used to demonstrate the changes to 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.

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)

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 criteria should broaden, rather than constrain, the extent of any assessment.

4.1.2 Regulatory compliance

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.

As the applicability, scope and nature of such regulations will vary globally, an appendix (Appendix 1) will be provided to help indicate the different elements that may need to be addressed during the different steps, and include a non-exhaustive list of examples of such regulations and guidance..

4.1.3 Environmental parameters to be assessed

The most common environmental issues from operational changes are noise, air quality, fuel consumption and greenhouse gases, though there may be others that need to be assessed.

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 take care of an 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.

Noise:

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

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 (NPRs))
- the prevailing weather conditions
- the topography of the airport and surrounding area
- the position and extent of local conurbations
- the operating procedures used
- general operating conditions

In addition, the way that an individual 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.

Air Quality:

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:

- NO_x – oxides of nitrogen, a mixture of nitrogen dioxide (NO₂) and nitrogen monoxide (NO)
- VOC – volatile organic compounds (including non-methane hydrocarbons (NMHC))
- CO – carbon monoxide
- PM – fine Particulate matter, the most common concern is for those with a mean aerodynamic diameter less than 10 µm (PM₁₀) and 2.5 µm (PM_{2.5})
- SO_x – oxides of sulphur

These emissions species can in turn become involved in the broader environmental issues related to ground level ozone, photochemical smog and other impacts.

Additional emission species of potential health and environmental concern may also need to be considered in emission inventories including so called hazardous air pollutants (HAPs). HAPs research is still at an early stage and it should be noted that knowledge of emission factors is therefore very limited for many of these species.

Fuel Consumption and Greenhouse Gasses:

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% carbon dioxide (CO₂), slightly less than 30% water vapour (H₂O), and less than 1% of a number of other emissions, which include oxides of nitrogen (NO_x), carbon monoxide (CO), oxides of sulphur (SO_x), 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.

The effects of these 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 (N₂O) emissions occur from modern gas turbines and, although methane (CH₄) may be emitted during idle, very little is emitted during other operational phases.

Other impacts

Additionally, when analysing airport related environmental impacts, attention may also be required to look at effects associated with water quality, ecology, etc. where these may be adversely affected by operational changes.

An appendix (Appendix 3) will be provided to give more detailed information along with a description of some common metrics in use to describe these environmental impacts.

4.1.4 Documentation, Communication and Reporting

A vital part of any assessment is the effective documentation, communication and reporting of the process and the results. It is an important part of any process 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 their views 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, helping to avoid problems after any changes have been implemented.

Throughout the process of conducting an assessment, it is important to document and appropriately communicate 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 local situation.

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 stakeholders groups and, where appropriate, individual stakeholders are methods that may be adopted.

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.

4.2 Environmental Assessment Steps

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 the flowchart below, and the four key steps are described in more detail later below.

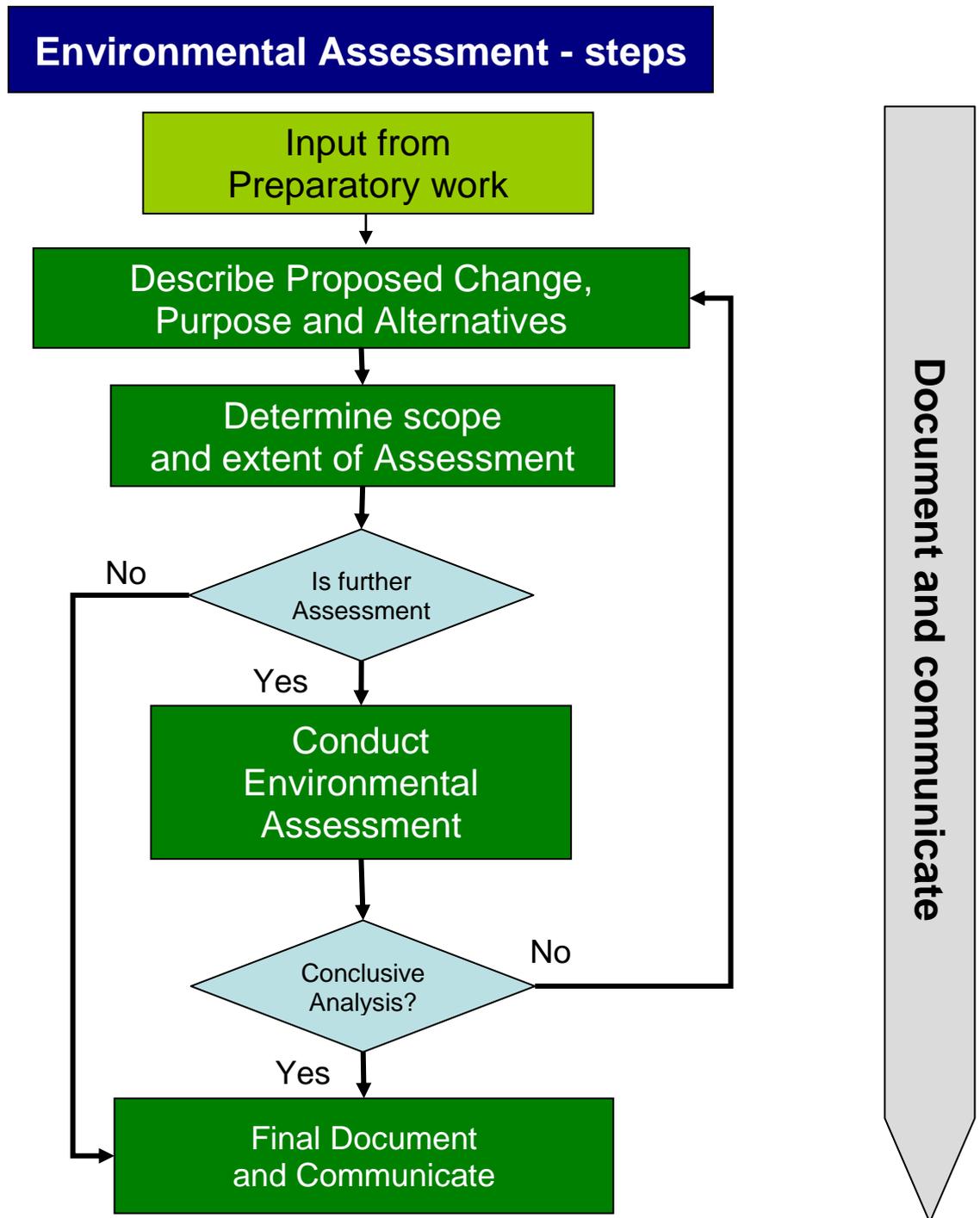


Figure 4.2-1 – Environmental Review Process

The advice in this section, assumes that the guidance given in the preliminary steps described in section 4.1 have already been followed. It is also assumes that, where

appropriate, the baseline information has been identified, gathered and is ready for use in the assessment process outlined in this section.

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.

4.2.1 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 are covered:

- What is the proposed change?
 - This should be a detailed description of the changes being proposed including what they are designed 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.
- 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 and runway use with fleet and operations forecasting, or by use of simulation modelling. Future proposals for larger projects are usually predicted through simulation modelling.

4.2.2 Determine scope and extent of assessment required

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 adding undue unnecessary 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:

An appendix (Appendix 2) will be provided to give additional information.

- 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 may also need to be evaluated before finalising the scope and extent of the environmental assessment.

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

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. Make a preliminary appraisal of the intensity of any environmental impacts and decide the scope and extent of the environmental analysis that needs to be performed.

- What geographic study area (GSA) should be used for the environmental assessment?

The GSA of an environmental assessment should be carefully defined early in the assessment to ensure it is appropriate for the type of study being performed. This needs to be large enough 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 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: e.g. the GSA for the noise analysis may be different than the GSA for a greenhouse gas analysis due to differences in the nature of the impact.

- Is screening required?

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 on the extent of the analyses to include in an assessment will have to be made.

- 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 dictate more intense levels of analysis than would normally be required. Consider if there are other circumstances related to the location or change that will affect the scope of the assessment.

When narrowing the scope and extent of environmental assessment, it is important to document the process(es) used, organizations consulted, and 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.

4.2.3 Conduct an assessment

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

Preparation

In preparing and conducting the assessment, the following items need to be considered:

- Very often, the environmental assessment is part of a larger exercise where other factors, such as safety, capacity, cost etc, may be being assessed as well. In this case, an overall planning strategy and validation plan may be established. The way the results from the different assessments can be combined into a business case will need to be clarified. This could drive particular requirements for the environmental assessment.

- 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), fast-time or real-time simulators. In some cases procedure design software may be used. Live flight trials may also be envisaged in certain cases.
- If using simulator or information from live trials the data required in order to drive the environment model should be defined as early as possible in the planning phase. This way any necessary interfaces required can be developed.
- Before starting the assessment, data quality and data availability versus required data must 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 made to obtaining required data in an indirect way, for example deriving it from already known information, running specific field surveys, etc. If data coverage is determined to be too small in order 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.

Assessment

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

An appendix (Appendix 3) will be provided to give more detailed information along with a description of some common metrics in use to describe these environmental impacts.

- Any gaps 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. Maybe the tool cannot fully capture the full nature of the change. This should be well documented and understood before the analysis is undertaken.

An appendix (Appendix 4) will be provided to give more detailed information on risk assessment.

- 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 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).

An appendix (Appendix 6) will be provided to give more detailed information on the differences and the advantages and disadvantages of each approach.

Analysis of Results

- The final part of conducting an assessment is analysing the results. Results may need to be compared to the expected outcomes, or targets, defined using well identified metrics. It may be that during the assessment, certain constraints or limitations may have become 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 in the case that the situation degrades one or more impact areas (i.e. environmental impact is worse) – then this 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 a conclusion regarding the environmental implications that can be made from the assessment. Where no conclusion can be made, the process may need to return to the start.

4.2.4 Final Documentation, Communication, and Reporting

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. Documentation of 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, then 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 or limitations of the analytical approach.

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.

Communication with stakeholders is also an important aspect to finalizing an assessment process. Frequently, the final report will be provided to stakeholders consulted during the process 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.

4.3 Interdependencies and trade-offs

The environmental footprint of aircraft operations is influenced by the location and altitude of flight paths, the manner in which an aircraft is operated (e.g. thrust level), and the number of aircraft operations. When performing an environmental assessment and using the results to inform decision-making, an important aspect is considering interdependencies or tradeoffs of the proposed action and/or alternatives. Note in the context of this document, the term interdependency refers to a situation where a change in quantity A results in a change to quantity B. The term trade-off is used to describe an interdependency where an improvement in quantity A results in a detrimental change in Quantity B.

There are some aircraft operations that have the potential to offer improvements in a number of areas, with no significant environmental trade-off – though there may well be other, non-environmental impacts. However, in many cases, the optimization of aircraft operations to reduce one type of environmental impact (e.g. aircraft noise) may lead to an increase for another environmental impact (e.g. aviation emissions), and possibly non-environmental effects as well. In these cases, the balance and optimization of impacts should be based on State and local policy and site-specific considerations. Therefore, an environmental assessment should consider and evaluate all reasonable options for managing environmental, and non-environmental, impacts including “compromise” options that manage tradeoffs between different impact areas (e.g. tradeoffs between noise and emissions, airspace flexibility and capacity, etc.).

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

4.3.1 Environmental Interdependencies

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.

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., NO_x), or shift noise impacts from one area to another.

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.

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.

4.3.2 Non-Environmental Interdependencies

The management of the air navigation system performance covers a broad spectrum of subjects: safety, security, environment, capacity, flexibility, predictability, etc. Many of these areas are mutually interdependent, which means that improving the performance in one area can come at the price of reduced performance in another area. This type of dilemma leads to the need for a more objective approach to the overall performance of the system.

This approach will inherently be the result of trade-off decision-making process between the various performance objectives and targets.

Preferably, innovative solutions should be chosen which are able to overcome the need for (some of the) trade-offs. History is full of examples where trade-offs were once necessary due to certain (technical or operational) limitations. Together with the elimination of those limitations, the need for trade-offs has disappeared.

However, if trade-offs are unavoidable, there is a need to make decisions based on priorities between the objectives and targets.

Optimum balance as a performance objective

This objective approach to overall performance implies the aim to achieve some “optimum performance” across different performance areas, objectives, metrics, etc. Such an aim should be treated as a true 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.

Trade-offs between key performance areas (KPAs)

Examples of the need to balance performance between KPAs include:

- 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 capacity.
- 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.
- Access versus capacity: the access of all aircraft, irrespective of their equipage or size, to a certain airspace or airport can have an impact on the capacity provided.

To improve overall performance when there are interdependencies, one must first determine if there are conflicting objectives that need to be balanced. When conflicting objectives emerge, techniques from multi-criteria decision-making (MCDM) should be applied. A detailed treatment of methods in this area is beyond the scope of this manual.

When considering trades between key performance indicators (KPIs), differences between two alternatives can result in an improvement or degradation in the values of different KPIs. Decision-makers must determine which choices represent

acceptable trades. In the air navigation system, there are many examples of this type of trade. Examples include: fuel consumed versus delay or level of inequity versus system-wide delay.

Suggested approach

To deal with the issue of performance trade-offs in an effective way, the subject should be approached in a careful, stepwise fashion:

- Start without immediately attempting to include trade-off considerations. This simplifies the discussions and permits a better focus on what should be achieved in each KPA to meet the expectations. During this step, one should define the various performance objectives and set initial (pre-trade-off) targets.
- As part of identifying candidate solutions to mitigate the effects of selected drivers and blocking factors, the expected performance of each solution should be assessed. At the same time, lateral interdependencies between KPAs and network effects leading to trade-offs need to be analysed and discussed within the aviation community.
- Using the shared understanding developed during the previous step, multi-criteria decision analysis (MCDA) techniques can be applied to select a suitable set of solutions. At this stage, the combined performance of the entire solution set should be assessed. In some cases, this may reveal that the initial targets are incompatible and that priorities need to be defined and a trade-off choice needs to be made.

In summary, after the initial target setting, the performance management process must take account of the identified interdependencies and trade-off aspects. Where the simultaneous meeting of different targets is not possible, the balance between targets must be adjusted so that they reflect an acceptable and feasible compromise.

Appendix 1 – Examples of Formal requirements and Guidance for Environmental Assessments

Appendix 2 – Determining the scope and extent of the assessment

Appendix 3 – Assessment Methodologies and Key Environmental Parameters

Appendix 4 – Risk assessment

Appendix 5 – Assessment Examples

Appendix 6 – Relative and Absolute Assessments

Glossary

Symbols and Units

Abbreviations

Definitions

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