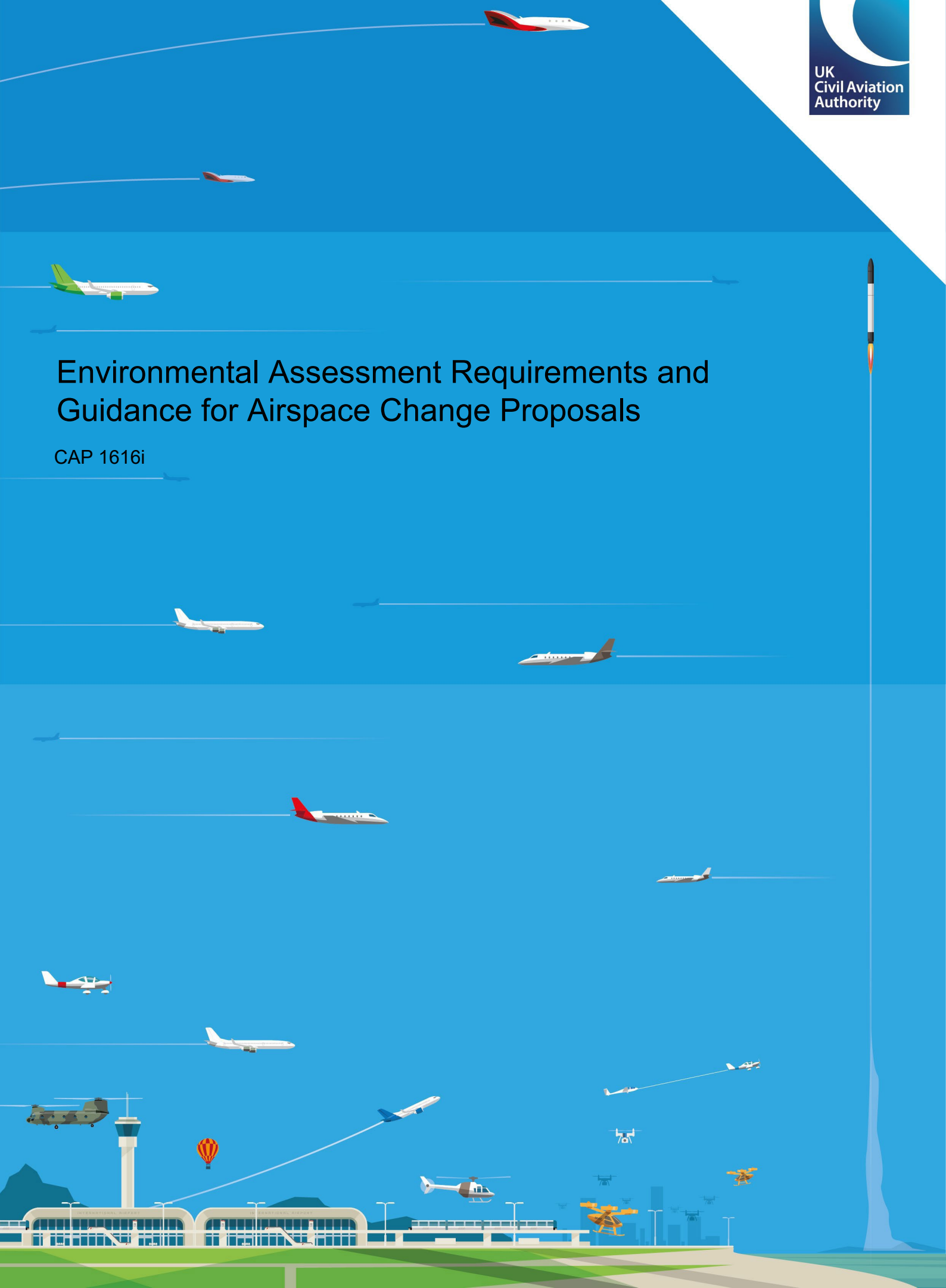
UK Civil Aviation Authority

Environmental Assessment Requirements and Guidance for Airspace Change Proposals

CAP 1616i



Published by the Civil Aviation Authority, November 2023

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First published November 2023

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The latest version of this document is available in electronic format at: www.caa.co.uk

Contents

Revision history

1. In response to feedback received during the review of the CAP 1616 airspace change process we have delivered a package of improvements that makes the airspace change process easier to understand and clarifies the requirements needed to be met to progress an airspace change proposal. As part of those improvements, we have consolidated the requirements and guidance on performing environmental assessments for airspace change proposals in CAP 1616i, Environmental Assessment Requirements and Guidance for Airspace Change Proposals.

2. This documents also contains additional environmental assessment requirements and guidance for airspace change proposals which facilitate vertical spaceflight activities and on performing habitats regulations assessments.

Chapter 1
Introduction

Who is this Document for?

1.1 This document is predominantly written for change sponsors. Anyone can sponsor an airspace change proposal, although it is most often an airport/spaceport operator, an air navigation service provider or a potential operator of a new or innovative aircraft type. In some cases, the change sponsor will work in partnership with other organisations (for example, aviation/airspace consultancy firms, approved procedure design organisations) when developing their airspace change proposal. However, the change sponsor remains solely responsible for complying with the airspace change process, and any UK and international airspace design policy requirements that they are required to take account of when developing their airspace change proposal. This document may also be of benefit to others who have an interest in the airspace change process.

Purpose of the Document

1.2 This document provides requirements and guidance on performing environmental assessments that must be undertaken for all airspace change proposals.

1.3 To avoid repetition, many environmental requirements are specified in CAP 1616, Airspace Change Process; CAP 1616f, Guidance on Airspace Change Process for Permanent Airspace Change Proposals; CAP 1616g, Guidance on Airspace Change Process for Temporary and Trial Airspace Change Proposals; and CAP 1616h, Guidance on Airspace Change Process for Level 3 and Pre-Scaled Airspace Change Proposals. Change sponsors must read this document in conjunction with CAP 1616, CAP 1616f, CAP 1616g and CAP 1616h.

How can the Civil Aviation Authority (CAA) Provide Guidance?

1.4 The CAA is the airspace regulator and primary decision-maker, and responsible for administering the airspace change process and providing guidance on the process to stakeholders. The CAA must develop this process in accordance with directions and environmental guidance provided by the Secretary of State. Additionally, the process is designed to enable the CAA to comply with its statutory duties.

1.5 Throughout the development of an airspace change proposal, change sponsors may seek guidance on the requirements of the process from the CAA's Airspace Regulation team. However, the most appropriate opportunity to provide change sponsors with guidance is following a gateway. The basic premise of the CAA

providing guidance is that it is focussed on offering information and support to change sponsors on the application of the airspace change process and understanding their responsibilities, technical matters relating to airspace change, highlighting appropriate policy requirements and other exemplar airspace change proposals.

1.6 It is important to note that this guidance does not constitute advice on the specific course of action change sponsors should take. However, there may be circumstances where we are required to direct the change sponsor to address specific matters such as a safety-related issue or compliance with national and international regulations and government policies. In such cases, we will clearly communicate the reasons for the guidance and publish it on the airspace change portal.

Definitions

1.7 Throughout this document, the degree of compliance expected is based on the following definitions:

- '**will**' or '**must**' is used to refer to requirements that **must** be met in full, unless it has been agreed in advance with the CAA that it would be disproportionate to do so
- '**should**' is used to refer to a requirement that is expected to be met in full, unless the change sponsor provides an acceptable rationale (within their submissions) that it would be disproportionate to do so
- '**may**' is used to refer to an action that the change sponsor is encouraged to consider taking. Given the unique circumstances of each airspace change proposal, there **may** be instances where we might instruct the change sponsor to take specific action.

Chapter 2

Scope of the Environmental Assessment

2.1 Consideration and assessment of the potential environmental impacts resulting from an airspace change proposal is a necessary part of the CAA's decision-making process, and also enables those who are affected by the proposed airspace change to better understand the impacts of the different design options being considered. In order to achieve this, the CAA requires change sponsors to provide an environmental assessment that evolves through the various stages of the airspace change process.

2.2 Note that throughout this document, all altitude figures in feet are expressed in feet above mean sea level (AMSL), unless specified otherwise.

Accordance with Government Policy

2.3 Section 70 of the Transport Act 2000 states that after maintaining a high standard of safety in the provision of air traffic services, the CAA must "take account of any guidance on environmental objectives given to the CAA by the Secretary of State after the coming into force of this section" when exercising its air navigation functions (among other factors). The CAA's air navigation functions include making decisions on airspace change proposals and the guidance from the Secretary of State on environmental objectives is the Air Navigation Guidance 2017. While developing and assessing the environmental impacts of airspace change design options, change sponsors **must** take into account the Air Navigation Guidance 2017, including the Government's environmental objectives and altitude-based priorities as set out in that guidance.

2.4 The environmental objectives with respect to air navigation are designed to minimise the environmental impact of aviation within the context of supporting a strong and sustainable aviation sector. The Government's key environmental objectives are, in support of sustainable development, to:

a) "limit and, where possible, reduce the number of people in the UK significantly affected by adverse impacts from aircraft noise;

b) ensure that the aviation sector makes a significant and cost-effective contribution towards reducing global emissions; and

c) minimise local air quality emissions and in particular ensure that the UK complies with its international obligations on air quality."

2.5 For the purposes of assessing environmental impacts of airspace change proposals, the Government's priorities for consideration of the environmental impacts are set out below and must be taken into account during the

development, appraisal and discontinuation of all design options assessed during the airspace change process:

"…the CAA should apply the following altitude-based priorities of the Government:

a) in the airspace from the ground to below 4,000 feet, the Government's environmental priority is to limit and, where possible, reduce the total adverse effects on people;

b) where options for route design from the ground to below 4,000 feet are similar in terms of the number of people affected by total adverse noise effects, preference should be given to that option which is most consistent with existing published airspace arrangements;

c) in the airspace at or above 4,000 feet to below 7,000 feet, the environmental priority should continue to be minimising the impact of aviation noise in a manner consistent with the Government's overall policy on aviation noise, unless the CAA is satisfied that the evidence presented by the change sponsor demonstrates this would disproportionately increase CO_2 emissions;

d) in the airspace at or above 7,000 feet, the CAA should prioritise the reduction of aircraft CO_2 emissions and the minimising of noise is no longer the priority;

e) where practicable, it is desirable that airspace routes below 7,000 feet should seek to avoid flying over Areas of Outstanding Natural Beauty (AONB) and National Parks; and

f) all changes below 7,000 feet should take into account local circumstances in the development of the airspace design, including the actual height of the ground level being overflown, and should not be agreed to by the CAA before appropriate community engagement has been conducted by the sponsor."

2.6 The Government's noise policy is "to limit, and, where, possible, reduce the number of people in the UK significantly affected by adverse impacts from aircraft noise". For the purpose of assessing airspace change proposals, the Government wishes the CAA to interpret this objective to mean that the total adverse effects on people as a result of aviation noise should be limited and, where possible, reduced, rather than the absolute number of people in any particular noise contour. Therefore, from a noise perspective, it may on occasions be better to have multiple concentrated routes that share noise among more people, than a single concentrated route which affects fewer people but to a greater extent. Rather than a 'one size fits all' approach to whether single or multiple routes are better, change sponsors must consider the impacts of different options and decide what will work better in a given situation. These decisions should be informed by considering the anticipated noise impacts, and through engagement with communities.

2.7 The Air Navigation Guidance 2017 also recognises that given the finite amount of airspace available in the UK, and the fixed location of airports and National Parks or Areas of Outstanding National Beauty (AONBs), it will not always be possible to completely avoid overflying National Parks or AONBs, and that there are no legislative requirements to do so as this would be impractical. The Government's policy continues to focus on limiting and, where possible, reducing the number of people significantly affected by adverse impacts from aircraft noise and the impacts on health and quality of life associated with them. As a consequence, this is likely to mean that one of the key principles involved in airspace design will be avoiding overflight of populated areas below 7,000 feet. Nonetheless, in line with the altitude-based priorities, change sponsors should seek to avoid flying over National Parks or AONBs, and they must show how they have considered and taken account of this impact as part of their options development and final design.

2.8 In terms of impacts on biodiversity, the CAA has various duties including under the Natural Environment and Rural Communities Act 2006, the Wildlife and Countryside Act 1981 and the Conservation of Habitats and Species Regulations 2017.

2.9 Part 6, Chapter 1 of the Conservation of Habitats and Species Regulations 2017 requires that airspace change proposals which are likely to have a significant effect - either alone or in combination with other plans or projects - on European sites[1] must be subject to an appropriate assessment of their potential adverse effects on the integrity of those sites. This is known as a habitats regulations assessment which also includes consideration of any mitigation measures to reduce adverse effects.

2.10 The CAA is the competent authority under the Conservation of Habitats and Species Regulations 2017. This means that the CAA may only approve an airspace change proposal if satisfied that it will not adversely affect the integrity of one or more European sites, unless there are no alternative solutions, and the proposal must nevertheless be approved for imperative reasons of overriding public interest. However, in such cases, change sponsors must satisfy the CAA that sufficient compensatory measures will be implemented to ensure the overall coherence of the national site network of European sites.

2.11 Additionally, under the Natural Environment and Rural Communities Act 2006, the CAA has a duty to regularly consider what action we can properly take, consistent with the proper exercise of our functions, to further the conservation

[1] European sites consist of Special Areas of Conservation (SAC) and possible SACs, Special Protection Areas (SPA) and potential SPAs, Ramsar sites and proposed Ramsar sites, and compensatory habitat (areas secured to compensate for damage to SACs, SPAs and Ramsar sites).

and enhancement of biodiversity in England[2]. We must then determine what policies and specific objectives are appropriate for taking that action. Similar duties to enhance the conservation of biodiversity exist in respect of Northern Ireland[3], Scotland[4] and Wales[5].

Scalability

2.12 The requirements for the environmental assessment are scalable and proportionate, primarily determined by the characteristics of the change and potential for impacts, which is in part based on the altitude and location in which the changes occur.

2.13 The CAA would expect airspace changes that have the potential to alter flight behaviours below 7,000 feet over land to be assigned as Level 1. These are airspace changes that **will** require detailed consideration of changes to aircraft noise exposure in the vicinity of the airspace change and an assessment using the Department for Transport's transport analysis guidance (TAG). A Level 1 change **will** also require a quantified assessment of fuel and greenhouse gas impacts of the airspace change proposal, and monetised using TAG. Other metrics such as overflight, local air quality, tranquillity and biodiversity **will** also require assessment. All environmental metrics **will** require assessment over a 10-year forecast period.

2.14 The CAA would expect airspace changes that have the potential to alter flight behaviours above 7,000 feet or alter flight behaviours below 7,000 feet over sea and not alter flight behaviours below 7,000 feet over land to be assigned as Level 2. The Air Navigation Guidance 2017 determines that noise impacts are not a priority for consideration for these airspace changes. Therefore, for Level 2 changes, a quantified assessment of fuel and greenhouse gas impacts of the airspace change proposal, and monetised using TAG **will** be required. Longer-term greenhouse gas emissions based on a 10-year forecast period **will** also be required.

2.15 For Level 3 changes, a set of minimum requirements are detailed in CAP 1616h, Guidance on Airspace Change Process for Level 3 and Pre-Scaled Airspace Change Proposals. These minimum requirements may be supplemented with the requirements for Level 1 and 2 changes at the discretion of the CAA depending on the nature of the Level 3 airspace change proposal.

[2] Natural Environment and Rural Communities Act 2006

[3] Wildlife and Natural Environment Act (Northern Ireland 2011, section 1).

[4] Nature Conservation (Scotland) Act 2004, section 1.

[5] Environment (Wales) Act 2016, section 6.

2.16 The requirements for an environmental assessment include a number of specific metrics that must be used in order to derive a quantitative output, as set out in this guidance. However, irrespective of the level of the airspace change proposal, if a change sponsor believes that a quantitative assessment using the metrics identified by the CAA will result in no difference in the outputs for a metric (that is, neither the pre- and post-implementation scenario, nor the forecast scenarios are affected by the airspace change proposal for that metric), then a qualitative assessment of that impact may be used instead.

2.17 In such circumstances, change sponsors **must** present a robust rationale supported with appropriate evidence to the CAA justifying that undertaking a specific metric or quantitative assessment of a proposed option would result in no environmental impact. After consideration, the CAA will confirm whether or not we have accepted the case made by the change sponsor. If the CAA is satisfied with the rationale and supporting evidence provided, then there will be no need to undertake that assessment. In all instances, if the CAA agrees and accepts the change sponsor's rationale, that same rationale plus the supporting evidence **must** be clearly explained in any consultation material and in the final airspace change proposal submitted to the CAA.

Direct and Consequential Impacts

2.18 Change sponsors **must** consider the environmental impacts resulting from its direct airspace operations as well as any environmental impacts caused due to indirect consequential changes on the flight behaviour of other airspace users. For example, an airspace change may have no direct environmental impacts, however, may cause a change in the flight patterns of other airspace users at another location, such as a concentration of flight tracks leading to an increase in noise levels or a rerouting around the proposed airspace change causing an increase in miles flown and thereby greenhouse gas emissions.

Airspace Change Proposals Sponsored by the Ministry of Defence

2.19 The Ministry of Defence need only ever assess the anticipated environmental impacts of the consequential changes on civil aviation patterns. Environmental impacts that are a direct result of military aircraft or military operations (including civil aircraft carrying out military function under contract) are not required to be considered or assessed. Consequential environmental impacts from other airspace users (i.e., civil aviation) that are a result of the airspace change proposal **must** be assessed in accordance with Level 1, Level 2 or Level 3 requirements. For example, if the airspace change proposal is likely to have an effect upon general aviation activity and/or traffic patterns, then environmental impacts from that effect (such as noise) must be appropriately considered and assessed and reflected in consultation material.

Linked Airspace Change Proposals

2.20 If an airspace change proposal is linked in any way with another airspace change proposal (for example, it is either contingent upon or an enabler for, or is part of a 'phased' implementation programme of changes) this link must be clearly identified through the engagement and consultation processes, and in the final airspace change proposal submitted to the CAA.

2.21 The environmental impacts of the linked proposals **must** be assessed on a combined basis, for example, if the cumulative noise impacts for two or more airports are above the lowest observed adverse effect level (LOAEL), 51 dB $L_{Aeq,16h}$ daytime and 45 dB $L_{Aeq,8h}$ night-time. Change sponsors **must** discuss and agree their methodology for the combined environmental assessment with the CAA.

Chapter 3

Inputs to the Environmental Assessment

Baseline Scenarios and Traffic Forecasts

3.1 The environmental assessment will be informed by clearly described scenarios for the future baseline scenarios without the airspace change proposal and the design options with the proposed airspace change. Traffic forecasts are essential to the airspace change process, not only providing justification for changes, but also enabling the impact of changes to be properly considered. The amount of air traffic is an important consideration in the environmental assessment of airspace changes and change sponsors **must** therefore include information on the current level of traffic using the present airspace arrangement and a forecast.

3.2 The forecast will need to indicate the traffic growth on the different routes contained within the airspace change volume. For some airspace change proposals it may be necessary for traffic forecasts to contain not only numbers but also types of aircraft, particularly if the mix of aircraft types is expected to change over the period of the forecasts. Where such a change in fleet mix is anticipated, change sponsors **must** ensure that it is considered and if necessary, reflected in the traffic forecasts.

3.3 There are considerable uncertainties in forecasting growth in air traffic as forecasting is not an exact science. There are many factors outside the control of change sponsors, but they should aim to be as robust as possible in their calculations.

3.4 Change sponsors **must** provide traffic forecasts for year 1 and year 10. Change sponsors may provide traffic forecasts for the intermediate years within this 10-year period as supporting evidence.

3.5 The design options **must** be assessed against baseline scenarios with no airspace change in the same two years such that the assessment comparisons are:

- year of implementation with the proposed airspace change vs the same year without the proposed airspace change (year 1)
- 10 years after implementation with the proposed airspace change vs the same year without the proposed airspace change (year 10).

3.6 Please refer to CAP 1616f, Guidance on Airspace Change Process for Permanent Airspace Change Proposals for more details.

3.7 Please also refer to the chapters associated with each environmental metric in this document for additional details.

Chapter 4

Environmental Assessment Outputs

4.1 Once design options have been developed, their resulting environmental impacts will need to be assessed and that information provided to stakeholders. The following chapters provide guidance on the expected forms of information required and, in some cases, the precise form that the information must have.

4.2 Change sponsors should present information on environmental assessments in ways that are clear and accurate, without omitting essential detail, but which can be readily understood by a non-technical audience. For example, operational diagrams should be considered as communication tools with limited applicability in the assessment process. There is a proportionate balance to be struck between the amount of data produced and the degree to which this information actually helps the audience to understand the key issues.

Monetising Environmental Impacts

4.3 TAG is the Department for Transport's suite of guidance on how to assess the expected impacts of transport policy proposals and projects. It includes a series of guides and spreadsheet tools based on up-to-date evidence following the principles of HM Treasury's The Green Book.

4.4 During the options appraisals, change sponsors **must** monetise the environmental impacts of the airspace change using the TAG: environmental impacts worksheets. Note that this suite of environmental impacts worksheets includes an aviation specific noise workbook.

4.5 The environmental impacts are monetised as an annual cost over the 10-year appraisal period and the output is the net present value of the change in noise exposure/greenhouse gas emissions/local air quality emissions.

4.6 More information on using these tools is given in TAG unit A3 environmental impacts, TAG unit A5-2 aviation appraisal and in Annex C of the Air Navigation Guidance 2017.

Chapter 5
Noise

General Principles for Noise Modelling

Minimum Standards for Noise Modelling

5.1 In January 2021, the CAA published CAP 2091, CAA Policy on Minimum Standards for Noise Modelling. The CAP 2091 policy specifies the minimum acceptable level of sophistication of noise modelling that can be used to provide the CAA with the outputs required for an airspace change proposal.

5.2 The sophistication with which the CAA require an airport to model noise depends on the number of people exposed to noise at that airport. The more people exposed, the greater the sophistication that is required to be used. The category of noise modelling required by the CAA is based on the highest category calculated for their 51 dB $L_{Aeq,16h}$ daytime and 45 dB $L_{Aeq,8h}$ night-time contours for the 10-year forecast period (either before or after the proposed airspace change, whichever is greater).

5.3 As part of the Stage 2 submission (or earlier if preferred), change sponsors applying for an airspace change proposal **must** justify to the CAA which category their noise modelling methodology is required to fall into, and which category it currently falls into. Change sponsors will not be permitted to proceed with their application until they can demonstrate that the methodology which they have used is at least at the level of the minimum required category as defined by CAP 2091.

5.4 It will be acceptable for change sponsors to use their current noise modelling methodology to undertake the CAP 2091 category assessment, even if the assessment shows that the change sponsor needs to improve their noise modelling methodology in order to complete the options appraisals. At all times, it will be for change sponsors to justify their decision not to meet the relevant category.

5.5 If a change sponsor has no current noise modelling methodology, then it will be acceptable for them to use Category E to demonstrate the correct category that applies to that airport.

5.6 Some airports may already be providing noise modelling at a higher category than the minimum required here. The CAA expect these arrangements to persist, and no change sponsor must do less in terms of its noise modelling than it did before.

Noise Modelling Software

5.7 The noise contours **must** be produced using a recognised and validated noise model such as the UK CAA Aircraft Noise Contour Model (ANCON), EUROCONTROL IMPACT or the US Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT). For consistency and comparison purposes, if a noise model is already in use at an airport, the same model should be used for the assessment of any airspace change proposal related to that airport.

Runway Modal Split

5.8 Runway usage can vary considerably from year to year due to variations in wind direction. It is therefore recommended that average summer day contours be produced using long-term average runway usage. Where sufficient data is available this **should** be based on the last 20 years' runway usage. If less than 20 years' data is available, it should be based on best available data.

Terrain Adjustments

5.9 Terrain adjustments **must** be included in the calculation process to ensure that the height of the aircraft relative to the ground is accounted for. These corrections are limited to geometrical corrections for aircraft-receiver distances and elevation angles. It is not necessary to include consideration of other more complex effects, such as absorption of sound over uneven ground surfaces, noise screening or reflections from topographical features or buildings.

5.10 Change sponsors **must** confirm that this requirement has been reflected in its environmental assessment and provide details of any geographic areas where such adjustment has been necessary.

Flight Behaviours and Patterns

5.11 Some airspace designs simply define blocks of airspace for aircraft to pass through with no defined routes. However, near most airports, airspace design includes defined routes to be followed by aircraft. Aircraft cannot fly these routes as precisely as cars follow roads, and consequently the actual tracks flown are dispersed around the routes defined by the airspace design.

5.12 Airspace modernisation, for example, and the introduction of performance based navigation (PBN), will likely change the way routes are defined and may lead to aircraft flying such routes more precisely. This will concentrate aircraft and affect noise exposure and noise impacts. While the impacts of concentration will be captured via the use of the Department for Transport's TAG, the use of operational diagrams can be useful tools for change sponsors to explain and illustrate the anticipated effect of concentration on traffic patterns.

Dispersion variation around centrelines

5.13 Change sponsors will need to take account of this lateral flight path dispersion in their noise assessments as per the applicable CAP 2091 category. Change sponsors **must** take account of this degree of dispersion which may differ between the baseline scenarios and design options. This aspect **must** be applied to the noise assessment and the calculation of overflight.

5.14 Change sponsors **should** provide indications of the likely lateral dispersion of traffic about the centre line of each route. This should take the form of a statistical measure of variation such as the standard deviation of lateral distance from the centre line for given distances along track in circumstances where the dispersion is variable. Change sponsors may supply the outputs from simulation or trials to demonstrate the lateral dispersion of traffic within the proposed airspace change or bring forward evidence based on actual performance on a similar route. Change sponsors **must** explain different aspects of dispersion, for example, dispersion when following a departure routeing and when vectoring – where the aircraft will go and their likely frequency.

Flight profiles

5.15 Change sponsors **must** provide a description of the vertical distribution of traffic in airways, standard instrument departures, standard arrival procedures, instrument approach procedures, noise preferential routes (NPR) and other arrangements that have the effect of positioning traffic over a particular geographical area. For departing traffic, change sponsors **should** produce profiles of the most frequent type(s) of aircraft operating within the airspace. Change sponsors **should** show vertical profiles for the maximum, typical and minimum climb rates achievable by those aircraft. A vertical profile for the slowest climbing aircraft likely to use the airspace **should** also be produced. All profiles **should** be shown graphically, and the underlying data provided in a spreadsheet with all planning assumptions clearly documented.

Noise Metrics

5.16 When considering noise impacts, the CAA will weigh the outcomes from ‘primary’ metrics over ‘secondary’ metrics. Primary metrics will be those that are used to quantify total adverse noise effects, such as the Department for Transport’s TAG outputs. Secondary metrics will be those that are not being used to determine total adverse noise effects, but which are still able to convey noise effects, such as number above contours. While not a noise metric, overflight contours will be a secondary metric for the purposes of decision-making.

Primary Noise Metrics

Total Adverse Effects on People

5.17 Adverse effects are considered to be those related to health and quality of life. These adverse effects **must** be assessed using a risk-based approach above the lowest observed adverse effect level (LOAEL), 51 dB $L_{Aeq,16h}$ daytime and 45 dB $L_{Aeq,8h}$ night-time. Adverse effects of noise are determined through TAG calculated on the basis of changes in L_{Aeq} noise exposure.

Equivalent Continuous Noise Levels (L_{Aeq}) and Contours

5.18 Conventional noise exposure contours, which are produced regularly for major airports, **must** be calculated for an average summer day over the period from 16 June to 15 September inclusive, for traffic in the busiest 16 hours of the day, between 0700 and 2300 local time. These are known as L_{Aeq}, 16 hour contours, typically written as $L_{Aeq,16h}$. Where changes to airspace are proposed during night-time, aircraft noise **must** be calculated for an average summer night over the period from 16 June to 15 September inclusive, for traffic in the busiest eight hours of the night, between 2300 and 0700 local time. These are known as L_{Aeq}, 8 hour contours, written as $L_{Aeq,8h}$.

5.19 This calculation produces a cautious estimate of noise exposure (that is, it tends to over-estimate exposure). This is mainly because airports are generally busier during the summer and a higher number of movements is likely to produce higher L_{Aeq} values. Aircraft tend to climb less well in higher temperatures so, because they are closer to the ground, L_{Aeq} values will tend to be higher than in colder weather.

5.20 L_{Aeq} metrics and use of TAG to measure and portray the noise impacts **must** be used for all Level 1 airspace change proposals. However, in some cases change sponsors may believe that its proposed airspace change will not cause a change to the L_{Aeq} contours that will result in a demonstrable change in a measurable output (in other words, that the impact is not quantifiable using TAG). In such cases, change sponsors **must** provide a robust rationale along with supporting evidence why the proposed airspace change is unlikely to exceed or result in changes at and above the 51 dB $L_{Aeq,16h}$ for daytime and 45 dB $L_{Aeq,8h}$ for night-time noise. If the CAA accepts the change sponsor's justification and evidence, then L_{Aeq} contours may not be required. Evidence **must** be provided separately for each primary and secondary noise metric, the reason being that each noise metric may have a different geographic extent.

5.21 Contours **must** be portrayed from 51 dB $L_{Aeq,16h}$ (for daytime) and 45 dB $L_{Aeq,8h}$ (for night-time) at 3 dB intervals and overlaid on a suitable map, for example, 1:50 000 Ordnance Survey map. The underlying map and contours **must** be sufficiently clear for those who are affected to be able to identify the extent of the

contours in relation to their home and other geographical features. As such, the underlying map **must** show key geographical features, for example, streets, railway lines and rivers.

5.22 Change sponsors **must** portray $L_{Aeq,16h}$ daytime and $L_{Aeq,8h}$ night-time noise exposure contours as a means of explaining noise exposure for airports where the proposed option is likely to result in a change in traffic patterns, traffic volumes or fleet mix below 7,000 feet.

5.23 If L_{Aeq} contours are required, the following **must** be produced:

- current-day, for example, latest available noise contours
- year of implementation without the airspace change proposal (year 1)
- year of implementation with the airspace change proposal for each design option (year 1)
- 10 years after implementation without the airspace change proposal (year 10)
- 10 years after implementation with the airspace change proposal for each design option (year 10).

5.24 In order to explain noise exposure, a table **must** be produced showing the following data for each 3 dB contour interval:

- area (km2)
- population (thousands) – rounded to the nearest hundred
- noise sensitive buildings (for example, hospitals, places of worship, schools).

5.25 This table **must** show cumulative totals for areas and populations; for example, the population for 51 dB $L_{Aeq,16h}$ contour will include residents living in all higher contours. Typically, the total area impacted by noise increases by approximately 20% for a 1 dB increase in average source levels. The source and date of population data used **must** be specified; population data **must** be based on the most recent updated population data or the latest available national census.

5.26 It is sometimes useful to include the number of households within each contour, especially if issues of mitigation and compensation are relevant.

TAG Noise Workbook – Aviation

5.27 The output from the TAG noise workbook - aviation will form the primary measure of the noise impact for the purpose of the CAA's decision-making on a proposal.

5.28 Change sponsors **must** input the number of people experiencing an increase or decrease in 1 dB bands for the with airspace change and without airspace change scenarios for year 1 and year 10. Change sponsors must not input any

changes below the lowest observed adverse effect level (LOAEL), 51 dB $L_{Aeq,16h}$ daytime and 45 dB $L_{Aeq,8h}$ night-time. Change sponsors may find it easier to calculate noise exposure change at individual population receptors directly, rather than derive the data from noise contours.

5.29 The 'assessment method' in the workbook must be set to 'individual'. The 'appraisal period (years)' must also be set to 10 years. Whilst the workbook refers to the night noise metric as L_{night}, the input required is the average summer night, i.e., $L_{Aeq,8h}$.

5.30 A monetary value is assigned for the change in the following health impacts: amenity (annoyance), acute myocardial infarction (AMI), dementia, stroke, and sleep disturbance. Given that annoyance due to noise will be far more common than any of the other health factors (sleep disturbance, acute myocardial infarction (AMI, commonly referred to as a heart attack), stroke and dementia) it can often be the most dominant impact when health and quality of life are assessed. Therefore, in accordance with Department for Transport guidance, change sponsors can propose options that reduce the impacts of sleep disturbance, AMI, stroke or dementia even if this leads to increased annoyance.

Secondary Noise Metrics

Number Above Contours (N65 daytime and N60 night-time)

5.31 Number above contours show the locations where the number of events (i.e., flights) exceeds a pre-determined noise level, expressed in dB L_{ASmax}. For example, N65 contours show the number of events where the noise level from those flights exceeds 65 dB L_{ASmax}. Change sponsors **must** present N65 daytime and N60 night-time contours as part of their noise assessment. Contours ranging from five events and above **should** be plotted.

5.32 The modelling assumptions and input data used for the number above contours **must** be consistent with those used for the production of L_{Aeq} contours. As with L_{Aeq} contours, the N65 contours **must** reflect a long-term average summer day (16 hours, from 0700 to 2300) and the N60 contours **must** reflect a long-term average summer night (8 hours, 2300 to 0700), using actual runway usage and including all air traffic movements.

Overflight Contours

5.33 The measurement of 'overflight' is a secondary metric that can be useful for explaining the operational impacts of airspace change proposals. These are a means of defining and portraying the pattern and dispersion of aircraft below 7,000 feet, and the frequency that they occur. They are based upon a perception of overflight – they do not illustrate noise impacts.

5.34 The CAA has developed an approach to calculating and portraying traffic patterns so that stakeholders, especially communities close to airports, can better understand existing aircraft movements and how this might be expected to change as a result of an airspace change proposal. The CAA publication CAP 1498, Definition of Overflight presents a definition of 'overflight' based on the angle of elevation between a person on the ground and an aircraft in the sky. The report suggests two elevation angles, 60° and 48.5°. Change sponsors **must** use a 48.5° angle for representation of overflight.

5.35 The modelling assumptions and input data used for the overflight contours **must** be consistent with those used for the production of L_{Aeq} contours. Change sponsors **must** present number of daytime and night-time overflights with population overflown as part of their assessment. Contours ranging from five overflights and above **should** be plotted. As the overflight metric does not reflect noise impacts, there is no need to produce an area count or to identify noise-sensitive buildings.

Operational Diagrams

5.36 Operational diagrams portray a representation of how the airspace is to be used. These diagrams are used to illustrate the patterns of current or anticipated aircraft movements on geographical maps and are often based upon radar track data.

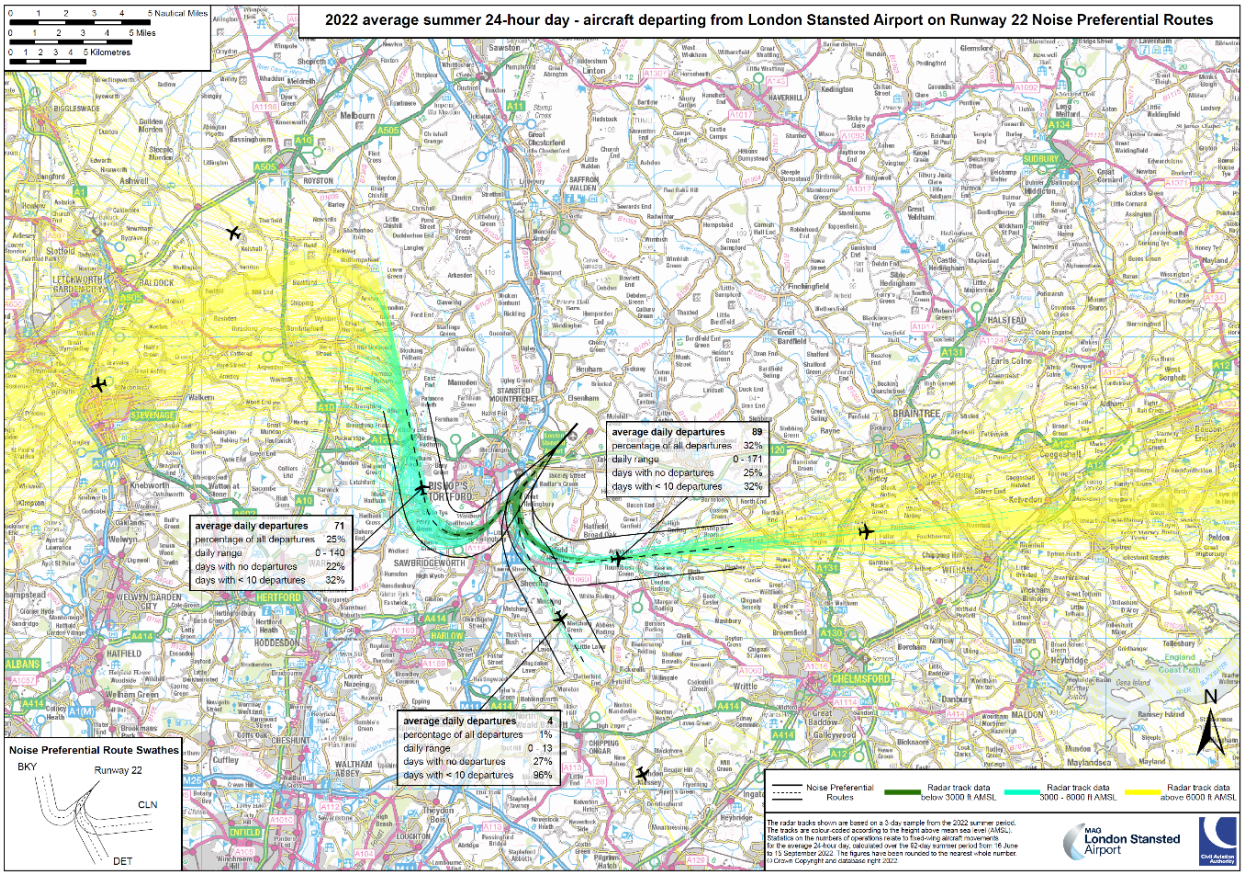
5.37 Operational diagrams **must** be overlaid on high-quality maps, for example, Ordnance Survey, and must show the extent of the airspace change in relation to known geographical features and centres of population. The maps **must** be clearly legible and have sufficient detail to enable affected communities in identifying their location in relation to the changes in traffic patterns.

5.38 As shown in Figure 1, for each route, a box with information about the distribution of air traffic is shown on a diagram of the airspace overlaid on a map. Each box can include the following information (change sponsors may vary the information displayed providing that the diagram is a fair and accurate representation of the situation portrayed):

- average number of daily movements (possibly further broken down by hour)
- percentage of all aircraft movements at the airport using that route
- minimum and maximum number of daily movements
- percentage of days with no movements.

5.39 Operational diagrams do not portray noise impacts, nor use or contain any information about noise levels but they can assist in people's understanding of the change, especially when viewed in conjunction with noise metrics.

Figure 1: Example of an operational diagram



Additional Noise Metrics

5.40 Change sponsors **should** present additional analysis on any of the noise impacts if they feel it would aid stakeholders' understanding of those impacts. For example, additional noise metrics may be considered appropriate following engagement with local communities.

Maximum Spot Point Noise Levels (L_{ASmax})

5.41 Change sponsors **should** produce diagrams portraying maximum sound event levels (L_{ASmax}) for specific aircraft types at a number of key locations (as identified via engagement or consultation). The height of these key locations **must** be taken into account while calculating the L_{ASmax} levels.

5.42 If the L_{ASmax} is used, it is recommended that typical and noisiest aircraft types are portrayed, at typical and 'worst case' altitudes. Information about the frequency of flights on a route-by-route basis (both currently and forecast) is also recommended to aid understanding of the anticipated impacts.

100% Mode L_{Aeq} Noise Contours

5.43 Since a runway can be used in one of two directions, there will be two 100% mode L_{Aeq} noise contours, one for each runway direction. 100% mode L_{Aeq} noise contours portray averaged noise impacts based on single direction runaway usage rather than the standard method of reflected actual or forecast runway usage. The modelling assumptions and input data used for the 100% mode L_{Aeq} contours **must** be consistent with those used for the production of L_{Aeq} contours.

Difference Contours

5.44 Indicators such as those described so far are important in measuring and portraying the total noise impact but can be complemented by showing how an airspace change proposal redistributes noise burdens. In effect, other indicators can be used to show the changes in noise exposure over an area. One way of portraying changes in noise exposure is the difference contour. These contours show the relative increase or decrease in noise exposure, typically in L_{Aeq}, compared to the baseline scenarios. The increases/decreases are shown in bands:

- increase/decrease (±) of 1 – 2 dB
- ± 2 – 3 dB
- ± 3 – 6 dB
- ± 6 – 9 dB
- ± > 9 dB.

5.45 As the contours show increases and decreases, some form of colour shading is required to show whether a particular area will experience an increase or decrease in noise exposure. It is recommended that red is used for increases in noise exposure and blue is used for decreases in noise exposure.

5.46 Population counts can be used to compare the numbers of people that may experience increased noise exposure with those who will gain from the proposal.

5.47 The modelling assumptions and input data used for the difference contours **must** be consistent with those used for the production of L_{Aeq} contours.

5.48 Difference contours are particularly applicable where the degree of redistribution of noise impact may be large, for example, revising arrival and departure routes or in adapting the mode of runway operation. Change sponsors may use difference contours if it is considered that redistribution of noise impact is a potentially important issue.

Chapter 6

Greenhouse Gas Emissions

Modelling Methodology

6.1 Change sponsors **must** consider and demonstrate how the design and operation of the design options will impact greenhouse gas emissions. Change sponsors **must** therefore provide evidence that continuous climb operations (CCO)/continuous descent operations (CDO) and low power/low drag (LP/LD) have been considered in the course of developing an airspace change proposal.

6.2 Change sponsors **must** undertake greenhouse gas emissions modelling as per best practice, while remaining proportionate to the scale of potential impacts and therefore, **must** discuss and agree their methodology for the greenhouse gas emissions modelling with the CAA.

6.3 Change sponsors **must** provide the input data for their calculations including any modelling assumptions made. The mass of fuel burned and, therefore, the amount of greenhouse gases emitted can be derived from a range of aircraft performance models and simulators. Some examples are the EUROCONTROL Base of Aircraft Data (BADA) and IMPACT model. Change sponsors **must** state details of the aircraft performance model used including the version numbers of software employed.

6.4 When calculating changes to greenhouse gas emissions, change sponsors **must** show the estimated actual change in emissions rather than the theoretical change. Specifically, this means that the assessment must be based on anticipated actual changes to aircraft behaviour (for example, reduced miles flown, improved climb profile flown, improved descent profile flown) rather than simply comparing the differences in published flight procedures (for example, changes to flight-planned routes that do not reflect current or expected actual routeings).

6.5 For the purposes of the Department for Transport's TAG workbook, once fuel consumption has been estimated, this **must** be converted into carbon dioxide equivalent (CO_2e) emissions by multiplying by the relevant and latest conversion factors published for UK Government conversion factors for company reporting of greenhouse gas emissions, that is published by Department for Energy Security and Net Zero (DESNZ) and Department for Environment, Food and Rural Affairs (DEFRA) and updated annually. CO_2e is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of carbon dioxide (CO_2) which would have the equivalent global warming impact.

6.6 Change sponsors **must** estimate the total annual fuel burn and mass of CO_2e in metric tonnes emitted for:

- current-day
- year of implementation without the airspace change proposal (year 1)
- year of implementation with the airspace change proposal for each design option (year 1)
- 10 years after implementation without the airspace change proposal (year 10)
- 10 years after implementation with the airspace change proposal for each design option (year 10).

TAG Greenhouse Gases Workbook

6.7 Changes to CO_2e impacts **must** be included in the options appraisal process. The impacts of greenhouse gas emissions are monetised as an annual cost over the 10-year appraisal period and the output is the net present value of the change in greenhouse emissions.

6.8 The TAG workbooks require greenhouse gas emissions to be inputted as metric tonnes (i.e., 1,000 kilograms) of carbon dioxide equivalent emissions (tCO_2e).

6.9 All greenhouse gas emissions **must** be presented in tCO_2e, split by traded sector and non-traded sector. Change sponsors **must** discuss and agree the methodology used to take account of the traded and non-traded emissions with the CAA.

Chapter 7

Local Air Quality

7.1 While change sponsors should prioritise noise impacts below 7,000 feet, consistent with the altitude-based priorities, there could be circumstances where local air quality is a relevant consideration because emissions from aircraft taking off, landing or while they are on the ground have the potential to contribute to overall pollution levels in the area.

7.2 Where these activities are directly affected by the airspace change proposal, this could lead to a situation where prioritising noise creates unacceptable impacts in terms of local air quality or might risk breaching legal limits for air quality. Change sponsors **must** therefore take local air quality issues into account when they consider they are relevant, for example, when determining airspace changes affecting the initial departure or the final arrival stage of a flight.

7.3 The Air Navigation Guidance 2017 states that oxides of nitrogen (NO_x) and particulate matter (PM) are the two most important emissions affecting the local air quality around airports. Therefore, as a minimum, change sponsors **must** assess NO_x, PM2.5 and PM10.

7.4 Due to the effects of mixing and dispersion, emissions from aircraft above 1,000 feet above aerodrome level (AAL) are unlikely to have a significant impact on local air quality. Therefore, the impact of airspace design on local air quality is generally negligible compared with other factors such as changes in the volume of air traffic, and local transport infrastructures feeding the airport. However, change sponsors **must** still show explicit consideration of whether local air quality could be impacted when developing airspace change proposals.

7.5 Change sponsors **must** produce information on and monetise local air quality impacts only where there is the possibility of pollutants breaching legal limits and target values[6] following the implementation of an airspace change proposal (or worsening an existing breach of legal limits and target values). The CAA deems that this is only likely to become a possibility where:

- there is likely to be a change in aviation emissions (by volume or location) below 1,000 feet AAL, and

[6] The national Air Quality Objectives and Air Quality Standards Regulations limit and target values with which the UK must comply are summarised in the National air quality objectives of the Air Quality Strategy Volume 1 and Volume 2.

- the location of the emissions is within or adjacent to a designated Air Quality Management Area (AQMA).

7.6 Examples that may result in such a change are:

- changes to departure or arrival procedures – both laterally or vertically
- changes to operating procedures that effect thrust and therefore emissions
- changes to the number of aircraft movements.

7.7 If both conditions in paragraph 7.5 are met and an assessment of local air quality is required, modelling of impacts **must** be undertaken using a recognised and validated emissions model such as Cambridge Environmental Research Consultants (CERC) ADMS-Airport or AEDT. Concentrations should be portrayed in microgram per cubic metre ($\mu g.m^{-3}$). They **must** include concentrations from all sources whether related to aviation and the airport or not.

7.8 If concentration contours are required, the following **must** be produced:

- current-day, for example, latest available concentration contours
- year of implementation without the airspace change proposal (year 1)
- year of implementation with the airspace change proposal for each design option (year 1)
- 10 years after implementation without the airspace change proposal (year 10)
- 10 years after implementation with the airspace change proposal for each design option (year 10).

7.9 Changes to local air quality impacts are included in the options appraisal process, with Department for Transport's TAG providing guidance on the assessment of a monetised value based on the change in volume of local emissions if any breaches of statutory air quality limits are anticipated.

7.10 In all instances, the change in emissions is only relevant to this process when it is a result of the airspace change proposal itself, and not when it results from, for example, changes in the aircraft fleet mix where no airspace change is involved.

Chapter 8

Tranquillity

8.1 The consideration of impacts upon tranquillity for airspace change proposals is with specific reference to National Parks, Areas of Outstanding Natural Beauty (AONB), National Scenic Areas (NSA) (broadly equivalent to AONBs in Scotland), the Norfolk and Suffolk Broads, plus any local 'tranquil' areas that are identified through community engagement and are subsequently reflected within an airspace change proposal's design principles.

8.2 These are designated areas with specific statutory purposes to ensure their continued protection in relation to landscape and scenic beauty[7]. Change sponsors **must** have regard to these statutory purposes when developing airspace change proposals and are encouraged, where it is practical, to avoid overflight of tranquillity receptors below 7,000 feet. This does not preclude either a designated Quiet Area (or any other local area that has similar characteristics) from being identified via community engagement during the early development of design options. It is important that local circumstances, including community feedback on specific areas that should be avoided, are taken into account where possible.

8.3 Change sponsors **must** show how they have considered and taken account of these impacts by using operational diagrams or overflight contours to identify any tranquillity receptors overflown below 7,000 feet. An assessment is also required for the opening year and across the forecast period (normally 10 years).

[7] DEFRA, Duties on relevant authorities to have regard to the purposes of National Parks, Areas of Outstanding Natural Beauty (AONB) and the Norfolk and Suffolk Broads Guidance Note, 2005

Chapter 9

Biodiversity

9.1 Biological diversity or 'biodiversity' can be taken to mean "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems"[8].

9.2 Given that all changes below 7,000 feet should take into account local circumstances in the development of airspace structures, change sponsors **must** include in their engagement and consultations the potential biodiversity implications associated with design options under consideration and **should** be mindful of such potential impacts as are identified by stakeholders.

9.3 Change sponsors **must** use operational diagrams or overflight contours to identify any biodiversity receptors overflown below 7,000 feet. Biodiversity receptors include locally identified biodiversity receptors and European sites such as:

- Special Areas of Conservation (SAC) and possible SACs
- Special Protection Areas (SPA) and potential SPAs
- Ramsar sites (wetlands of international importance) and proposed Ramsar sites
- Compensatory habitats[9] (areas secured to compensate for damage to SACs, SPAs and Ramsar sites).

9.4 Where an airspace change proposal is likely to have an impact on biodiversity, change sponsors **must** provide an explicit consideration of biodiversity, including a habitats regulations assessment where necessary.

9.5 The legal duty to ensure a habitats regulations assessment is conducted before deciding to approve an airspace change proposal only applies to the CAA's decision at Stage 5 of CAP 1616. However, it is in the interests of all parties that regard is had to the need to avoid or minimise adverse effects on European sites through all stages of the CAP 1616 process. Otherwise, there is a risk that less

[8] Convention on Biological Diversity (1992), Art. 2

[9] There is currently no publicly available database which provides information on areas of compensatory habitat (areas secured to compensate for damage to SACs, SPAs and Ramsar sites). We recommend contacting the Statutory Nature Conversation Bodies who may be able to provide further information on these sites.

damaging options will be overlooked; and airspace change proposals could progress all the way to Stage 5, but still fail to secure final approval.

9.6 Change sponsors **must** therefore consider a habitats regulations assessment as part of the development of their design options, options appraisals (Stages 2, 3 and 4), updates to their final design option and final airspace change proposal submission (Stage 4). The overall aim should be to eliminate as many adverse effects on European sites as practicable, prior to the CAA's consideration of the final proposal at Stage 5.

9.7 The CAA does not expect change sponsors to rule-out options which could avoid adverse effects on the integrity of European sites without good reason. At the same time, it is important to bear in mind that a finding of adverse effects on the integrity of a European site does not necessarily mean that an airspace change proposal cannot proceed to final approval. For example, it may be the case that design options avoiding adverse effects on European sites would not comply with the airspace and infrastructure requirements set out in UK law and policy, the International Civil Aviation Organisation's standards and recommended practices, EUROCONTROL standards, or give rise to unacceptable safety risks. In those circumstances, where the habitats regulations assessment finds that adverse effects cannot be avoided completely, and there are no alternative solutions available, then the airspace change proposal **must** be supported by justification to demonstrate there are imperative reasons of overriding public interest why it should nevertheless proceed.

9.8 In order to ascertain whether an airspace change proposal is likely to have a significant effect on a European site (and therefore whether an appropriate assessment of the potential adverse effects of the proposal on that site is needed), change sponsors **must** undertake a screening exercise. The CAA has developed early screening criteria for change sponsors to use to check whether their airspace change proposal is likely to have a significant effect on a European site.

9.9 The answers to the questions in the early screening criteria form must include a robust rationale supported with appropriate evidence. The CAA may require additional evidence from the change sponsor. If a change sponsor concludes that a habitats regulations assessment is not necessary, and the CAA accepts that rationale, that same rationale plus the supporting evidence must be clearly explained in any consultation material and in the final airspace change proposal submitted to the CAA.

9.10 For the purposes of these early screening criteria, the zone of influence for potential impacts on European sites relates to flights at an altitude of 3,000 feet and below, and within 18 kilometres of a runway end.

Habitats Regulations Assessment – Early Screening Criteria

Q1. **Are there any changes to air traffic patterns or number of movements expected below 3,000 feet due to the airspace change proposal?**

If the answer to Q1 is 'no' then habitats regulations assessment is no longer required.
If the answer to Q1 is 'yes' then proceed to Q2 below.

Q2A. **Are there any European sites within a radius of 18 km of each runway end?**

Q2B. Are any European sites identified in Q2A overflown (i.e. plane passing directly overhead or within 2,655 feet of the boundary of a European site at 3,000 feet or below) by proposed flight routes?[10]

If the answer to Q2A and Q2B are both 'no' then habitats regulations assessment is no longer required.
If the answer to Q2A or Q2B is 'yes' then proceed to Q3 below.

Q3A Will the airspace change proposal reduce the number of movements overflying one or more European sites, while not increasing them over another?[11]

Q3B Will the airspace change proposal increase the altitude of aircraft overflying one or more European sites, whilst not decreasing altitude over another?

If the answer to Q3A and Q3B are both 'yes' then habitats regulations assessment is no longer required.
If the answer to Q3A or Q3B is 'no' then secondary screening will be required.

[10] CAP 1498 provides the CAA's definition of overflight as it relates to airspace regulation. Adopting this definition, for a 48.5° elevation angle threshold, overflight would be experienced from any aircraft flying at a height of 3,000 feet and within a lateral distance of approximately 2,655 feet from the boundary of a European site.

[11] In the event that more than one European site is overflown, consideration **must** be given to whether or not changes are positive, remain the same or are negative at each individual location. A habitats regulations assessment can only be screened out where there is no change or where there is benefit to all relevant European sites.

Chapter 10

Environmental Assessment Requirements for Vertical Spaceflight Airspace Change Proposals

Introduction

10.1 The Space Industry Act 2018 regulates all spaceflight activities carried out in the UK, and associated activities. This includes operating a spaceport and launching objects into space. Change sponsors who are progressing airspace change proposals which facilitate spaceflight activity must also follow CAP 1616, Airspace Change Process.

10.2 Each of these regulatory processes contains environmental assessment requirements which the applicants for spaceport or launch operator licences under the Space Industry Act 2018 and the change sponsors of airspace change proposals **must** follow.

10.3 The purpose of this chapter is to provide a summary and comparison of what the environmental assessment requirements are, to assist change sponsors in identifying:

- where environmental information submitted as part of an application for a spaceport or launch operator licence can be referenced and/or used in airspace change proposal submissions to satisfy the environmental assessment requirements of CAP 1616, Airspace Change Process (and to avoid duplication of effort)
- where additional information is required to satisfy the environmental assessment requirements of CAP 1616, Airspace Change Process.

10.4 The guidance in this chapter has been developed specifically for change sponsors of vertical spaceflight airspace change proposals who are applying for, or have been granted, a spaceport or launch operator licence under the Space Industry Act 2018.

Space Industry Act 2018

10.5 Section 11 of the Space Industry Act 2018 stipulates that all applicants for either a spaceport or launch operator licence **must** submit an assessment of environmental effects as part of their licence application. The regulator is required to take the assessment of environmental effects into account when deciding whether to grant a licence and what, if any, conditions should be attached to such a licence.

10.6 The purpose of the assessment of environmental effects is to ensure that applicants for either a spaceport or launch operator licence have considered the likely significant environmental effects of their intended activities and, if necessary, taken (or identified) proportionate steps to avoid, mitigate or offset the risks and their potential effects. The assessment of environmental effects **must** cover the direct effects and any indirect, secondary, cumulative, transboundary, short term, medium term, long term, permanent and temporary, positive and negative effects of the proposed spaceflight activities (but not on any other activities, such as other airspace users). CAP 2215, Guidance for the assessment of environmental effects sets out the requirements for the form and content of an assessment of environmental effects.

10.7 Section 2(2) requires the CAA, when deciding whether to grant a spaceport or launch operator licence, to take into account any environmental objectives set by the Secretary of State. The Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018 (2018 Guidance) sets out what the environmental objectives are and provides specific guidance to the CAA on how to interpret its environmental duties with respect to these objectives.

CAP 1616 Airspace Change Process

10.8 In addition to the environmental requirements of CAP 1616, Airspace Change Process (as detailed in this guidance) change sponsors of airspace change proposals which facilitate spaceflight activity **must** also take into account the Additional guidance under s70(2)(ca) Transport Act 2000: Carrying out air navigation functions for the purpose of spaceflight activities (2021 Guidance). In accordance with this guidance, change sponsors are not required to monetise noise impacts, but **must** continue to monetise other direct and indirect (as a result of consequential changes on civil aviation patterns) environmental impacts such as CO_2e. Change sponsors are also not required to undertake a cost benefit analysis of their design options (as noise is no longer monetised) and they should disregard certain daytime and night-time noise levels.

10.9 The sections below summarise the environmental assessment requirements of the Space Industry Act 2018 and CAP 1616, Airspace Change Process. They cover the main characteristics that **must** be considered by change sponsors when undertaking the environmental assessment as part of CAP 1616, Airspace Change Process for airspace change proposals which facilitate vertical spaceflight activity.

10.10 Change sponsors may choose to obtain the relevant information for each of the direct impacts of spaceflight activities from an applicant's assessment of environmental effects (where available) for the corresponding spaceport or

launch operator licence to keep the environmental assessment process as proportionate as possible.

10.11 The information for assessing each of the indirect (consequential) impacts on other airspace users is unlikely to be available from an applicant's assessment of environmental effects for the corresponding spaceport or launch operator licence and change sponsors may need to obtain their own data for those purposes.

Inputs to the Environmental Assessment

Baseline

Direct Impacts – Spaceflight Activities

10.12 A description of the current-day scenario for spaceflight activities **must** be provided. If the spaceport has yet to operate, this description would assume no spaceflight activities. If the spaceport already has an active permanent airspace structure, then the description **must** include details of the activities including launch trajectories, frequency of activations, duration, timings and how these might change over the 10-year forecast period.

Indirect (Consequential) Impacts – Other Airspace Users

10.13 A description of the current-day scenario of other airspace users **must** be provided. This description must include the current airspace usage by other airspace users in the volumes of airspace likely to be impacted by the airspace change proposal. The description **must** also consider how this usage is likely to change over the 10-year forecast period without the addition of the proposed airspace change proposal which facilitates vertical spaceflight activity. For example, how traffic is anticipated to grow from its current-day usage.

10.14 It is recommended that operational diagrams are provided as supporting evidence to aid the description of other airspace users' traffic movements. These operational diagrams might include the categories of airspace, typical general aviation traffic patterns at lower altitudes and air traffic service routes at higher altitudes.

Traffic Forecasts

Direct Impacts – Spaceflight Activities

10.15 Change sponsors **must** provide the number of space launches anticipated annually over a period of at least 10 years from the planned implementation date of the airspace change proposal, describing any differences to the trajectories, frequency, duration and timings of launches.

Indirect (Consequential) Impacts – Other Airspace Users

10.16 Change sponsors **must** provide a traffic forecast depicting other airspace users' movements for the current-day Scenario out to at least 10 years from the planned implementation date of the airspace change proposal.

10.17 The data may be obtained from the sources suggested below:

- above 7,000 feet – NATS traffic forecasts, EU Network Manager, other airspace change proposals
- below 7,000 feet – local airports/aerodromes/air navigation service providers.

Environmental Assessment Outputs

Noise

Direct Impacts – Spaceflight Activities

10.18 Change sponsors **must** consider single noise events.

10.19 Noise exposure footprints. Change sponsors **must** map all areas exposed to spaceflight noise exceeding 80, 85, 90, 95, 100, 105, 110, 115 and 120 dB L_{Asmax}[12]. Noise footprints **must** be overlaid on a suitable map background (for example, Ordnance Survey) identifying any exposed dwellings and noise sensitive buildings (for example, hospitals, places of worship, schools).

10.20 Structural damage assessment. Change sponsors **must** map all areas exposed to spaceflight noise exceeding 100, 105, 110, 115 and 120 dB L_{Zmax}[13]. The maps **must** illustrate any structures in the area impacted above 100 dB L_{Zmax}.

10.21 For both of the above, PC software RUMBLE is freely available from the US Transportation Research Bureau and is populated with a database of several US launch vehicles.

10.22 Sonic boom assessment. Change sponsors **must** provide an assessment of sonic boom for all phases of flight, including any stages or vehicles that return to the launch pad or area. In general, sonic booms over land should be avoided; where this is not possible, the maximum overpressure on land should not exceed 47.88 pascals (Pa) or one pound per square foot (psf). Areas exposed to sonic boom **should** be mapped to illustrate the maximum overpressures on land. Software PC Boom available free of charge from the US Transportation Research Bureau is recommended for this assessment.

[12] Slow time weighted L_{ASmax}

[13] Z weighted (unweighted) L_{max}

10.23 Probability of awakening[14] (night-time launches, 2300 – 0700 only). Change sponsors **must** assess the probability of awakening for night-time launches calculated based on L_{Asmax} noise exposure and using the awakening estimation function defined in the 2018 Guidance.

10.24 Operational diagrams. Change sponsors **must** present all the trajectories of space launches including all staged returns.

10.25 Exposure to repeated noise events. Change sponsors **must** provide a report on:

- human receptors (dwellings and noise sensitive buildings)
- wildlife receptors[15].

10.26 Where there is a difference, all assessments **should** be modelled assuming predominant meteorological conditions and the weather conditions which are favourable for launch.

10.27 The noise assessment is required for the opening year and across the 10-year forecast period.

Indirect (Consequential) Impacts – Other Airspace Users

10.28 Change sponsors **must** consider whether any consequential impacts on other airspace users is likely to result in changes to airspace usage below 7,000 feet and over any inhabited areas.

10.29 For impacts below 7,000 feet, over any inhabited areas and where more than 10 other airspace users' operations are altered, change sponsors **must** provide:

- noise exposure contours[16] above 51 dB LAeq,16h daytime and 45 dB LAeq,8h night-time and evaluated by Department for Transport's TAG for impacts on health and quality of life
- number above contours (N65 for daytime and N60 for night-time noise)
- overflight contours

[14] In the absence of a rocket noise awakening probability function, the probability of awakening is based on Elmenhorst, E-M. et al. (2012), adapted for the faster event rise time typical of a rocket noise event and defined in defined in 2018 Guidance.

[15] Farm animals and any wildlife identified as part of the biodiversity assessment.

[16] $L_{Aeq,16h}$ daytime and $L_{Aeq,8h}$ night-time is defined as being over an average summer's day. However, because of the infrequency of launches, the assessment of the indirect impacts should be assessed for a single launch day, i.e., $L_{Aeq,16h}$ and $L_{Aeq,8h}$ should be evaluated for a launch day and compared with a baseline average summer's day with no launches. If impacts on other airspace users vary depending on launch type and/or trajectory, the assessment of a single day should be evaluated for the worst-case scenario.

- operational diagrams.

10.30 For impacts below 7,000 feet, over any inhabited areas and where less than 10 other airspace users' operations are altered, change sponsors **must** provide:

- overflight contours
- operational diagrams.

10.31 The noise assessment is required for the opening year and across the 10-year forecast period.

Consideration of Alternative Fuels

Direct Impacts – Spaceflight Activities

10.32 A statement illustrating the change sponsor's consideration of other fuel types which could have been used to launch the vehicle, with rationale explaining why a particular fuel has been chosen **must** be provided.

Greenhouse Gas Emissions

Direct Impacts – Spaceflight Activities

10.33 Change sponsors **must** provide the total annual fuel burn and mass of greenhouse gas emissions (expressed as CO_2e) in metric tonnes (assuming forecast number of launches). The impacts of greenhouse gas emissions must be monetised using Department for Transport's TAG greenhouse gases workbook.

10.34 Change sponsors **must** include a rationale explaining fuel to emissions conversion factors used if a fuel has no relevant fuel to CO_2e conversion factor available.

10.35 The greenhouse gas emissions assessment is required for the opening year and across the 10-year forecast period.

Indirect (Consequential) Impacts – Other Airspace Users

10.36 Change sponsors **must** provide the total annual fuel burn and mass of greenhouse gas emissions (expressed as CO_2e) in metric tonnes. The impacts of greenhouse gas emissions must be monetised using Department for Transport's TAG greenhouse gases workbook.

10.37 The greenhouse gas emissions assessment is required for the opening year and across the 10-year forecast period.

Local Air Quality

Direct Impacts – Spaceflight Activities

10.38 Change sponsors **must** provide an assessment of the impact, if any, upon:

- statutory air quality limits and target values[17]
- designated Air Quality Management Areas (AQMAs)
- national air quality objectives for pollutants.

10.39 An assessment is required for a single launch event, against the likely exceedance of short-term mean periods, and consideration of any changes that might occur across the 10-year forecast period.

10.40 Likely pollutant emissions that could affect local air quality include primary pollutants such as carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs) – benzene, 1,3-butadiene, sulphates (SO_x) and particulate matter – PM2.5 and PM10; and secondary pollutants such as ozone (O_3) and nitrogen dioxide (NO_2).

10.41 A full air quality assessment using dispersion modelling and impacts monetised using Department for Transport's TAG local air quality workbook is required if any breaches of statutory air quality limits and target values are anticipated.

Indirect (Consequential) Impacts – Other Airspace Users

10.42 Impacts on local air quality **must** be assessed only if a breach of statutory limits and target values[18] for pollutants (or worsening of an existing breach) is anticipated as result of consequential changes to other airspace users and in combination with the direct impacts.

10.43 A breach of legal limits and target values is assumed if there are any changes to airspace usage below 1,000 feet above the spaceport level and within or adjacent to an identified Air Quality Management Area (AQMA). Impacts below 1,000 feet are considered to occur if there are any changes to traffic numbers or typical flight tracks.

10.44 A full air quality assessment using dispersion modelling and impacts monetised using Department for Transport's TAG local air quality workbook is required if any breaches of statutory air quality limits and target values are anticipated.

10.45 The local air quality assessment is required for the opening year and across the 10-year forecast period.

[17] The national Air Quality Objectives and Air Quality Standards Regulations limit and target values with which the UK must comply are summarised in the National air quality objectives of the Air Quality Strategy Volume 1 and Volume 2.

[18] The national Air Quality Objectives and Air Quality Standards Regulations limit and target values with which the UK must comply are summarised in the National air quality objectives of the Air Quality Strategy Volume 1 and Volume 2.

Tranquillity

Direct Impacts – Spaceflight Activities

10.46 Change sponsors **must** consider overflight of any tranquillity areas. Operational diagrams identifying any tranquillity receptors overflown **must** be provided.

10.47 Tranquillity receptors include National Parks, Areas of Outstanding Natural Beauty (AONB), National Scenic Areas, designated Quiet Areas and other locally identified tranquillity areas.

10.48 The tranquillity assessment is required for the opening year and across the 10-year forecast period.

Indirect (Consequential) Impacts – Other Airspace Users

10.49 Change sponsors **must** consider overflight below 7,000 feet of any tranquillity areas. Operational diagrams or overflight contours identifying any tranquillity receptors **must** be provided.

10.50 Tranquillity receptors include National Parks, Areas of Outstanding Natural Beauty (AONB), National Scenic Areas, designated Quiet Areas and other locally identified tranquillity areas.

10.51 The tranquillity assessment is required for the opening year and across the 10-year forecast period.

Biodiversity

Direct Impacts – Spaceflight Activities

10.52 Change sponsors **must** consider overflight of any biodiversity areas. Operational diagrams identifying any biodiversity receptors overflown **must** be provided.

10.53 Biodiversity receptors include European sites[19] and other locally identified biodiversity areas.

10.54 Habitats Regulations Assessment. Change sponsors **must** undertake assessments for the habitats regulations assessment as specified by the CAA. Habitats regulations assessment carried out as part of an application for a spaceport or launch operator licence may be referenced for the purposes of any habitats regulations assessment required for the airspace change proposal.

10.55 The biodiversity assessment is required for the opening year and across the 10-year forecast period.

[19] European sites consist of Special Areas of Conservation (SAC) and possible SACs, Special Protection Areas (SPA) and potential SPAs, Ramsar sites and proposed Ramsar sites, and compensatory habitat (areas secured to compensate for damage to SACs, SPAs and Ramsar sites).

Indirect (Consequential) Impacts – Other Airspace Users

10.56 Change sponsors **must** consider overflight below 7,000 feet of any biodiversity areas. Operational diagrams or overflight contours identifying any biodiversity receptors overflown **must** be provided.

10.57 Biodiversity receptors include European sites[19] and other locally identified biodiversity areas.

10.58 Habitats Regulations Assessment. Change sponsors **must** submit the completed early screening criteria form and undertake any additional assessments for the habitats regulations assessment as specified by the CAA.

10.59 The biodiversity assessment is required for the opening year and across the 10-year forecast period.

Chapter 11

Noise Impacts from Remotely Piloted Aircraft Systems (RPAS)

Available Data

11.1 Government guidance requires change sponsors to consider and assess the likely noise impacts resulting from their airspace change proposals. Currently however, detailed noise data is not readily available or documented for remotely piloted aircraft systems (RPAS) or advanced air mobility.

11.2 CAP 2506, Noise measurements from eVTOL aircraft: A review of available data presents an initial review undertaken in respect of conference papers, reports and other available research papers on noise impacts of lightweight RPAS (less than 25 kilograms in mass). This review provides some data which change sponsors can refer to as part of the assessment of noise impacts from their RPAS activities.

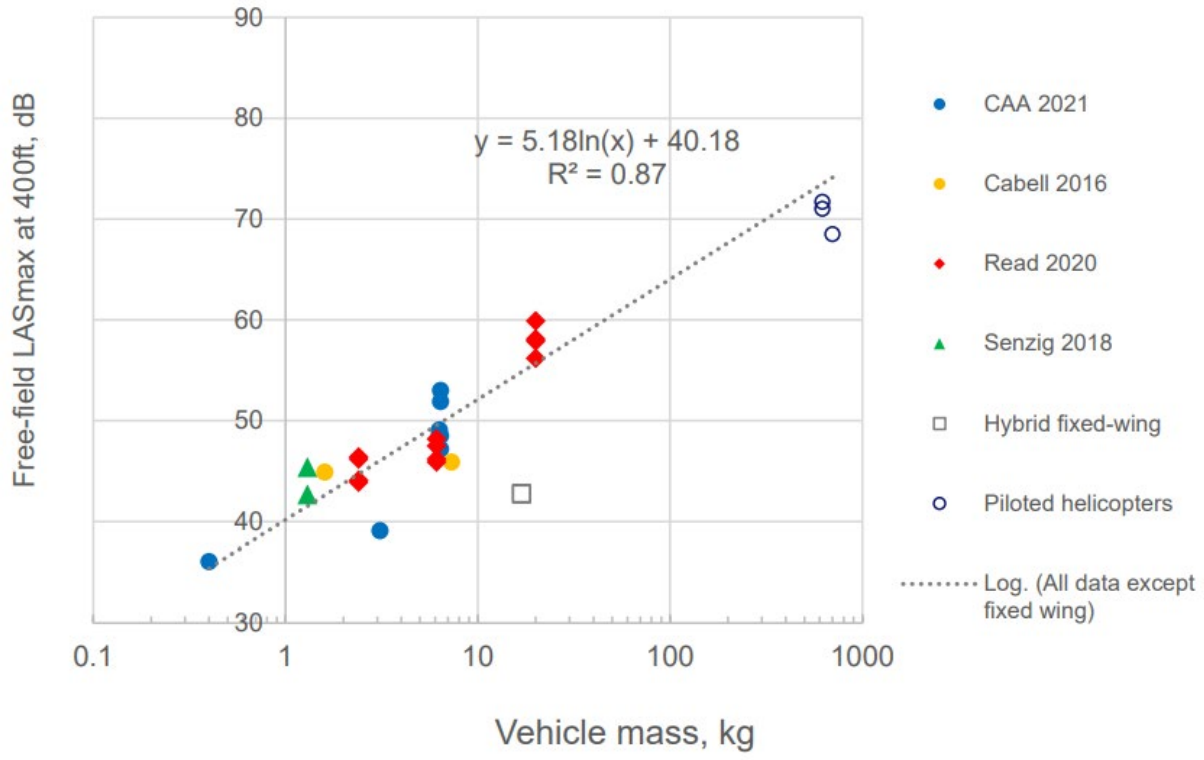
11.3 Table 1 provides a summary of available overflight data referenced in this review, with a focus on overall L_{ASmax} sound pressure levels for vehicles operating at a reference height of 400 feet (120 metres).

Table 1 RPAS overflight noise measurement summary

Study	Vehicle	Weight	Ref. free-field L_{ASmax} @400 ft (120 m)
CAA, Newbury	DJI M300	6.4 kg	51.9 dB (IGP mic, headwind conditions) 53.0 dB (1.2 m mic, headwind conditions) 47.2 dB (IGP mic, tailwind conditions) 48.5 dB (1.2 m mic, tailwind conditions)
	Hybrid fixed-wing	16.9 kg	42.7 dB (IGP mic) 42.8 dB (1.2 m mic)
CAA, Cranfield	DJI M300 (1)	6.3 kg	48.6 dB (IGP mic)
	DJI M300 (2)	6.3 kg	49.2 dB (IGP mic)
	DJI Inspire 1 V2	3.1 kg	39.1 dB (IGP mic)
	DJI Mavic Air	0.4 kg	36.1 dB (IGP mic)
Cabell, R et al (2016)	DJI Phantom 2	1.6 kg	44.9 dB (GP mic)
	Prioria Hex	7.3 kg	45.9 dB (GP mic)
Read, D R et al (2020)	Yuneec Typhoon	2.4 kg	44.1 dB (IGP mic, fast flyover) 46.4 dB (1.2m mic, fast flyover) 43.9 dB (IGP mic, slow flyover) 46.2 dB (1.2m mic, slow flyover)
	DJI M200	6.1 kg	46.2 dB (IGP mic, fast flyover) 48.2 dB (1.2m mic, fast flyover) 45.9 dB (IGP mic, slow flyover) 47.5 dB (1.2m mic, slow flyover)
	Gryphon Dynamics GD28X	20 kg	58.1 dB (IGP mic, fast flyover) 59.9 dB (1.2m mic, fast flyover) 56.2 dB (IGP mic, slow flyover) 57.9 dB (1.2m mic, slow flyover)
Senzig, D A et al (2018)	DJI Phantom 3 Adv.	1.3 kg	42.7 dB (IGP mic) 45.4 dB (1.2 m mic)

11.4 CAP 2506 also includes datapoints for a range of RPAS plotted graphically according to the weight (kg) and associated noise levels (L_{ASmax}) at an operating height of 400 feet as shown in Figure 2.

Figure 2 Variation of electric vertical takeoff and landing (eVTOL) noise level by mass at a reference height of 400 feet.



11.5 In cases where the change sponsor's RPAS does not align with any of the characteristics given in Table 1, the regression analysis equation (equation one) from Figure 2 can be used to estimate noise levels for a specific RPAS weight at a reference flyover height of 400 feet.

$$y = 5.18 \ln(x) + 40.18$$

$$R^2 = 0.87$$

Where:

- $y = L_{ASmax}$, dB
- x = vehicle weight, kg

11.6 Should alternate source data based on a different height be used, or there is a need to adjust the data in Table 1 to a different flyover height, then the source L_{ASmax} data can be easily adjusted to different overflight heights using equation 2:

$$L_{ASmaxh} = L_{ASmax400} + 20 \times \log_{10}(400/h)$$

Where:

- L_{ASmaxh} = L_{ASmax} at reference height
- $L_{ASmax400}$ = source L_{ASmax} data at 400 feet

11.7 If the reference height differs from 400 feet, replace the 400 in equation two with the reference height. The method assumes no atmospheric absorption, which is appropriate for the shorter propagation distances associated with RPAS operations, compared with fixed commercial aircraft operations.

11.8 There is emerging evidence that noise from multi-rotor RPAS can be perceived as more annoying compared to conventional aeroplanes and helicopters. It is recognised that multi-rotor RPAS produce multiple discrete tones. These tones are close together in pitch, and their absolute and relative pitches do not remain constant but vary slightly due to RPAS control systems varying rotor speed in order to maintain altitude and orientation, and to manoeuvre the RPAS. As it is generally accepted that the noise produced by these aircraft types is more annoying than from a fixed-wing aircraft at the same L_{ASmax} level, for assessments related to CAP 1616, a +10 dB tone correction **must** be applied to noise exposure levels calculated for multi-rotor RPAS until such time that this aspect is better understood.

Permanent Airspace Change Proposals

11.9 Air Navigation Guidance 2017 requires that the resulting change in aircraft noise exposure above 51 dB $L_{Aeq,16h}$ daytime **must** be assessed where a permanent change of airspace design is proposed.

11.10 The general equation for the calculation of $L_{Aeq,16h}$ aircraft noise exposure is given by equation three:

$$L_{Aeq,16h} = SEL_{avg} + 10 \times \log_{10} N - 47.6$$

Where:

- SEL_{avg} = average sound exposure level (SEL) for the operations between 0700-2300
- N = number of operations between 0700-2300

11.11 The data in Table 1 has been measured directly or scaled to a 400 feet overflight height. The data is reported in the noise unit L_{ASmax} and needs to be converted to SEL in order to estimate $L_{Aeq,16h}$. The conversion between L_{ASmax} and SEL is dependent on the height of the vehicle relative to the observer and the vehicle speed. A rough estimate is that the SEL is 10 dB higher than the L_{ASmax}.

However, a Volpe Center report[20] that measured L_{ASmax} and SEL at different flyover heights, shows that the difference is much less than 10 dB for heights less than 400 feet. From the data published in the report, the following empirical relationship is given in equation four:

$$SEL = L_{ASmax} + (2.4 + 0.03897 \times height - 0.0000541 \times height^2)$$

Where:

- height = height of the vehicle relative to the observer

11.12 Note, equation four is applicable for heights between 50 and 400 feet. For heights above 400 feet, SEL = L_{ASmax} + 10 dB is assumed.

11.13 Using the data in Table 1, adjusted to SEL using equation four, the first term in equation three can be addressed.

11.14 The tone correction of +10 dB **must** be added to the calculated $L_{Aeq,16h}$ value to account for the noise characteristics of multi-rotor RPAS.

Temporary and Trial Airspace Change Proposals

11.15 For all temporary and trial airspace change proposals less than three months in duration, change sponsors **must** present an assessment of noise impacts from the RPAS operations as L_{ASmax} noise levels at key locations. Noise assessments for $L_{Aeq,16h}$ are not required.

11.16 For trial airspace change proposals longer than 90 days yet shorter than 12 months, change sponsors **must** present an assessment of noise impacts from the RPAS operations as 65 dB L_{ASmax} footprints for noise from day flights and 60 dB L_{ASmax} footprints for noise from night flights. Noise assessments for $L_{Aeq,16h}$ are not required.

11.17 If a trial airspace change proposal extends beyond 12 months, then change sponsors **must** present noise assessments for $L_{Aeq,16h}$ that result from the RPAS operations.

11.18 Please refer to CAP 1616g, Guidance on Airspace Change Process for Temporary and Trial Airspace Change Proposals for more details.

[20] Senzig et al (2018) “Sound exposure level duration adjustments in UAS rotorcraft noise certification tests”, Final Report – September 2018, DO-VNTSC-FAA-18-07