SUSTAINABLE AVIATION

QUIETER ROAD-MAP

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DISCLAIMER

Sustainable Aviation (SA) believes the data forecasts and analysis in this report to be correct as at the date of publication. The opinions contained in this report, except where specifically attributed to, are those of SA, and based upon the information that was available to us at the time of publication. We are always pleased to receive updated information and opinions about any of the contents.

All statements in this report (other than statements of historical facts) that address future market developments, government actions and events, may be deemed 'forward-looking statements'. Although SA believes that the outcomes expressed in such forward-looking statements are based on reasonable assumptions, such statements are not guarantees of future performance: actual results or developments may differ materially, e.g. due to the emergence of new technologies and applications, changes to regulations, and unforeseen general economic, market or business conditions.

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KEY INFORMATION FROM THIS ROAD-MAP

- UK aviation noise output is forecast to reduce by 35% in 2035 compared to 2019, despite a rise in air traffic movements.
- Beyond 2035, continued reduction will reflect any further technological advances.
- These figures present a UK wide result - actual noise exposure at individual UK airports will vary depending on many individual issues, these figures cannot be taken as a guide to any individual airport performance.
- On top of this, operational improvements can be expected to offer further noise reductions which could provide a notable beneficial effect.
- Unrestricted housing growth under flight paths will be the main potential factor increasing the number of people affected by noise outside of aviation growth.
- There are opportunities to inform how residents respond to noise based on how they understand the cause of the noise and role of aviation in the local and national economy.
- Operating restrictions to tackle aircraft noise are seen as a measure of last resort by industry. This is because they are a blunt and expensive way of reducing noise impacts, they do not encourage progressive holistic improvement in noise management.
- Noise improvement needs to be achieved in conjunction with delivering a reduction in Greenhouse Gas and local air quality emissions.

Necessary Actions

Industry

- Continue to invest in aircraft technology research programmes and upgrading to latest technology aircraft.
- Develop and deploy new operational techniques and airspace changes that reduce noise where possible.
- Continue to develop best practice noise management strategies for the future.
- Promote open and transparent engagement with communities affected by noise, to better understand their concerns and priorities.

Government

- Support further ongoing research and development in aerospace technology.
- Support ongoing work on operational trials and simpler airspace changes aimed at managing noise.
- Accelerate the main airspace modernisation programme with Government support to remove obstacles to early completion.
- Deliver research to improve understanding of how people react to aircraft noise events.
- Support local authorities' ability to enforce land use planning controls around airports.
- Ensure that operational restrictions are employed only as a final resort.

Stakeholders (including local authorities and communities)

- Work with the aviation industry to achieve a successful outcome.
- Share relevant information in a timely manner with their constituents.

FOREWORD

BY SUSTAINABLE AVIATION CHAIR

Welcome to this second Noise Road-Map from Sustainable Aviation.

The aviation industry has been working to reduce noise emissions and impacts for decades, and this document references the amazing progress made on individual aircraft noise since the 1950s.

Today, air travel has become a mass market activity in the UK. More British people holiday abroad than ever before, and more of British business is conducted internationally – both through people and freight.

Over the decades, more flying overall has meant more noise generated by aircraft, and this noise can have an impact on those living near airports and under flight paths. However, in the UK and for the first time, this latest Road-Map shows how we have reached a tipping point where noise is going to start reducing, even whilst aviation continues to grow. This is consistent with the projections from our 2013 version, which indicated that noise output would remain relatively flat until starting to drop in the mid-2020s.

What is behind this positive development? Aircraft are now coming into use that are very substantially quieter than those they replace. This reduction in per-plane noise will now outpace the growth in flights, meaning over the UK as a whole noise will fall over the next 10-15 years. Whilst this will not be felt uniformly as noise impacts depend on the circumstances of each individual airport, it should be the general positive trend across the UK as a whole.

This Road-Map sets out the collective efforts of the UK's aviation industry to minimise noise impacts, including by optimising flight paths, managing descent profiles and sharing operational best practice, and by supporting the continued development of new technology so that noise gains can continue in the long term. It also highlights the vital role that mitigations on the ground will play to support local communities, and the ongoing importance of managing factors outside of industry's control, not least the growth of housing under the flight paths.

We hope that the evidence provided through this analysis will help policy makers in Government make balanced decisions when seeking to weigh the significant and growing benefits of aviation to our communities across the UK, alongside minimising any noise impacts as much as possible.

We hope you find it of use.

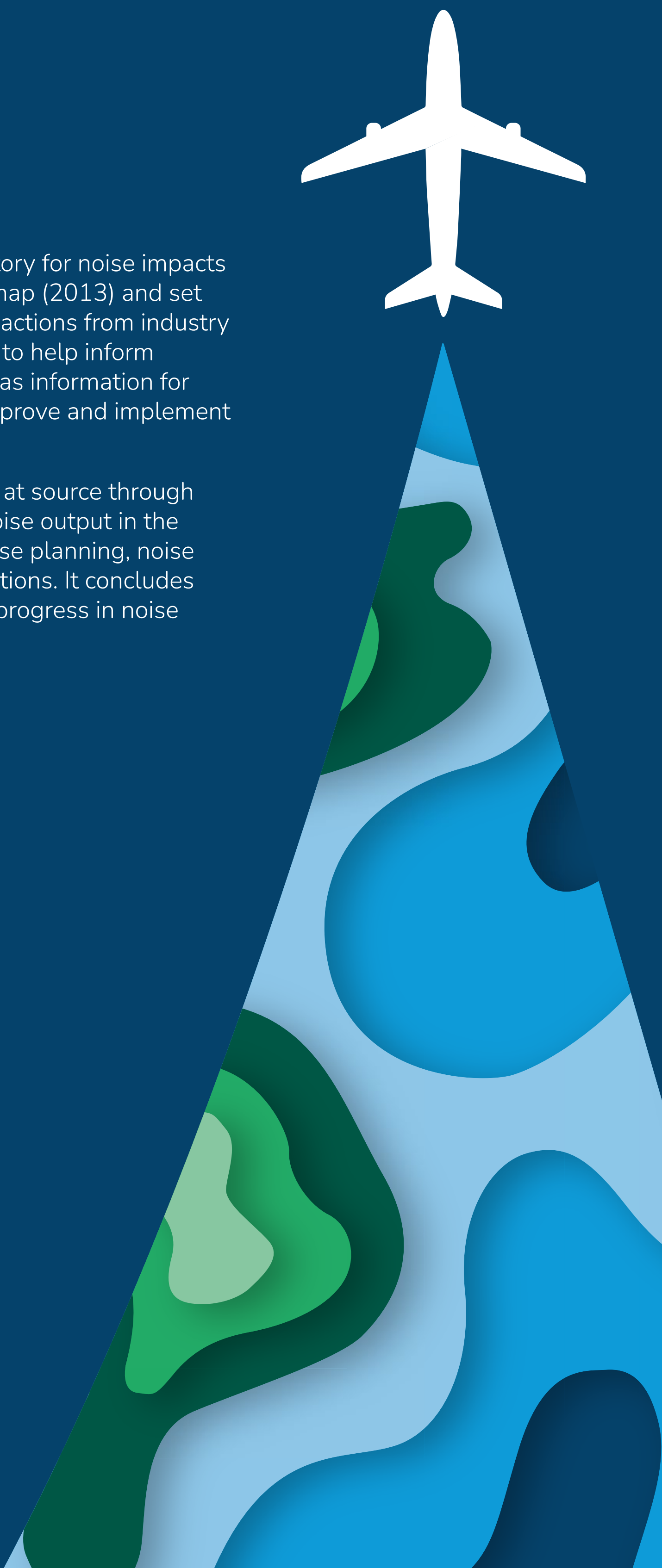
Neil Robinson, Chair
Sustainable Aviation

EXECUTIVE SUMMARY

Introduction

This Noise Road-Map seeks to set out the anticipated future trajectory for noise impacts from aviation in the UK. It will review progress since the last road map (2013) and set out an updated evidence-based set of projections, with options for actions from industry and government to manage noise impacts. The document is aimed to help inform debate, actions and policy formulation. The Road-Map also serves as information for individual parts of the UK aviation industry to help them assess, improve and implement actions for reducing noise impacts from aircraft operations.

Chapter by chapter it considers developments in reduction in noise at source through technology, and then sets out the updated trajectory for aviation noise output in the UK. It then considers the roles of operational improvements, land use planning, noise communications and community engagement and operating restrictions. It concludes by setting out the actions needed on all sides to ensure continued progress in noise impact management.



EXECUTIVE SUMMARY

Noise Output Forecasts and Scenarios

UK aviation noise output is forecast to reduce in the order of 35% by 2035 compared to 2019, despite a rise in air traffic movements. After that point continued reduction is dependent on further technological advances.

Continued noise research by UK industry, supported by government, is required to ensure this trend continues from the mid-2030's onwards. This work needs to be done in conjunction with delivering a reduction in Greenhouse Gas and local air quality emissions within the aircraft fleet.

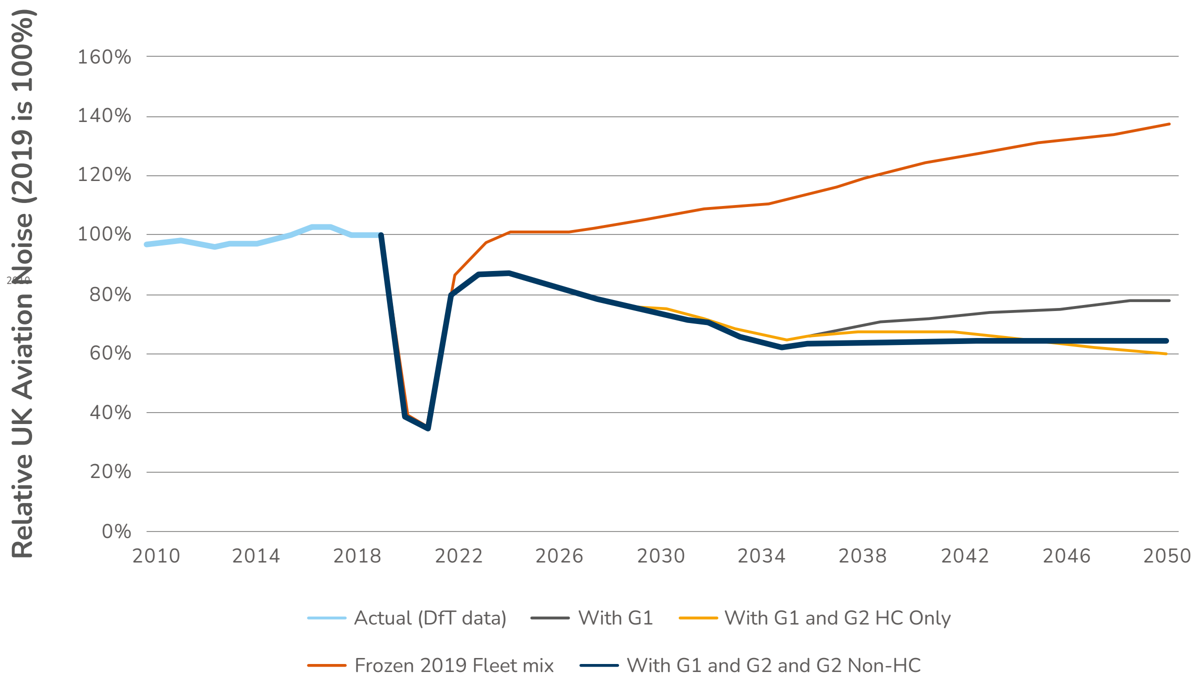


Figure 1: Forecast Changes in UK Aviation Noise Output between 2019 and 2050

These results are a UK average and actual noise exposure at individual UK airports will vary depending on the fleet mix, route structure, number of runways, operating restrictions, land-use planning and the scope for adopting new operational procedures to reduce noise. Therefore, it is not possible to draw direct comparisons between the indicative UK wide noise output trends illustrated here and the future noise footprints of any specific airport.

Technology

Aircraft and engine manufacturers have been researching and deploying low-noise technology for the past 50 years resulting in the very significantly reduced noise levels of latest-generation aircraft which are currently entering service. These aircraft demonstrate up to a 50% noise footprint reduction when compared to the older generation 'Legacy' aircraft they are now replacing, thanks to new engine and airframe design and technology. The introduction of these latest-generation aircraft (Generation 1 or G1) into the fleet will bring, with a relatively high degree of certainty, significant noise output benefits through to the mid-2030's, with the proportion of UK flights operated by these aircraft increasing year on year.

Beyond the mid 2030s, when nearly all flights are likely to be operated using G1 aircraft, securing additional noise reduction benefits will require the introduction of future-Generation 2 (G2) aircraft. Much of the technology and knowledge in both airframe and engine design to achieve G2 low-noise aircraft are yet to be developed, so manufacturers are engaged in extensive noise research programmes. Such research and development programmes are high risk investments, and due to the wider societal benefits of delivering improved aircraft noise performance in future, an element of risk sharing between the public and private sectors will be necessary, for example through continued Government support through research grants.

EXECUTIVE SUMMARY

Operational Improvement Opportunities

Operational improvements provide an opportunity to influence noise both close to the airport and further away. There is scope to extend the use of noise sharing techniques which may reduce the impact of noise on local communities. Operational improvements can be expected to offer noise reductions of between 1 and 5 dB(A). Although marginal, various operational procedures can be combined to provide cumulative effect.

The exact noise improvement will vary for different communities depending on the current noise exposure and local scope for adopting new techniques. Some operational procedures suggested here may not be suitable for all operating environments owing to airspace constructs and aircraft fleet mixes.

Careful consideration needs to be made to balance the effect of noise reductions vs potential carbon/emissions increases, in line with UK regulatory policy and Government policy priorities.

Realising operational improvements to reduce noise may also require changes to airspace and flightpaths around airports. In many cases, these are already part of a wider UK airspace moderisation plan.

Land Use Planning

Housing growth in noise affected areas, alongside growth in Air Traffic Movements (ATMs), will be the main potential factors? Increasing the number of people affected by noise, and so must be managed successfully.

Overall housing and land use planning in the UK is currently in a state of flux. Allied to this is the lack of detailed consideration about planning issues that affect the airport industry. In the most recent reforms, gaps and conflictions in policy that could lead to further residential encroachment around airports have arisen.

The aviation industry, and airports in particular, should play an active role in contributing to and shaping local planning policy. This is to ensure that, where possible, development in noise sensitive areas, and population encroachment into previously noisy areas, are prevented. Any planning controls or agreements should be related to the area of an airport's noise contour rather than the population within it.

UK airports should continue to prepare long-term Masterplans that provide details of future development and forecasts of future impacts (including forecast noise contours). The Masterplan process should be consistent with the Noise Action Plan and be incorporated within local planning policy. There is an Industry commitment to work with Government, local authorities and local communities to achieve improvements required.

Noise Communication and Community Engagement

There are opportunities to improve how residents feel about noise from aviation. This is based on seeking to improve how they understand what noise they are experiencing and why, how operations contribute to the local, regional and national economy, and whether the airport is a good partner to the local community.

Aircraft noise is a complex subject to engage upon in an open, clear, and transparent way. The historic challenge for all airports is to ensure that engagement activities are underpinned by information and noise metrics that are easily understood and relateable. Since the last edition of the SA Noise Road-Map (2013) the industry has made progress in the range and type of communication and engagement with a broader spectrum of stakeholders, particularly on the issues of airport development and airspace change.

Operating Restrictions

Operating restrictions are a blunt disruptive and consequently, expensive way of reducing noise from aviation. They do not encourage progressive holistic improvement in noise management. In line with the ICAO balanced approach, SA considers operational restrictions to be a measure of last resort. Where used, they should focus on the noisiest remaining aircraft.

The aviation industry believes that collaborative working and voluntary agreements are a more effective and responsive approach than operating restrictions but is nevertheless committed to meeting these wherever they apply.

The industry wants to work with Government to develop policies and procedures that drive a move to more proactive ways of managing the impact of aircraft noise.

The benefits of introducing modern aircraft are significant for local communities and remain a win-win for all stakeholders. A vibrant and profitable aviation industry will help accelerate progress in upgrading to these aircraft.

EXECUTIVE SUMMARY

Conclusions - the Way Forward

SA is committed to developing ways to limit and where possible reduce the number of people adversely affected by aircraft noise. SA believes further growth of the aviation sector, at a level projected by the DfT, can be achieved whilst meeting this commitment.

This Road-Map is a toolkit to help all parts of the UK aviation industry assess and implement strategies to reduce noise from aircraft operations. But the aviation industry cannot tackle noise on its own; support and guidance are also required from Government and other stakeholders.

Continued investment into research to understand ways to reduce the effects of aircraft noise by UK industry, supported by government, is required to ensure the downward trend for aviation noise continues from the mid-2030's onwards. This work needs to be done in conjunction with delivering a reduction in Greenhouse Gas and local air quality emissions within the aircraft fleet.

Industry Commitments and Recommend Actions for Government and Stakeholders

There are opportunities to inform how residents feel about noise from aviation based on how they understand what noise they are experiencing and why, how operations contribute to the local, regional and national economy, and whether the airport is a good partner to the local community.

Aircraft noise is a complex subject to engage upon in an open, clear, and transparent way and the historic challenge for all airports is to ensure that engagement activities are underpinned by information and noise metrics that communities can easily understand and relate to. Since the last edition of the SA Noise Road-Map (2013), the industry has made progress in the range and type of communication and engagement with a broader spectrum of stakeholders, particularly on the issues of airport development and airspace change.

Industry Commitments

- The industry is committed to increasing the use of existing operational techniques that reduce noise where safe and feasible.
- The industry is committed to working with others to explore and develop new operational techniques that reduce noise where safe and feasible.
- SA members will use this Road-Map to develop best practice noise management strategies for the future.
- The Aerospace sector will continue to invest in aircraft technology research programmes.
- The Aerospace sector will work towards the visionary noise goals of Flightpath 2050 and CLEEN.
- Industry commits to continue to upgrade aircraft fleets over time, which will mean newer, quieter aircraft are in use.
- The industry will actively contribute to improving aircraft noise guidance in local planning policy.
- Airports will review masterplans to ensure they are consistent with Noise Action Plans.
- Airports will work with Government, local authorities and local communities to achieve identified land use planning improvements.
- The industry will promote open and transparent engagement with communities affected by noise, to better understand their concerns and priorities.
- The industry will ensure that any changes to noise impacts or noise mitigation efforts are clearly communicated through agreed channels in a timely and non-technical manner.
- The industry will present the best practice engagement recommendations from the Road-Map to local stakeholders through channels such as consultative committees to help airport operators better evaluate their engagement techniques.

EXECUTIVE SUMMARY

Government Requests

SA requests the following support from the UK Government.

- Support ongoing research in aerospace technology ensuring the right incentives are in place to enable uptake by the industry.
- Commit to ten-year long-term R&D support to 2035 through the ATI programme, to drive further development of lower noise technologies, required to ensure the downward trend for aviation noise continues from the mid-2030's onwards. This work needs to be done in conjunction with delivering a reduction in Greenhouse Gas and local air quality emissions within the aircraft fleet.
- SA would welcome Government support for research, in partnership with industry, into innovative solutions to mitigate noise, including operational trials and airspace changes where these are required to prove the concepts of new and emerging techniques.
- The DFT has commissioned several studies into the impacts of flying on health but to date has not develop robust metrics to assess the benefits. This is critical to the Balanced Approach and should be carried out before the next night flights regime begins. This is an opportunity to ensure that when decisions on future regimes can be made with full regard to the Balanced Approach taking into account both the local and national strategic economic importance of night flights, in the context of aircraft noise impacts.
- Work with the industry, local authorities and communities to optimise noise communication, monitoring and reporting processes.
- SA supports a policy statement on the application of the balanced approach to local planning decisions affecting airports. Such a statement should provide guidance for local authorities on the application of the Balanced Approach to local planning decisions, including on night controls, where these have a national, economic implications.
- Ensure that operational restrictions are employed only as a final resort after full consideration has been given to the other three dimensions of the ICAO Balanced Approach, namely:
    - Reduction of noise at source.
    - Land use planning and management.
    - Noise abatement operational procedures.
    - Operating restrictions on aircraft.
- SA requests the Government commissions further independent research on:
    - Community perceptions of aircraft noise, in particular the issue of noise annoyance vs. noise acceptability and the role of non-acoustic factors.
    - The various noise metrics that are available and evaluate their parameters. In particular, the proportion of populations located under specific noise exposure bands that are classified as 'highly annoyed' by aircraft noise. The outcomes of this research would be expected to inform government aviation noise policy.
    - The effectiveness on health and wellbeing of noise mitigation interventions such as noise insulation. The outcomes of this research would help inform engagement between airports and noise affected communities.
    - The value of night flights - this is critical to the Balanced Approach and should be carried out before the next night flights regime begins. This is an opportunity to ensure that when decisions on future regimes can be made taking into account both the local and national strategic economic importance of night flights, to measure against aircraft noise impacts.

Requests to Other Stakeholders

SA will work collaboratively with local authorities, local communities and other community support organisations to encourage that they:

- Work with the aviation industry to achieve a successful outcome.
- Share relevant information in a timely manner with their constituents.
- Acknowledge successes achieved by the industry as well as highlighting areas for improvement.
- Work to manage housing growth under flight paths to avoid increasing exposure to aviation noise.

CONTENTS

1. INTRODUCTION

1.1 About this Document

This Noise Road-Map seeks to set out the anticipated future trajectory for noise impacts from aviation in the UK. It will review progress since the last Road-Map (2013) and set out an updated evidence-based set of projections, with options for actions by industry and government to manage noise impacts. The document is aimed to help inform debate, actions and policy formulation. The Road-Map also serves as information for individual parts of the UK aviation industry to help them assess, improve and implement actions for reducing noise impacts from aircraft operations.

It presents an overview of aircraft noise at a UK level. It does not, nor should it be interpreted as, providing details for any specific Airport. Actions or noise forecasts for individual locations will be developed separately from this report and it should not be used a prediction for individual sites.

The 2nd Sustainable Aviation Noise Road-Map is published in the context of a noise debate that is focusing on a wide range of issues, including the nature, acceptability and impacts of aircraft noise. Issues such as noise dispersion versus concentration, the economic benefits and social acceptability of night flights, and the noise level at which communities become impacted. Government continues to keep aviation noise policy under periodic review, along with the specific issues around night flights. Research continues into the health effects of noise as experienced by people, which will help shape government policy in future.

This document aims to make a useful contribution to those debates by setting out industry views on the expected trajectory of noise output from aviation in the UK and issues around noise management that can be addressed under the ICAO Balanced Approach.

Sustainable Aviation (SA) is a unique alliance of the UK's airlines, airports, aerospace manufacturers and air navigation service providers. Together, we drive a long term strategy to deliver cleaner, quieter, smarter flying. SA was the first alliance of its type in the world. Our work has included developing Road-Maps on key environmental issues, defining the nature of the challenges and how they can be addressed and reporting regularly on the industry's progress in reducing aviation's environmental impact.

1. INTRODUCTION

1.2 UK Aviation's Economic Value[1]

Aviation brings massive social and economic benefits to the UK. It supports trade, tourism and investment and enables British people to engage with the world, whether for business or pleasure. In a normal year aviation facilitates over 140 million passengers coming to or leaving the UK. Almost 450 destinations round the world are served from the UK. Spending by foreign tourists creates £27 billion to the UK economy each year.[2] Almost two thirds of British people take the opportunity of foreign holiday each year[3]. Millions of these passenger journeys are also for business purposes, enabling British people to build businesses connections abroad and helping secure foreign investment in the UK.

Air freight is small in volume but massive in economic importance. It carries half of the UK's intercontinental exports (when judged by value) and over a third of our imports. Key industries reliant on air freight connections include pharmaceuticals, computers, electrical and the creative arts[4]. Most air freight goes in the hold of passenger planes, but vital just-in-time connectivity is also provided by dedicated freight only services.

The UK's aerospace manufacturing sector is the world's second largest, directly employing over 100,000 people and directly generating over £10 billion of UK GDP, with a further £7.6 billion of UK GDP being generated by the aerospace sector's supply chain[5]. The sector brings further economic benefits through the generation of intellectual property which frequently has spin-off benefits in other sectors.

UK aviation supports one million jobs and contributes £22bn a year to the economy. Holistically aviation contributes £93 billion to the UK economy each year, equating to 4.5% of British GDP[6].

1.3 Covid, Aviation and Noise

Whilst the aviation industry is now recovering well from the COVID pandemic there are a number of consequences that have resulted.

The noise characteristics from UK aviation have fundamentally changed with the accelerated phase out of the Boeing 747 aircraft from both British Airways and Virgin Atlantic fleets, and their replacement by quieter large twin engined aircraft. In 2022 for instance, a similar level of passengers were handled by 5 of the major UK airports compared to 2013, whilst their combined noise contour footprint reduced by over 60 square kilometres.

The significantly lower levels of aircraft operations during the COVID pandemic than usual, coinciding with an increase in people working from home, may have created a new expectation of aircraft noise by communities living close to airports.

The aviation industry made significant financial losses during the pandemic, which will take a number of years to recoup.

1 All figures pre-Covid
2 IATA
3 ABTA
4 Steer
5 Oxford Economics 2011 Economic Benefits from Air Transport in the UK
6 IATA

1. INTRODUCTION

How noise measuring works – decibels explainer

The amount of noise produced by an aircraft is measured in Decibel units (dBs). At its crudest, dBs tell us how much acoustic energy(Footnote strictly acoustic intensity) is present using a logarithmic scale, which is different to the type of scales we normally use in everyday life. Normally we use linear scales where an increase in the scale implies a proportionate increase in the thing being measured. So, for instance, we know that an 8Watt lightbulb will consume twice the energy of a 4Watt lightbulb, which, in turn, consumes twice the energy of a 2Watt lightbulb.

In a logarithmic scale like dB, the increases increase in scale as you go up the numbers. This kind of scale is used because the human ear can detect a very large range of acoustic energy levels so using a linear scale would result in either excessive use of decimal places or extremely large numbers, both of which are unwieldy. On the decibel scale, the quietest audible sound (perceived near total silence) is 0 dB, while a sound with ten times the energy is 10dB and one with 100 times the energy of the quietest sound perceivable is 20dB. A sound with 1,000 times the energy of the quietest sound perceivable is 30dB, and so on.

Furthermore, our perception of loudness does not correspond directly to the amount of acoustic energy. The ears sensitivity to sound diminishes as the amount of acoustic energy increases which makes the dB scale very useful as a measure of our perception of loudness. Roughly speaking, an increase of about 10dB in sound is subjectively perceived as a doubling in loudness.

This is very important in aviation noise as it can mask very significant changes in noise output, as they only appear to be a few numbers apart (which on a linear scale would mean very little change). So for example, 70 dB looks close to 80 dB but is in fact half as loud. 60 dB is then half as loud as 70 dB again, and so on. So, when a change in operations, technology etc. results in a reduction in noise on the ground from, say, 78 dB to 73 dB, this is not a minor adjustment but a very considerable reduction.

Unfortunately this is not the whole story. Noise measurement also needs to take account other factors in how the human ear responds to different types of sound and their duration. It is well known that our ability to detect sound depends on its frequency. We also know that certain types of noise are more annoying than others, independently of their loudness, and that continuous sounds can interfere with everyday life more than a louder short duration sound.

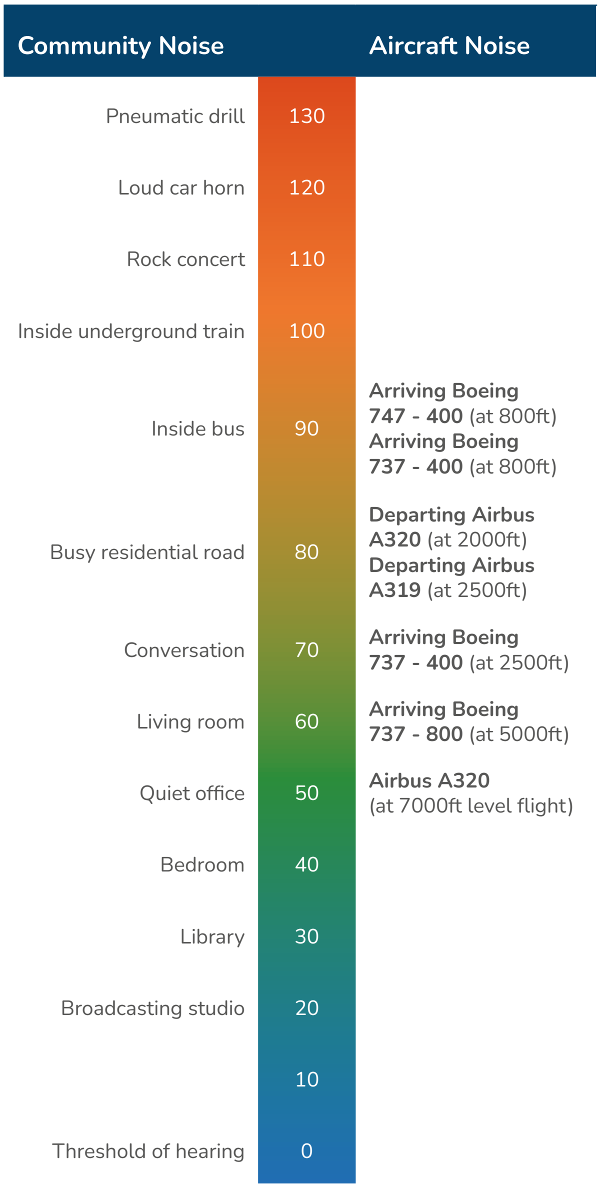


Figure 2: Noise and decibels.

To account for these types of things supplemental units are used. The A-weighted sound level known as dBA is used to express the subjective response to noise and includes a weighting that varies with both intensity and frequency. A further measure is Effective Perceived Noise measured in Decibels - EPNdB. This measurement accounts for the human response to spectral shape, intensity, tonal content, and duration of noise from an aircraft.

Lastly, a common way of reporting noise close to airports is by way of Leq values. This represents an average of the noise from many different aircraft operations over a given period of time.

7 It should be noted dB uses 0 as its first measurement rather than 1, so 0 is the lowest level of sound possible for the human ear to detect.

1. INTRODUCTION

1.4 The Noise Challenge

A variety of metrics are used to judge noise output on the ground. Noise contours are a key measure used by the CAA and industry. Noise contour maps make it possible to identify how many people live in areas where there is significant annoyance from noise. They allow planners to consider noise or projected noise when working within affected areas, though they must balance economic, environmental and social factors when making decisions.

Noise contours have played and will continue to play an important role in representing ‘area-wide’ changes in noise exposure and how these change over time, but SA recognises that they can be difficult to explain and that local communities do not always feel that contours accurately reflect their individual experiences of noise.

This illustrates one of the most significant challenges in producing this Road-Map: the subjective nature of noise. As history and experience of seeking to manage aircraft noise issues have shown, people’s reactions and perception of aircraft noise is complex. The reduction in aircraft noise achieved by the industry over the last half century has clearly resulted in fewer people being significantly affected by noise within the 57 Leq contour. However, based on regular stakeholder feedback received by the industry, and reinforced in the UK Government’s Aviation Policy Framework, it is apparent that noise from aircraft operations can be a source of tension between airports and some people within local communities. Some local residents believe that current noise metrics, including the use of average noise contours, do not fully reflect their experience of aircraft noise. Consequently, SA still believes the number of people annoyed by aircraft noise is made up of a range of inter-related variables which combine to generate the total result as shown in figure 3.

1. INTRODUCTION

1.4 The Noise Challenge (continued)

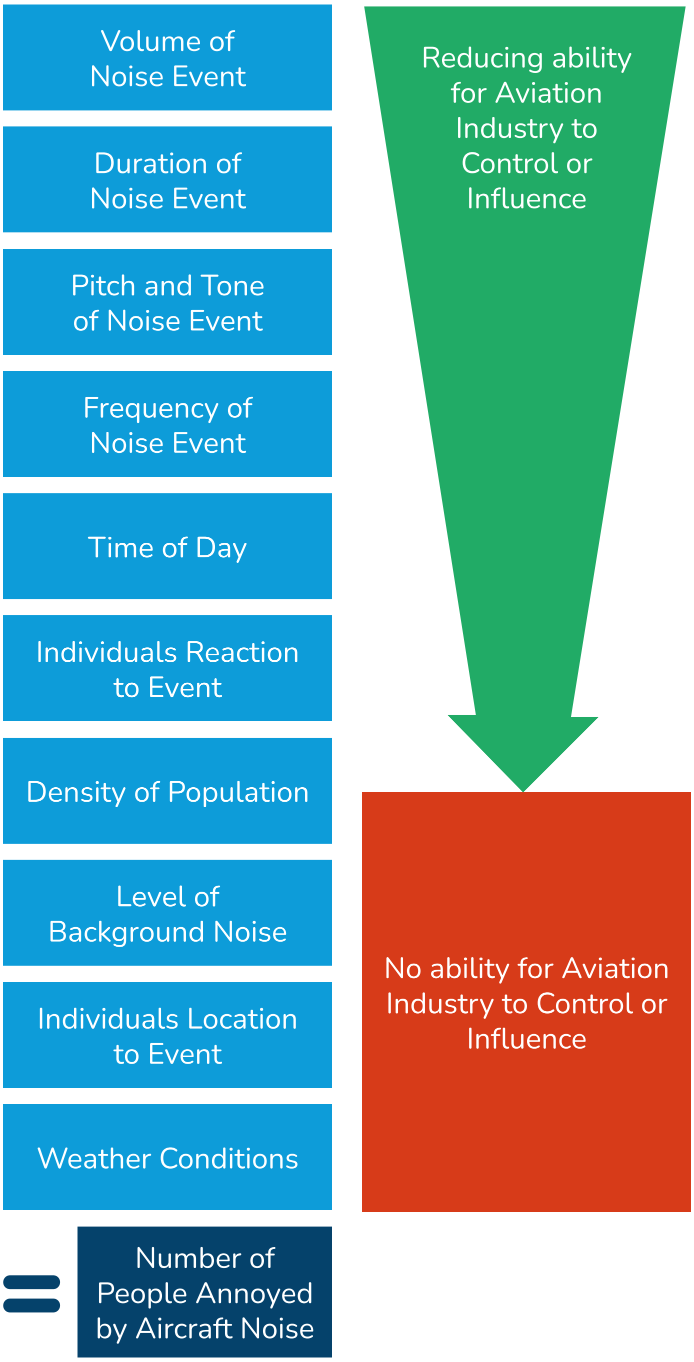


Figure 3: The Noise Challenge in reducing the number of people affected.

Three key conclusions arise from this diagram.

1. The number of people impacted by each variable is not consistent, for instance a loud aircraft event on a windy morning generally results in fewer people annoyed than the same aircraft event on a still, foggy morning.
2. While the aviation industry can take direct control of some of the variables, it has only indirect influence over others and no control at all over the remainder.
3. Research is required to understand in more detail the specific weighting and inter-relationships each of the variables has on the final result.

This makes the job of measuring, managing and reducing the number of people affected by noise from aircraft a challenge. Consequently this Noise Road-Map has been designed to identify and advocate best practice approaches to matters of land use planning and community engagement as well as how technology and operational advancements can reduce noise issues from aircraft operations.

In addition to the complexities outlined in Figure 3 above, the nature of the noise problem can often change over time, or as a result of attempts to reduce its impact. For example, noise from departing aircraft was at one time the key area for concern among communities. Technology solutions were developed to reduce noise on departure, only for this to highlight the relative impact of arrival noise. Reducing the source noise of aircraft engines led to a need to focus on airframe noise as that source then became dominant. These unintended consequences of industry action to reduce noise impacts demonstrate the complexities of this work. Efforts to reduce noise impact can also result in other unintended outcomes; a drive to concentrate noise impact on as few people as possible will obviously have adverse effect on the few that experience all of the noise. Reducing engine source noise often drives weight increase and therefore additional fuel burn and emissions. This dynamic nature of noise problems along with the risk of trade-offs and unintended consequences must be borne in mind when seeking to limit and reduce noise impacts.

Clearly, perception of noise is a significant issue which requires further research and a shared commitment from the industry, Government, local authorities and communities to resolve.

1. INTRODUCTION

1.5 Scope of the SA Noise Road-Map

Issues of aircraft noise fall into two key categories, noise generated while the aircraft is in flight and noise generated while the aircraft is on the ground. The scope of this document is noise from aircraft in flight, as noise from aircraft on the ground have separate characteristics, as well as lesser impact. This issue was however addressed in the aviation industry Departures and Arrivals Code of Practice[8].

The Noise Road-Map addresses the management of noise impacts from aircraft movements arriving and departing UK airports out to 2050. This timeframe is intended to make the document consistent with the commitment to reach net zero by 2050, which will be the context in which aviation needs to operate. The previous Road-Map generally considered noise generated as the key metric. This update will start to seek to incorporate where possible a more rounded assessment of the actual issue of concern – the trend in noise effects on people.

Figure 4 summarises how we continue to consider the aspects of aircraft noise management. It sets out how the mitigation and management of these sources of noise can be split into five main categories which will be specifically explored in this Road-Map.

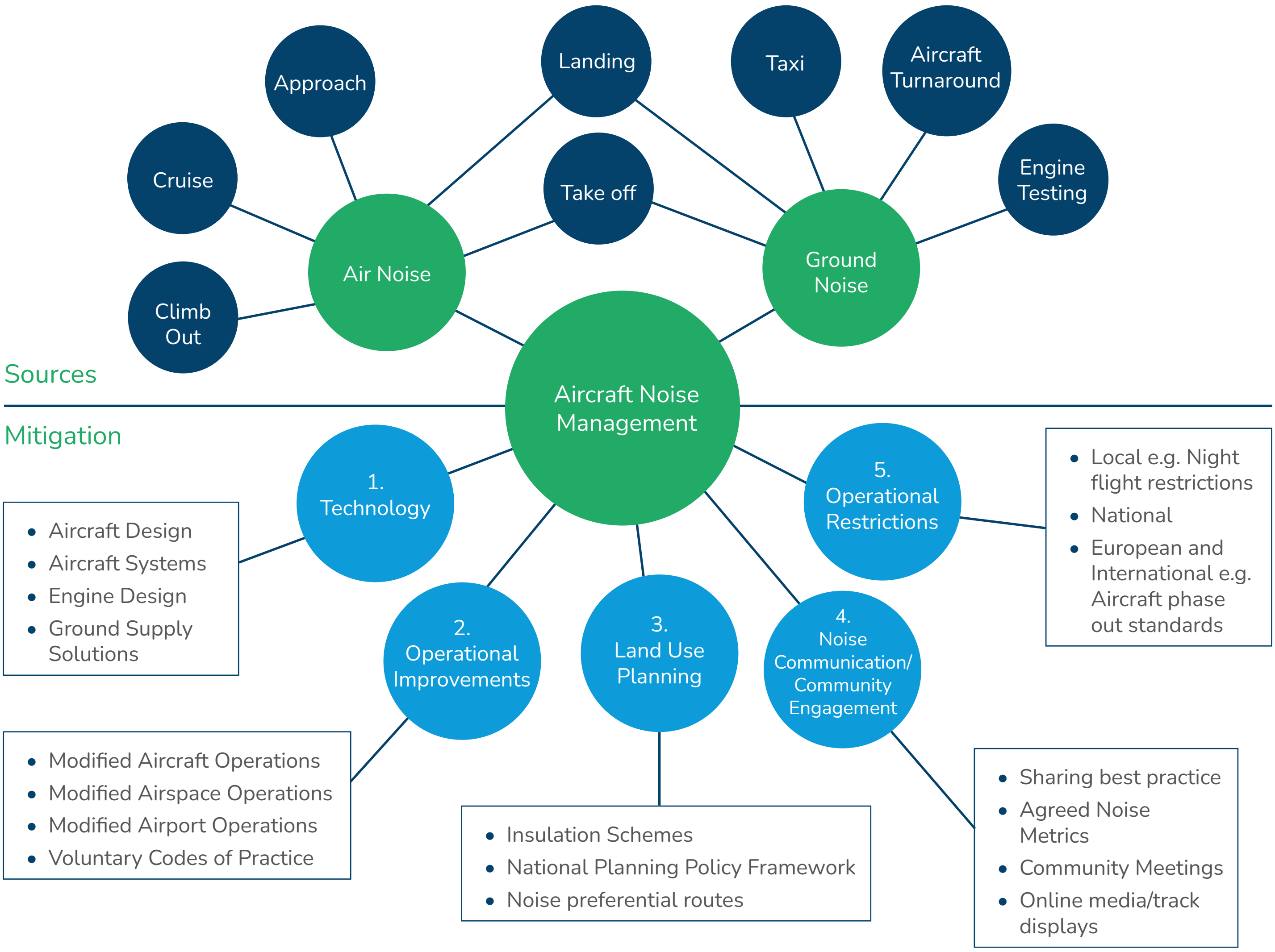


Figure 4: Sources and Mitigation of Aircraft Noise around Airports

8 www.sustainableaviation.co.uk/wp-content/uploads/2019/10/ACOP-v2-2006.pdf

1. INTRODUCTION

1.5 Scope of the SA Noise Road-Map (continued)

Our noise forecast work in the Road-Map is based on the latest UK Department for Transport aviation forecasts[9] amended to account for Covid and airport development plans since that date. It therefore includes assumptions of airport development in future including new runway infrastructure, but should not be taken as a recommendation of any specific proposal, as these are a matter for individual airports.

2017 - https://www.gov.uk/government/publications/uk-aviation-forecasts-2017

2018 - https://assets.publishing.service.gov.uk/media/5b16b68d40f0b634b469fa35/making-best-use-of-existing-runways.pdf

2022 - Jet Zero Strategy - https://www.gov.uk/government/publications/jet-zero-strategy-delivering-net-zero-aviation-by-2050

2024 - Announcement of updated aviation modelling framework - https://assets.publishing.service.gov.uk/media/668546fa541aeb9e928f43eb/dft-aviation-modelling-framework.pdf

This is then combined with knowledge from various current noise research programmes, together with the expert experience of UK aerospace manufacturing, airline, airport and air traffic service provider companies, many of which have a global reach to understand the noise implications of the assumed numbers of air traffic movements (ATMs).

Aviation is a highly regulated industry and noise generated by aircraft is the subject of extensive regulation and controls. These controls exist at international, national and local levels. A diagrammatic summary of aviation regulation is given in Figure 5 below.

International

- Aircraft operating standards
- Aircraft noise certification and phase out standards
- Balanced approach guidelines to aircraft noise management

National

- UK policies and regulations developed to ensure safe aircraft operations and manage aviation noise. This includes requirements at the three 'designated' airports and requirements for all airports to produce and report on noise action plans

Local

- Company operating procedures to enable and provide safe aircraft operations
- Operating controls agreed between local authorities and the aviation industry to address noise issues as they affect the local conditions, such as noise preferential departure routes from airports and maximum permitted noise contour areas as airports grow

Figure 5: Hierarchy of regulation relating to Aircraft Noise

9 DfT UK aviation forecasts 2017

1. INTRODUCTION

1.6 Methodology to our Noise Road-Map

The approach taken to develop our Road-Map is founded on the ICAO Balanced Approach to aircraft noise[10]. This establishes four principal elements for managing aircraft noise:

1. Reduction of noise at source
2. Land-use planning and management
3. Noise abatement operational procedures
4. Operating restrictions

SA has added an additional principal element, that of noise communication and community engagement. Although this is noted as an important element in the Balanced Approach, this document goes much further, giving examples and suggesting a possible basis for 'best practice'.

We have adopted a step by step approach to this Road-Map:

- We first consider the DfT's projection for growth in demand for UK aviation allowing for reaching net-zero carbon, using it to derive a hypothetical "no-improvements" noise emission scenario, corresponding to a level of technology, operational practices and land use planning controls for today's aircraft operations.
- We then consider the potential for mitigation of noise impacts from:
  - The adoption of improvements in quieter engines and aircraft design
  - Opportunities to reduce noise from improved airspace and aircraft operational techniques
- We explore the issue of land use planning controls to see how these could be used to greater effect to mitigate or avoid noise impacts to communities around airports.
- We then discuss opportunities to improve community engagement with the aviation industry on aircraft noise, looking at noise communication, measurement and reporting techniques and how these can be improved.
- We then review the issue of operating restrictions.

Using this structure and some assumptions, our Noise Road-Map is presented out to 2050.

This Road-Map is designed as a toolkit for SA members to use in considering their individual noise management strategies for the future. The use of the Road-Map in this way will enable the industry to exhibit clearly to Government and communities around airports what the future noise situation could be and, most importantly, be clear about their strategy to limit and where possible reduce the impact of airport noise.

1.7 Conclusion

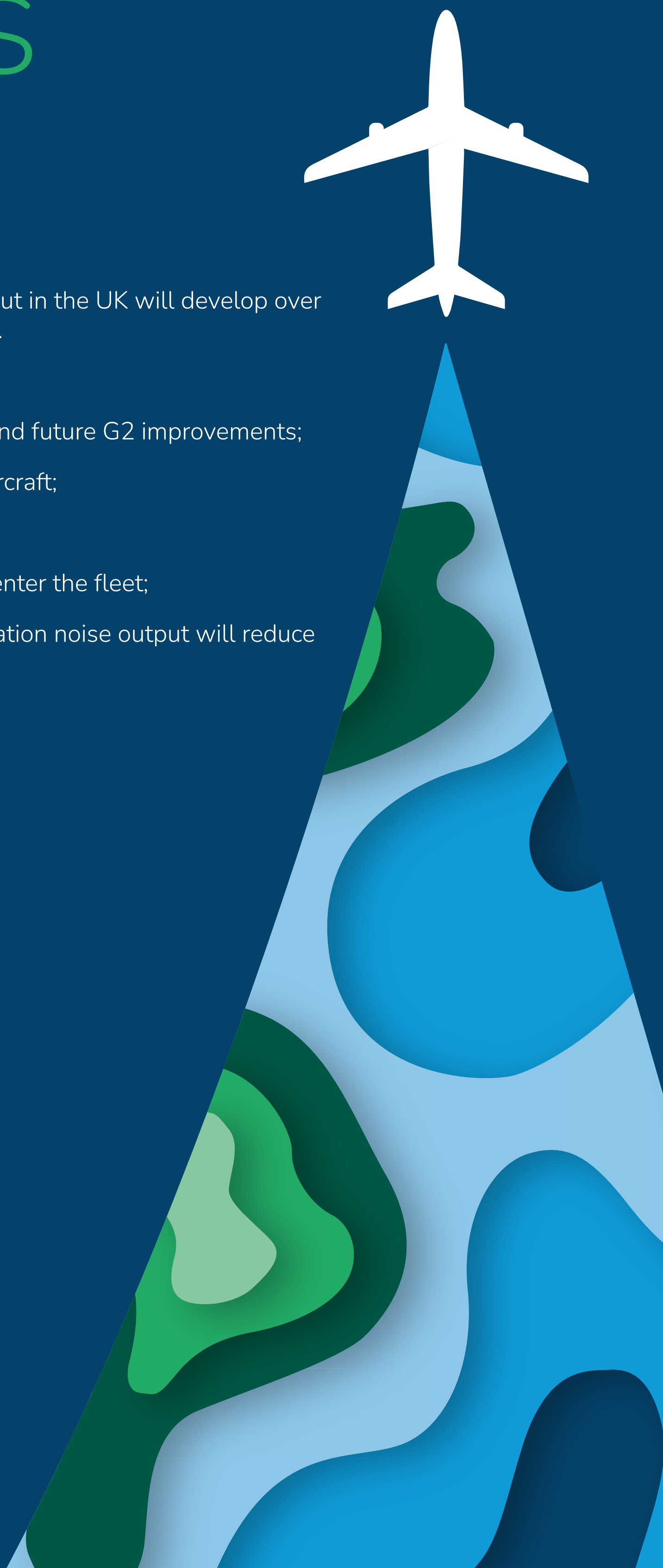
Based on the value of aviation to the UK economy and the industry's track record of reducing noise, SA believes further growth of the aviation sector, at a level projected by the DfT, can be achieved whilst effectively meeting the Government's stated objective of limiting and where possible reducing the number of people affected by noise from aircraft operations.

Given the complex nature of individual reactions to aircraft noise events, successfully reducing the number of people affected by aircraft noise in the future will require collaborative multi-stakeholder participation.

This document aims to promote knowledge and understanding in this area, helping encourage and support further work on noise. SA members will continue to focus on noise issues and the mitigation of the adverse effects they have upon communities.

10 Ref: ICAO Doc. 9829, AN/451, "Guidance on the Balanced Approach to Aircraft Noise Management", second edition 2008, ICAO

2. NOISE OUTPUT FORECASTS AND SCENARIOS



This section will set out how industry forecasts aviation noise output in the UK will develop over the next decades, and the basis on which this assessment is made.

We discuss the following:

- the evidence base and our assumptions concerning legacy, G1 and future G2 improvements;
- Our assumptions concerning the noise footprint of G1 and G2 aircraft;
- Our assumptions about aviation growth in the UK;
- Our assumptions concerning the rate at which new aircraft will enter the fleet;
- Our calculations, based upon these assumptions on how UK aviation noise output will reduce as quieter aircraft are introduced.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

Key Messages

Noise output is shown to reduce in total, compared to 2019 levels over the next 10 years, despite air traffic movements increasing. Continued noise improvement research by UK industry, supported by government, is required to ensure this trend continues from the mid-2030's onwards. This work needs to be done in conjunction with delivering a reduction in Greenhouse Gas and local air quality emissions within the aircraft fleet.

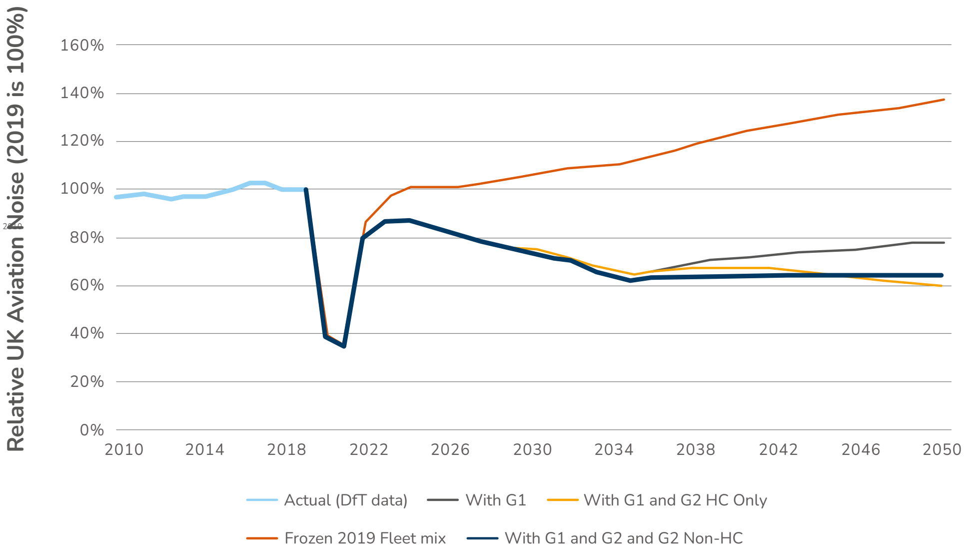


Figure 6: Forecast Changes in UK Aviation Noise Output between 2019 and 2050.

Higher fleet growth rates in regions around the world mean the UK will outperform the global trend on aviation noise. However, it remains vital that the UK aviation industry continues to adopt new noise technologies where available, in order to minimise noise exposure in accordance with the ICAO Balanced Approach to Aircraft Noise Management.

It should be noted that the noise forecasts presented in this roadmap are a UK average and actual noise exposure at individual UK airports will vary depending on the fleet mix, route structure, number of runways, operating restrictions, land-use planning and the scope for adopting new operational procedures to reduce noise. Therefore, it is not possible to draw direct comparisons between the indicative noise output trends illustrated here and the future noise footprints of any specific airport. SA member airports are committed to continuing their own work to manage noise in line with the work set out elsewhere in this Road-Map.

2.1 Aviation Forecasts

SA's 2023 CO_2 Road-Map used forecasts of passenger growth based on the forecasts of the UK's Department for Transport (DfT). For this report, this is converted to an Air Traffic Movement (ATM) forecast based on the fleet mix in 2019, with subsequent years ATMs assuming the same fleet mix increased in proportion to passenger numbers. This is done because ATMs are the more relevant parameter for aircraft noise.

Broadly, over the period from 2019 to 2050, ATMs in UK will grow annually by varying amounts between 0.8% and 2%, resulting in the overall growth by a factor of about 1.4 by 2050 (ie 40% growth to reach 140% of 2019 levels). This growth rate is less than that assumed in some global assessments (e.g. the global growth in passenger traffic of 3.6% per year over the next 32 years in ICAO's Environmental Report of 2022) as the UK is a relatively mature aviation market. The effect of higher traffic growth can be seen in the ICAO 2023 global noise trend prediction which shows a number of noise reduction technology scenarios which result in generally increasing global aviation noise[11].

11 Global trends in Aircraft Noise (icao.int) Figure 1-10.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

2.1 Aviation Forecasts (continued)

The historical noise trends presented between 2010 and 2019 are not measured data. Rather, the levels presented are calculated using historical ATM data (Source: DfT statistics on aviation activity are available at: https://www.gov.uk/government/statistical-data-sets/aviation-statistics-data-tables-avi#activity-by-uk-airlines-avi02-series -- We used Department for Transport table code: TSGB0201 (AVI0101).

Noise calculations were made in the same manner as that for the period 2019—2050 taking 2019 as being 100%. The fleet make-up was assumed constant over the period save that where G1 aircraft were present in 2019 it was assumed that they had been introduced over a period starting at their initial EIS date. The certification levels for all aircraft was taken to be that used in 2019. Because of this it is likely that the historical noise shown is an under estimate of the actual noise.

2.1.1 Demand Growth Projections

For the UK aviation market, the Government forecasts predict an average growth of approximately 1%. Aviation industry forecasts that look at global or regional demand growth, within which the UK demand is incorporated, and show global aviation growth forecasts of over 3% per annum[12].

The previous full SA Noise Road-Map forecast took place in 2013 and was based on the DfT aviation forecast existing at that time. Since 2013 DfT has published the 2017 UK Aviation Forecast[13] with supplemental information from 2018 related to the "Making Best Use" report[14]. Both forecasts were published prior to the COVID-19 pandemic and the UK Government subsequently updated its model and demand forecast for aviation as part of their work on the Jet Zero Strategy, published in 2022 in its further technical consultation[15]. This produced a range of scenarios from a 'policy off' baseline to the 'high ambition' scenario, with the 'high ambition' scenario being adopted for the central Jet Zero Strategy case.

To align with the SA CO_2 Road-Map[16], SA has used the UK Government 'policy off' baseline forecast to develop the hypothetical 'no-improvements' noise forecast in this Road-Map. Firstly, a baseline year of 2019 was chosen, against which to compare future changes. This year was chosen as it reflects the last year of normal aviation activity prior to the COVID-19 pandemic.

The Government forecasts available did not include the effect on aviation activity of the COVID-19 pandemic. Therefore, these forecasts were modified using insights from the World Economic Forum[17] on the rate of activity recovery following the pandemic, to define noise emissions as a percentage of the 2019 baseline year. The resulting passenger demand forecast was then used as the basis for the noise predictions shown in this Road-Map.

2.2 Hypothetical 'No Improvement' Noise Forecast

To calculate the noise emissions from flights departing from and arriving into the UK an assumption on the type of aircraft used is required. To create a 'hypothetical no improvement' noise output forecast, the mix of aircraft types are locked at their 2019 values. In future years, any growth in demand is met using a growing number of aircraft conforming to the 2019 fleet mix.

This scenario does not correspond to a "business as usual" scenario. Business as usual involves the regular replacement of older generation aircraft with newer aircraft as airlines seek to meet customer expectations, operating restrictions at airports and avoid escalating operating costs associated with older aircraft types. It is a hypothetical scenario based on no technology change from 2019 so as to enable us to correctly calculate the effects of ATM growth without technology change.

It should be noted that the 2019 fleet mix comprises both older and newer aircraft types. These are designated as "Legacy" and "Generation 1" (G1) aircraft. In practice legacy aircraft are increasingly being replaced by G1 aircraft as airlines seek to reduce the noise and CO_2 emissions of their fleets, but in the "no improvement" scenario we assume that the relative numbers of legacy and G1 aircraft types remain at the same ratio as in 2019.

12 ICAO Environmental Report 2022
13 UK aviation forecasts 2017 - GOV.UK (www.gov.uk)
14 https://www.gov.uk/government/publications/aviation-strategy-making-best-use-of-existing-runways
15 Jet Zero: updated evidence and analysis to inform our strategy for net zero aviation - GOV.UK (www.gov.uk)
16 https://www.sustainableaviation.co.uk/wp-content/uploads/2023/04/SA9572_2023CO2RoadMap_Brochure_v4.pdf
17 When will air travel return to pre-pandemic levels? | World Economic Forum (weforum.org)

2. NOISE OUTPUT FORECASTS AND SCENARIOS

2.2 Hypothetical 'No Improvement' Noise Forecast (continued)

The growth in air traffic movements (ATMs) results in a direct increase in total UK aviation noise output. Applying this approach shows how the noise output would change between 2019 and 2050 as a percentage of total noise emissions in 2019, as shown in figure 7.

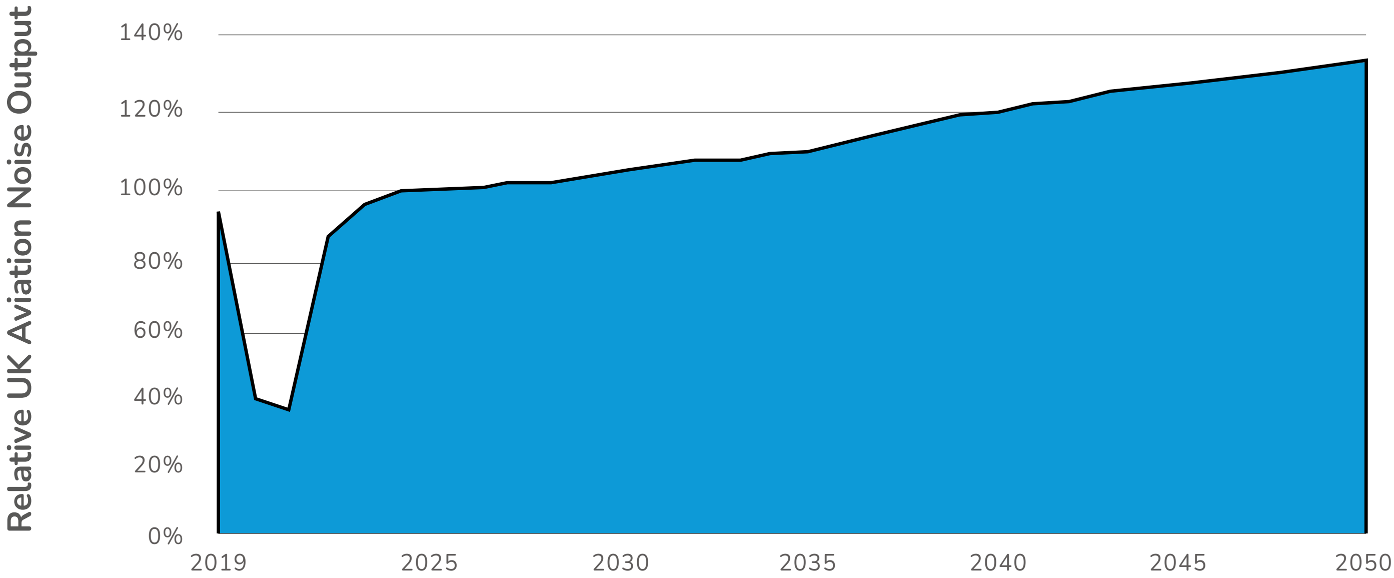


Figure 7: Relative UK Aviation Noise under "no-improvement" scenario.

This shows that, as you would logically expect, with ATMs increasing by nearly 40% over the period, we would expect that the use of a 2019 mix of aircraft to deliver this growth would result in the noise output also increasing by 40%.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

2.3 Assumptions concerning Generation 1 Aircraft (G1)

Aircraft incorporating G1 technology with significant noise and fuel burn benefits are mostly now in service (i.e. on sale and in use, though not yet dominating the fleet) including re-engined and all-new aircraft such as Airbus A330neo, A350, Boeing 787, Boeing 737 MAX and Airbus A320neo and A220 families and Embraer E2 series. These are aircraft whose noise characteristics are well-defined and for many examples are already certificated for noise. G1 aircraft yet to enter service include longer range versions of the A321neo and 777-9 and variants. The G1 aircraft impact on noise reductions at source from UK aviation over the next decades will be substantial.

We consider four distinct categories of G1 aircraft, namely Regional Jets, Single-Aisle aircraft, Twin-Aisle aircraft and Very-Large Aircraft in the UK Fleet Noise model. Within these categories, we do not distinguish between G1 aircraft produced by different manufacturers, but we do sometimes distinguish between light, medium and heavy weight versions[18]:

Categories of Generation 1 (G1) Aircraft	
Regional Jets (RJ)	These include noise level representative of aircraft such as the Embraer E2 family and Airbus A220.
Single-Aisle (SA)	We divide this category into small, medium and large family members (e.g. A319neo, A320neo and A321neo). Boeing 737 MAX family aircraft are also represented in these categories.
Twin-Aisle (TA)	There are three aircraft size dvisions, including Small TA represented by A330-800, Medium TA including Boeing 787-8 and -9 and A350-900 and Large TA such as A350-1000 and 777-9.
Very Large Aircraft (VLA)	We do not sub-divide this category, since the noise levels of the Generation 1 aircraft (A380-800 and B747-8) are broadly similar.

Table 1: Categories and Divisions of G1 Aircraft.

A number of these G1 aircraft have already been certificated. Table 2 and Figure 8 compare their noise levels with the levels of the aircraft they are replacing for two cases. We use the improvement in the average certificated margin to ICAO Chapter 3 aircraft as recorded on the European Aviation Safety Agency (EASA), database to characterise their noise improvement.

Legacy Aircraft	Bypass Ratio	Arrival Noise	Departure Noise[19]	G1 Aircraft	Bypass Ratio	Arrival Noise	Departure Noise
B767	4-5	-4.8dB	-5dB	B787	9-11	-5.8dB	-10.4dB
B747-400	4-5	-1.9dB	-5.9dB	B747-8	9-10	-4.5dB	-11.2dB

Table 2: Noise of legacy and G1 aircraft relative to Chapter 3.

18 The Sustainable Aviation CO_2 Roadmap does not consider these sub-divisions, but they are more critical for noise.

19 Average of Lateral and Flyover margins.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

2.3 Assumptions concerning Generation 1 Aircraft (G1) (continued)

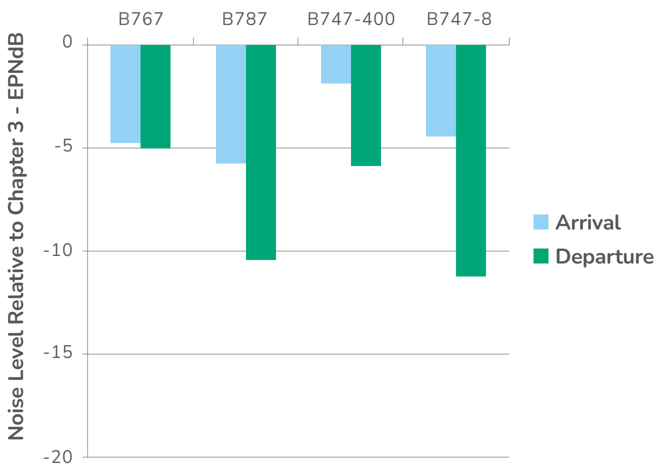


Figure 8: Noise of legacy and G1 aircraft relative to Chapter 3

We apply this typical level of improvements in noise across aircraft categories when predicting the noise of last remaining G1 aircraft that have not yet been certificated and hence whose noise is not yet known.

2.4 Assumptions concerning Generation 2 (G2) Aircraft

The technology and knowledge in airframe, engine and nacelle design to achieve further long term noise gain is currently being acquired, with manufacturers engaged in extensive noise research programmes with financial support from government. In the UK, industry and government have funded extensive collaborative noise research programmes using the capabilities of universities, research establishments and industry. Previously the Technology Strategy Board (TSB) and now the Aerospace Technology Institute (ATI) has funded several cost-sharing research projects into aircraft noise reduction. Progress towards long-term noise goals will largely depend on maintaining and enhancing funding support for noise research and development in the UK and elsewhere.

Our assessment of the noise reduction potential of the G2 aircraft in each of the four categories is derived with reference to the corresponding G1 aircraft, and is driven by three factors:

- the entry into service (EIS) date of the G2 aircraft type relative to its G1 predecessor;
- the rate of underlying annual improvement in aircraft and engine noise levels through evolutionary developments in technology;
- Any significant technologies or configurational changes which result in a step-change in aircraft noise.

Clearly, when attempting to form a view of the likely capabilities of aircraft decades into the future, we must be aware of the significant uncertainty in any assessment. The following constitutes Sustainable Aviation's judgement concerning each of the above three bullet points and should not be interpreted as a statement of intended product strategy. The decision to launch a new aircraft product is influenced not only by technology readiness but by many other factors such as the market demand, maturity of the in-service fleet, the prevailing economic situation, regulatory pressures and oil price predictions.

An important additional factor, partly envisioned in the previous noise Road-Map, is the requirement to reduce CO_2 emissions in line with the UK's 2050 net-zero ambition. It is assumed that a significant reduction in aviation's net CO_2 output will be achieved by the replacement of current aviation fuels with SAF, meaning that gas-turbine technology will continue to develop well into the future. However, it is also envisioned that a number of novel future products including electrical, and hydrogen powered aircraft are introduced to portions of the fleet. Where applicable, the basis for the following assumptions in the SA Noise modelling is consistent with that used in the SA Carbon Reduction Road-Map.

As a note on terminology, Hydro-carbon (HC) means aircraft powered by kerosene or SAF (drop in or not), whilst non-HC aircraft are those powered by hydrogen or electric.

Electric Aircraft

It is assumed that future electric aircraft in this timeframe are limited to 19 seats and an 800nm range. Within this range, routes once serviced by larger aircraft are upgraded to small electric aircraft, multiplying the number of flights as required. A multiple of at most 2 is accepted when replacing baseline activity with electric aircraft. The earliest EIS date is expected to be 2028. When technology capability is considered, it is assessed that electric aircraft start to partially replace the Turboprop and Turbofan Regional Jet categories.

The noise levels of electric aircraft are based on levels calculated within the NAPKIN[20] and FlyZero[21]UK projects.

20 https://www.heathrow.com/content/dam/heathrow/web/common/documents/company/about/future-flight-challenge/Technical%20Report%20-%20Noise%20Assessment%20(University%20of%20Southampton).pdf

21 https://www.ati.org.uk/flyzero/

2. NOISE OUTPUT FORECASTS AND SCENARIOS

Hydrogen Aircraft

Two notional types of future hydrogen aircraft have been utilised to create the bottom-up scenarios for fleet category replacement, based on the expected capability of the aircraft. In all cases it is not specified whether the products are new airframes or retrofit solutions, or whether the propulsion techniques involve hydrogen combustion or fuel cell technology: the trend is given for a mix of all these technical choices, in average. A regional hydrogen aircraft is assumed to have 70 seats and 800nm range capability, with first availability from 2028. A narrow body hydrogen aircraft is assumed to have 180 seats and 2,400nm range capability with an EIS date of 2035. In line with the approach to electric aircraft, where multiple flights would be required to deliver the replaced baseline activity due to reduced seat numbers, only a multiple of at most 2 is accepted. When technology capability is considered, the regional hydrogen aircraft partially replaces the Turboprop and Regional Jet categories, and the narrow body hydrogen aircraft partially replaces the Small and Medium Single Aisle (A220, A320 family & B737s) and a small proportion of the Large Single Aisle (A321, B737-9) category. A wide body hydrogen aircraft is not envisioned for service pre-2050.

As with electric aircraft the noise levels of hydrogen aircraft are based on levels calculated within the NAPKIN and FlyZero projects. The levels are again somewhat smaller for those aircraft with smaller PAX and range (again offset by increased ATMs) but for larger aircraft a slightly higher value than the average equivalent conventional aircraft was estimated. This was considered a prudent precaution because of the increased uncertainty surrounding a novel technology.

Our assumed EIS dates for G2 aircraft are as follows:

Introduction of Generation 2 (G2) Aircraft	
Regional Jets (RJ)	HC Fuelled Aircraft Electric and H_2 Aircraft
Single-Aisle (SA)	HC and H_2 G2 aircraft will replace their G1 counterparts over a 30 year period
Twin-Aisle (TA)	We assume a gap of approximately twenty years between G1 and G2 aircraft giving an approximate EIS of 2040
Very Large Aircraft (VLA)	We assume a gap of approximately thirty years between G1 and G2 aircraft leading to an approximate EIS of 2040

Table 3: EIS of G2 Aircraft.

These dates correspond to the EIS dates of the SA CO_2 Road-Map except that additional categories and dates have been introduced since a finer level of granularity is required for noise.

We assume an underlying rate of development in technologies applicable to all four aircraft categories. An approximate value of 0.1dB reduction in noise per certification condition per year is chosen as our baseline forecast based on the underlying component of historical data (assuming no technology step-changes or major configurational changes). This baseline scenario can be considered as a representation of the underlying historical balance of design priorities between noise and fuel burn.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

Hydrogen Aircraft (continued)

In addition, global airport noise ambitions and technology programmes' noise reduction aims have informed the G2 aircraft noise level estimates. These include the ACARE Flight 2050 noise goal, recently updated, and published work supporting ICAO's Committee on Aviation Environmental Protection (CAEP) noise certification rule making cycle[22]. In the US, the FAA's Continuous Lower Energy, Emissions and Noise (CLEEN) program now in its third iteration, has among its goals to develop and demonstrate aircraft technology that reduces noise by 25 dB cumulative relative to Stage 5 (Chapter 14 of ICAO).

Other considerations when estimating likely G2 aircraft noise levels include the general rate of stringency increases over time of airport noise rules, as well as technological and practical implementation limitations for new aircraft and propulsion system designs. We have also considered significant technological or configurational changes that could result in a step-change in aircraft noise. These include, for example, aircraft configurations such as a blended wing body that substantially shield the engine noise, significantly reducing the noise heard on the ground. However, our judgement is that such aircraft are very unlikely to enter service prior to 2050 and have therefore not been included in the forecasts.

2.5 Airline Fleet Transition

In previous sections we noted that G1 aircraft are already beginning to replace Legacy aircraft types and set out our assumptions concerning the EIS timescales of G2 aircraft types. In this section, we address the issue of fleet-turnover (the rate at which new aircraft types replace older aircraft in service). These transition rates are in line with those used in the CO_2 Road-Map and in all cases, we assume a transition period over which the proportion of newer aircraft within the fleet is a linear function of time. Subsequently, the ATMs are grown in proportion to increased passenger demand[23].

In some cases, there is an overlap between the introduction of G1 and G2 aircraft. In these cases, we assume that G2 aircraft preferentially replace Legacy aircraft types before G1 aircraft.

	G1 Aircraft		Conventional G2 Aircraft		Electric G2 Aircraft		Hydrogen G2 Aircraft	
	Start	End	Start	End	Start	End	Start	End
Regional Turbo-prop	2014	2025	2050	2070	2028	2038	2028	2038
Regional Turbo-fan	2019	2044	2060	2080	2028	2043	2028	2043
Single Aisle	2019	2035	2036	2055			2035	2060
Small Twin Aisle	2019	2027	2040	2060				
Medium Twin Aisle	2019	2030	2040	2060				
Large Twin Aisle	2021	2035	2040	2060				
Very Large	2021	2035	2040	2060				

Table 4: Transition dates for G1 and G2 Aircraft.

22 https://www.icao.int/publications/Documents/10017_cons_en.pdf

23 A small percentage of the fleet has been retained in the model with extended service life, to represent a modest level of aircraft re-purposing, such as use as dedicated freighter air transport.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

2.6 Calculation of UK Aviation Noise Output

The noise levels of Legacy, G1, and G2 aircraft and the fleet transition rates from current to G1 and G2 aircraft have been used to assess the impact of the increase in ATMs on UK aviation noise output. A simple robust transparent methodology has been adopted for assessing the relative change in noise output at a UK level, this approach does not take account of individual airport circumstances. It should not, therefore, be considered as a replacement for detailed modelling of individual airport noise footprints.

Noise output has been calculated by comparing current and future levels of the overall noise radiated by all scheduled flights arriving at or departing from UK airports. The noise output from an individual current aircraft has been assumed to be proportional to the averaged certification noise levels on the EASA database for that aircraft family; with a similar procedure for G1 aircraft. Certification values for G2 aircraft have been estimated as described previously. The relative importance of arrival and departure noise has been modelled by subtracting 9dB from the approach noise levels (to take account of the different microphone locations for the different certification conditions) in line with the procedure given by Powell[24]. This methodology is considered to provide a robust transparent and quick approach to predicting the impact on UK aviation noise output.

It must be emphasised again that the approach does not take account of individual airport circumstances and should not be considered as a replacement for detailed modelling of individual airport noise footprints or predicted improvements.

2.7 Scenario Impacts on UK Aviation Noise Output

Figure 9 shows the predicted variation in UK aviation noise output. If the current fleet were to grow with no further transition to G1 or G2 aircraft, the noise output would increase in line with the growth in ATMs by a factor of almost 1.4 over the period 2019 to 2050. As represented by the light blue line in figure 9.

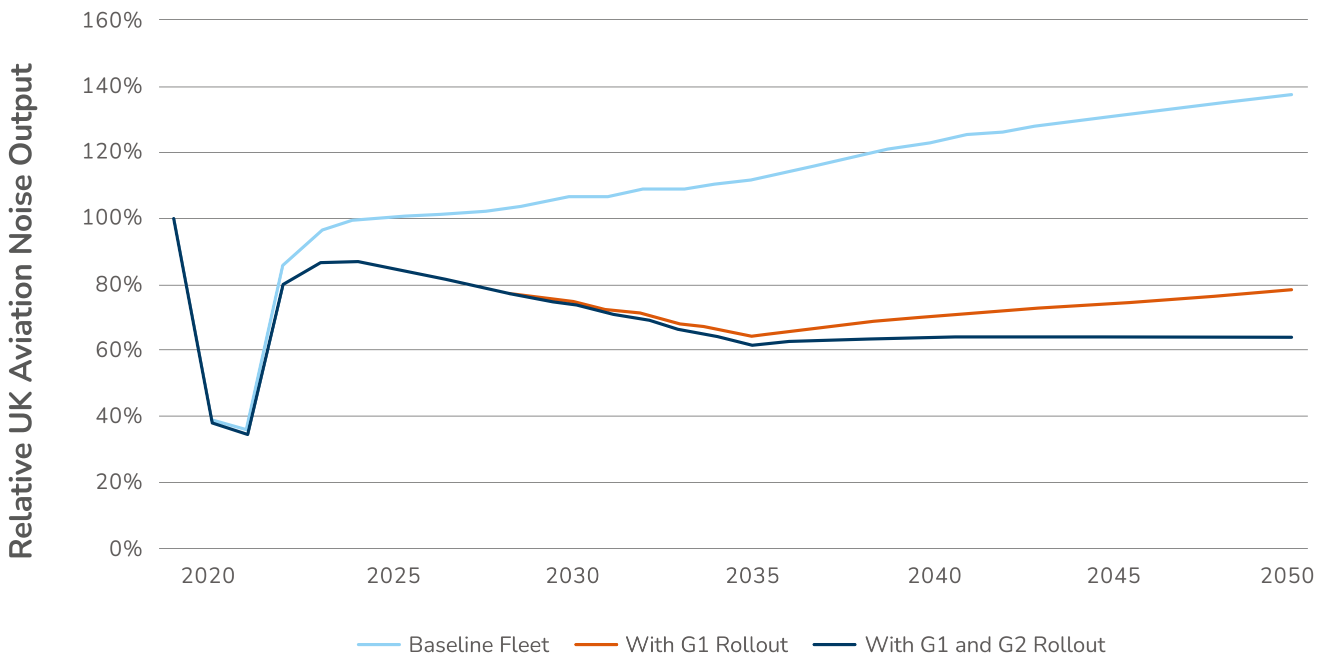


Figure 9: Variation in UK Aviation Noise Output - Impact of G1 and G2 aircraft.

24 Powell, C.A. Relationship between aircraft noise contour area and noise levels at certification points. Technical Report, NASA/TM-2003-212649, Virginia, USA, 2003.

2. NOISE OUTPUT FORECASTS AND SCENARIOS

2.7 Scenario Impacts on UK Aviation Noise Output (continued)

The continuing transition from legacy to G1 aircraft, however, significantly reduces the overall noise output up to the year 2035. Beyond this point the impact of growth in aviation would outweigh the impact any residual retirement of legacy aircraft and noise levels would rise. This clearly demonstrates the need for further technological improvement if noise levels are to be held stable or continue to reduce, as demand continues to grow. This is represented by the orange line in figure 9.

Given our assumptions about the noise of G2 aircraft, the result of the introduction of these aircraft types from 2028 onwards is seen to stabilise noise output at just over 60% of the 2019 level. It should be borne in mind, however, that this result is indicative of the UK as a whole and should not be applied to individual airports. It is also dependent on the underlying growth forecast, the rate of fleet replacement, and the ultimate noise levels of the replacement aircraft. This is represented by the dark blue line in figure 9.

2.8 Effect of decarbonisation costs

In the latest SA CO_2 Road-Map the effect of a number of decarbonisation costs on passenger demand is considered in detail.

Estimating the effect on noise of such a reduction on passenger demand is not straightforward. For example, reduced levels of passenger demand for flight due to increased costs could find expression in shorter flights rather than fewer flights. Some flights becoming shorter clearly has a direct carbon impact, but it is the number of aircraft movements (landings and take-offs) which matter for noise purposes.

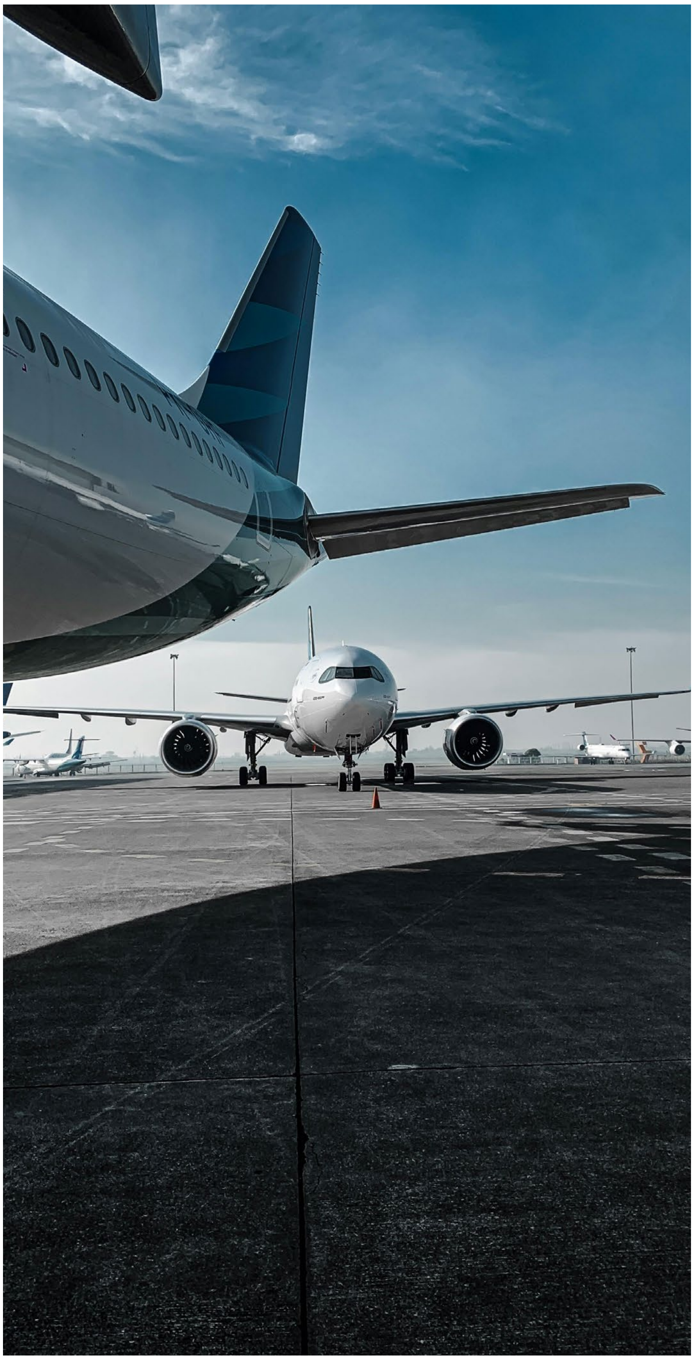
We have therefore not incorporated this possible reduction in noise into this Road-Map projection, due to an insufficient level of uncertainty, specifically as concerns the noise impact.

2.9 Conclusion

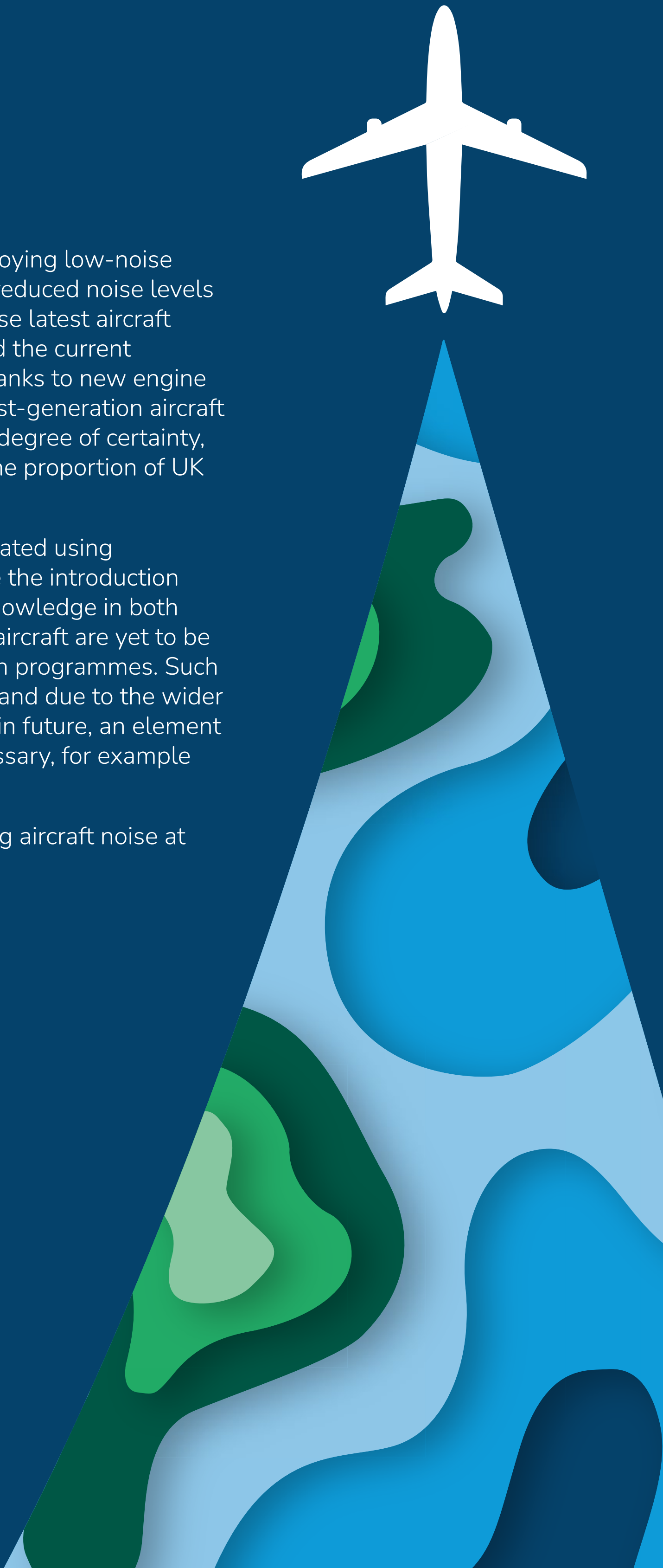
It is important to note these figures only represent the significant change which can be achieved through technological developments affecting noise at source. Other, mostly beneficial, changes can be achieved through other routes. These are detailed in the follow sections of the Road-Map.

Once again, it is important to note that actual noise performance will vary by airport, depending on the fleet mix, route structure, number of runways, capacity constraints, operating restrictions and the scope for adopting new noise mitigation measures. Therefore, it is not possible to draw direct comparisons between the indicative trends illustrated here and the future noise footprints of any specific airport. SA believes that airports should continue to set out their own noise plans utilising the information provided by this Road-Map.

Finally, the predicted UK Fleet Noise output trend looks more favourable when compared with the global noise trends predicted by ICAO in 2023.



3. AVIATION NOISE AND TECHNOLOGY



Key Messages

Aircraft and engine manufacturers have been researching and deploying low-noise technology for the past 50 years resulting in the very significantly reduced noise levels of latest-generation aircraft that are currently entering service. These latest aircraft demonstrate up to a 50% noise footprint reduction when compared the current older generation 'Legacy' aircraft they are now replacing. This is thanks to new engine and airframe design and technology. The introduction of these latest-generation aircraft (Generation 1 or G1) into the fleet will bring, with a relatively high degree of certainty, significant noise output benefits through to the mid-2030's, with the proportion of UK flights operated by these aircraft increasing year on year.

Beyond the mid 2030s, when nearly all flights are likely to be operated using G1 aircraft, securing additional noise reduction benefits will require the introduction of future-Generation 2 (G2) aircraft. Much of the technology and knowledge in both airframe and engine design to achieve G2 low emission and noise aircraft are yet to be acquired, so manufacturers are engaged in extensive noise research programmes. Such research and development programmes are high risk investments, and due to the wider societal benefits of delivering improved aircraft noise performance in future, an element of risk sharing between the public and private sectors will be necessary, for example through continued Government support through research grants.

This section sets the methods and our view of potential for reducing aircraft noise at source.

3. AVIATION NOISE AND TECHNOLOGY

3.1 Historic Improvements to aircraft noise

3.1.1 Previous Performance

Compared with early jet aircraft of the late 1960s, the noise output from modern aircraft has been reduced by around 15EPNdB at departure and 12EPNdB at arrival. These noise improvements have been achieved while simultaneously reducing fuel burn and consequent CO_2 emissions. To put these improvements in context, 15dB is considered equivalent to a 65% reduction in annoyance[25] and 97% noise energy reduction. It means 33 modern aircraft departing simultaneously from an airport produce together the sound output of one jet aircraft of the same size departing in the 1960s. Figure 10 shows the reduction in aircraft noise since the 1960s in terms of cumulative noise levels relative to ICAO noise certification standard Chapter 4 (see box below for explanation of noise Chapters).

Explainer: ICAO Noise Certification Standards

The International Civil Aviation Organisation (ICAO) which is a UN agency, has set requirements for new aircraft in terms of noise since the early 1970s. This is expressed through Annex 16 of the Chicago Convention (which governs internal aviation) which sets out Chapters determining allowable noise levels for new aircraft. These Chapters have progressed as per figure 10, with higher numbers (i.e. Chapter 4) indicating quieter aircraft. For more detail see Reduction of Noise at Source (icao.int).

When certifying the noise level of an aircraft, noise is measured at three certification points: on approach; at the point of take-off and 6.5km from the start of the take-off roll, as shown in figure 10. Each of these noise levels is added up and compared to the internationally agreed 'noise certification standard' defined above. The difference between the measured noise level and the certification standard is known as the 'cumulative margin'.

Figure 3.1 Single landing and take-off 80 dB noise contours for aircraft that just meet the noise limits of the Annex 16 Volume I chapters plus a state-of-the-art in-production aircraft

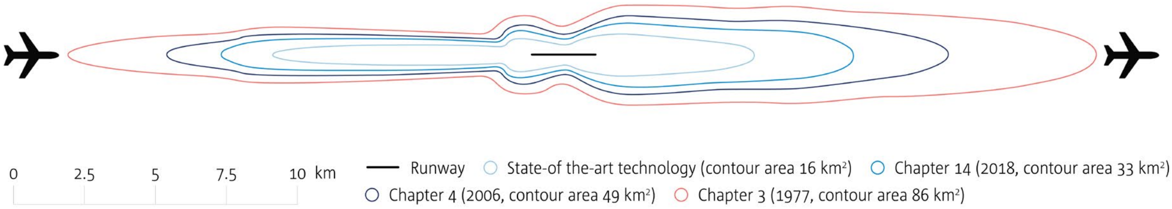


Figure 10: Position of certification points for noise certification.

25 ICAO Annex 16 Appendix 2-14 section 4.2. PNL=40+10xLog(N)/Log(2), where N is perceived annoyance. If PNL is reduced by ~15dB, N is reduced by 65%.

3. AVIATION NOISE AND TECHNOLOGY

3.1 Historic Improvements to aircraft noise

3.1.1 Previous Performance (continued)

Two trends in technological development are evident:

- Significant step-change reductions in noise associated with increases in engine bypass ratio, have delivered an overall reduction in aircraft noise of about 0.2dB per certification point per year (reference: ICAO Noise certification data).
- Smaller year-on-year reductions in noise associated with continuing improvements in noise reduction technologies with a broadly constant engine bypass ratio, have delivered typically 0.1dB reduction in noise per certification point per year (reference: ICAO Noise certification data).

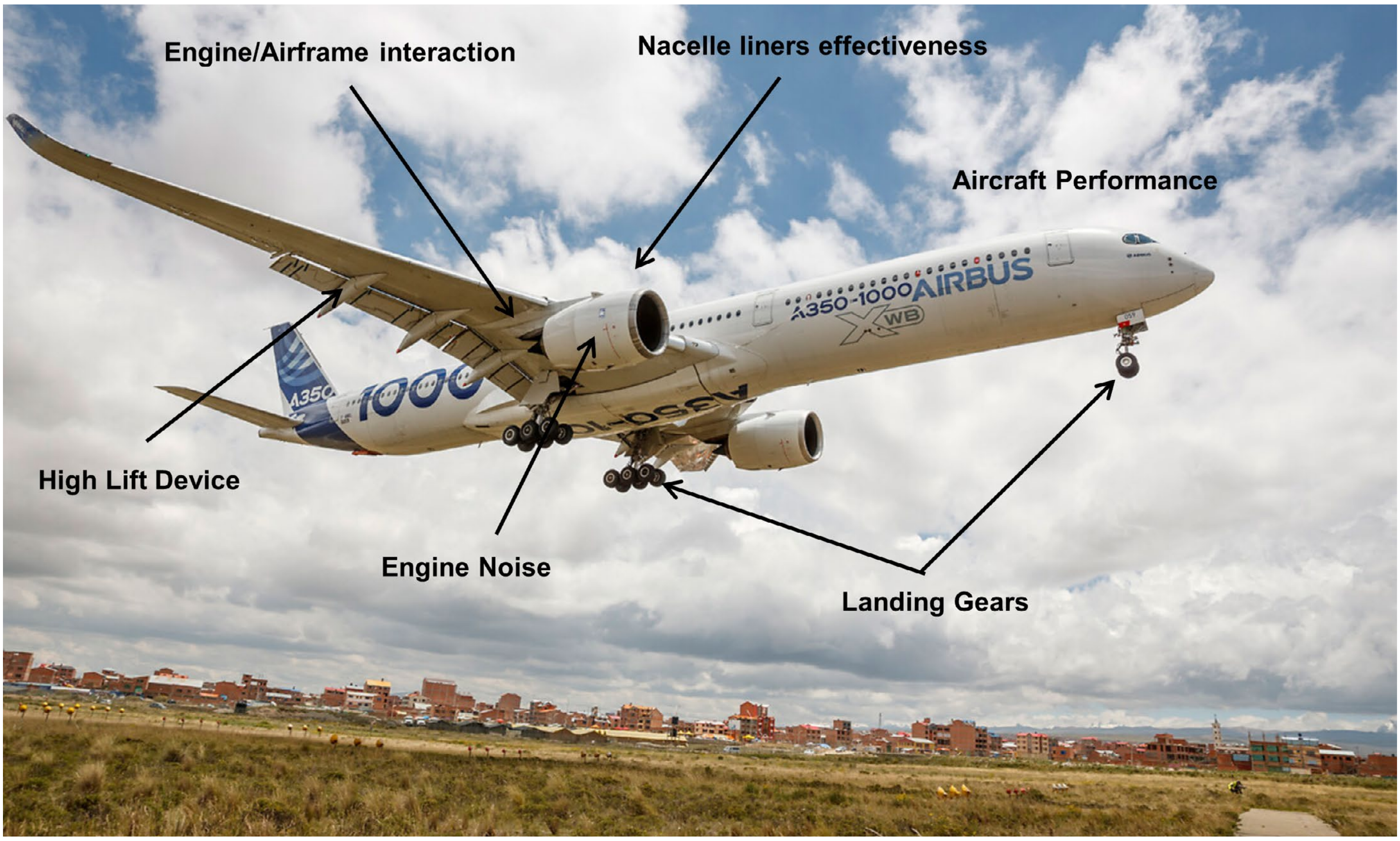


Figure 11: Features of the aircraft that influence noise – Airbus aircraft (Source: Airbus).

3. AVIATION NOISE AND TECHNOLOGY

3.1 Historic Improvements to aircraft noise

3.1.1 Previous Performance (continued)

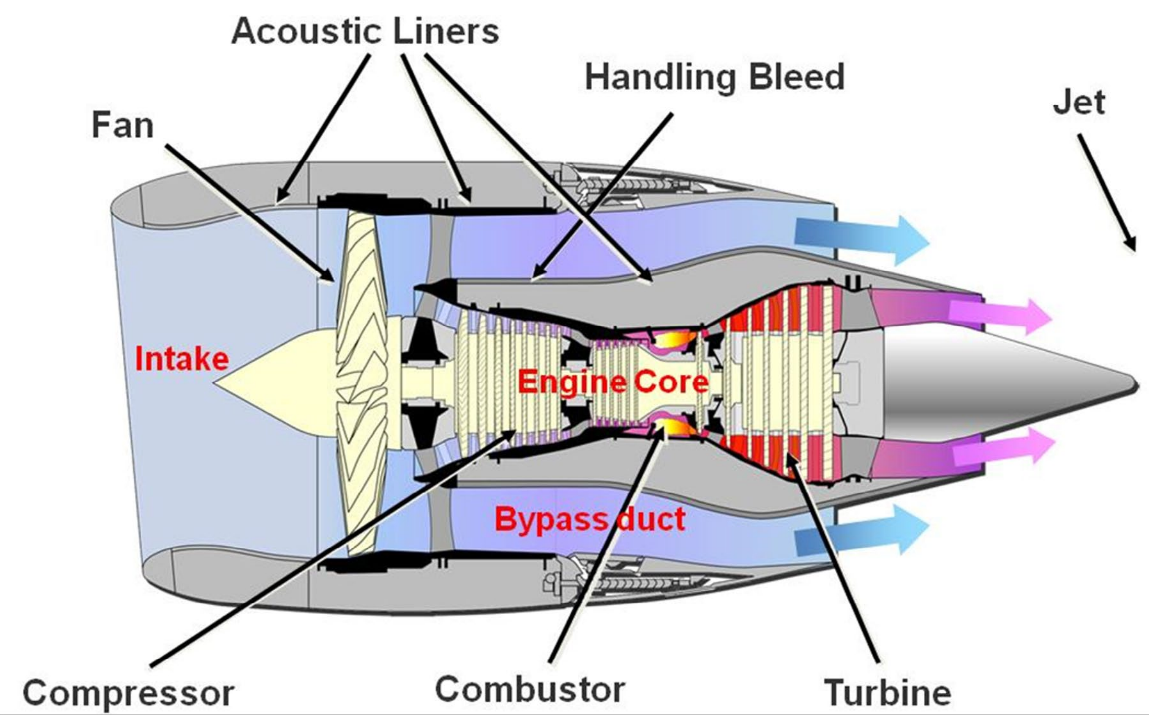


Figure 12: Features of the Jet Engine that influence noise.

Both the engine and airframe designs are important in determining the total aircraft noise, the relevant design features being illustrated in Figures 11 and 12. During the last decades the engine has traditionally been the major source of noise at take-off, with jet and then also fan noise being dominant in early aircraft types. With improved technology, other engine noise sources such as turbine, compressors, combustors and handling bleeds then became relatively more significant, especially at approach where engine and airframe contribute similar levels of noise. Overall, engine noise has been significantly reduced with each new aircraft generation as the bypass-ratio of the engine has increased and technology has been developed to reduce source noise and improve attenuation features. Acoustic liners in the nacelle are essential for reducing the noise from engine internal sources as it propagates along and out of the intake, bypass duct or core duct.

The pure turbojets and early turbofans of the 1960s were dominated by high jet exhaust noise. Modern high bypass-ratio turbofans, such as members of the Rolls-Royce Trent family of engines, achieve a high thrust level with significantly reduced jet velocities consequently make much less noise (see Figure 13). Recent advances in lighter weight materials and manufacturing technology have allowed these high bypass-ratio engines to avoid incurring unacceptable weight and drag penalties on the aircraft, delivering reduced aircraft noise whilst simultaneously reducing fuel burn.

3. AVIATION NOISE AND TECHNOLOGY

3.1 Historic Improvements to aircraft noise

3.1.1 Previous Performance (continued)

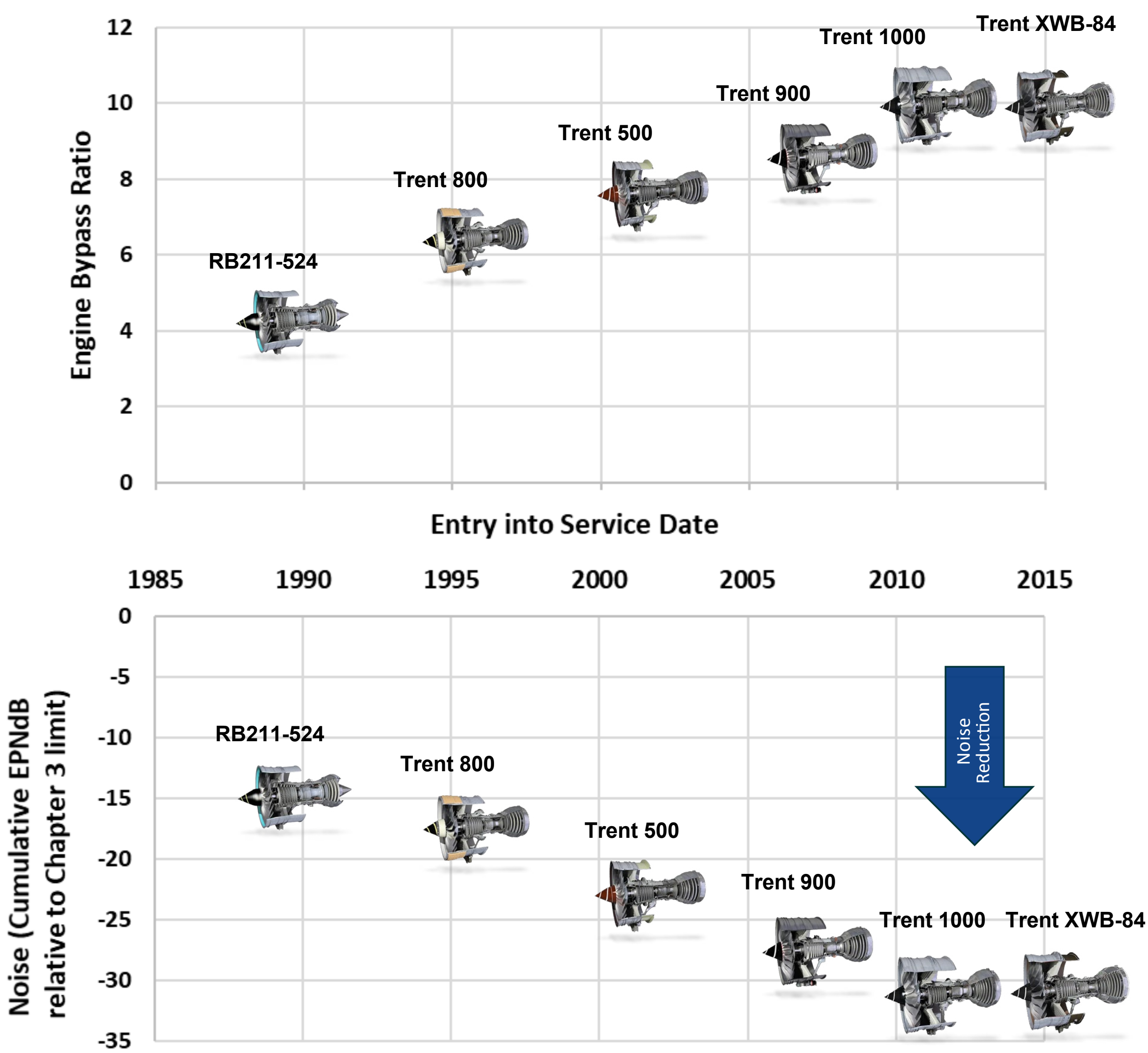


Figure 13: Rolls-Royce large engine examples: approximate bypass ratios and typical resultant aircraft noise levels.

3. AVIATION NOISE AND TECHNOLOGY

3.1 Historic Improvements to aircraft noise

3.1.1 Previous Performance (continued)

Among modern aircraft, the turbulence-induced noise caused by airflow contact with the airframe (the noise of a gliding aircraft) can have as great an impact as the engine noise for aircraft landing.

Aircraft take-off and climb performance has a direct influence on departure noise since the thrust required and altitude gained greatly affect the noise heard on the ground.

Recent aircraft such as the Airbus A350 powered by the Rolls-Royce Trent XWB-84 and the Boeing 787 powered by the Rolls-Royce Trent 1000 have demonstrated significant noise reductions compared with their predecessors (see figure 13). These aircraft feature technologies that have been developed through extensive research over many years. Sustained company, national and trans-national funding has been, and continues to be, essential. The technologies include increased engine bypass ratios, nacelles with zero-splice intake liners, advances in aircraft and engine component design, pursuit of advanced engine architectures, reduced aircraft weight and improved aircraft performance.

Figure 14: The new Airbus A350-900 can be quieter than much smaller legacy aircraft.

3. AVIATION NOISE AND TECHNOLOGY

3.1 Historic Improvements to aircraft noise

3.1.2 Future Noise Goals

Within SA our aerospace manufacturing partners are committed to working with other organisations across the world towards long-term goals to reduce noise from aircraft operations.

ICAO regularly sets technology goals to foster technology development and set targets for industry R&D. The latest set of noise goals was developed by a panel of independent experts, which ensure transparency and involvement from all stakeholders. This is detailed in the ICAO Doc 10127 - Independent Expert Integrated Technology Goals Assessment and Review for Engines and Aircraft (2019).[26]

The Advisory Council for Aviation Research and innovation in Europe, (ACARE) was established in 2001 to provide a network for strategic research in aeronautics and air transport throughout Europe that would enable aviation to satisfy the needs of society and secure global leadership for Europe in this important sector. It is made up of public and private sector organisations across Europe including Airbus and Rolls-Royce. In 2011 the European Commission's High Level Group on Aviation Research published a vision for aviation in 2050 called 'Flightpath 2050', as a follow-on from the original Strategic Research Agenda which set targets for 2020. The associated noise goal calls for the perceived noise emission of flying aircraft to be reduced by 65%, which translates to a 15dB reduction per operation in noise, by 2050 relative to year 2000 technology (the equivalent of a 0.3dB improvement per aircraft operation per year). The ACARE goals were reviewed and updated with more detail and the same overall noise goals in 2023[27]. This European-level work, alongside global initiatives, helps drive technological change in aircraft that will continue to benefit the UK.

3.2 Airframe and Engine Noise Reduction - Context

Aircraft noise is generated by many different parts of the engine and airframe. One feature of noise reduction is that once a dominant noise source is reduced using a new technology in a particular generation of aircraft, then other sources start to become relatively more prominent in the source balance. This then highlights these as additional sources to be tackled in the next generation of research and technology for the future aircraft. Aircraft noise reduction strategy is therefore about consolidating gains made previously and developing new technologies which provide the biggest overall noise reduction gains balanced against the other aircraft design features.

New engine and/or aircraft architectures for other purposes can re-set this progress, potentially introducing novel features and noise sources which require new or reinvigorated fields of research and technology development. This can be the case with many low carbon and non-hydrocarbon powered aircraft concepts, driving the need for a broad engine and aircraft noise research base.

3.2.1 How has Engine Noise Reduction in G1 Aircraft been achieved?

As described in a previous section, the increases in engine bypass ratio over time and the subsequent reduction in jet noise continues to be a major reason for the typical noise reductions found going from Legacy to Generation 1 (G1) aircraft, along with complementary engine and nacelle technologies which reduce overall engine noise.

Additional techniques for incrementally reducing jet noise at a given bypass ratio involve promoting faster mixing of the jet exhaust with the atmosphere whilst minimising the turbulence created in the mixing process. Such treatments bring with them potential aerodynamic and mechanical design challenges, and there is a trade-off between noise benefits and potential fuel-burn penalties. Ultimately this limits the effectiveness of these treatments at ever higher bypass ratios. Nozzle treatments similar to those shown in Fig.15 are now a feature of a number of in-service G1 aircraft.

Figure 15: Quiet Technology Demonstrator Engine, showing Nozzle Treatment options on a 777-200ER with Rolls Royce Trent 800 Engines.

26 https://www.icao.int/environmental-protection/Pages/Noise_TechGoals.aspx
27 https://www.acare4europe.org/acare-goals/

3. AVIATION NOISE AND TECHNOLOGY

3.2.1 How has Engine Noise Reduction in G1 Aircraft been achieved? (continued)

With the reduction in jet noise, turbomachinery and combustion noise have become even more prominent. For the fan and the most exposed compressor and turbine, lower noise design features include optimisation of the number of rotating blades and static vanes, the distance between aerofoil rows, technology development to identify lower noise aerofoil geometries and the rotational speed. These are balanced with other key issues including the aerodynamic performance and stability, weight, mechanical behaviour, and the manufacturing complexity and cost.

Combustion noise and noise sources not in the main air flow-paths in the engine such as cavity resonances and compressor bleed noise are also addressed, using advanced test and modelling techniques. An example of this is the development and introduction of lower noise handling bleed valve systems (for instance on the Trent XWB-84). This features staged pressure drops using multiple perforated sheets to minimise the overall compressor bleed noise.

The overall engine system noise is optimised by harnessing the power of advanced numerical techniques, including to model the detailed aerodynamic flow around the fan blades in the case of figure 16.

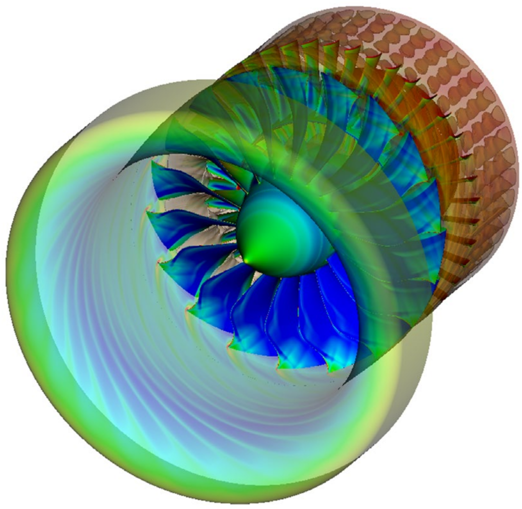


Figure 16: Computational Fluid Dynamics model of fan rotor noise.

Acoustic liners in the engine and nacelle play an essential role in reducing engine noise before it propagates from the powerplant, by converting acoustic energy into small amounts of heat as the sound waves pass over the porous acoustic liner surface. Simply extending the length of the nacelle to increase the area available for acoustic liner introduces weight and drag penalties, so there is a need to increase the effective acoustic areas within the existing nacelle length and to enable acoustic liners to be employed reliably in some of the more hostile areas of the engine, bringing significant manufacturing, materials and design technology challenges.

Striking the right balance is important, and the zero-splice intake liner (which first entered service on the Airbus A380 with the Rolls-Royce Trent 900 engine, see Figure 17) has been very effective in reducing fan noise at aircraft departure, far greater than the relatively small increase in acoustic liner area would indicate. This type of technology has been widely adopted by subsequent aircraft programmes.

Figure 17: Novel nacelle acoustic technologies – industry-first acoustically spliceless acoustic inlet on A380 / Trent 900.

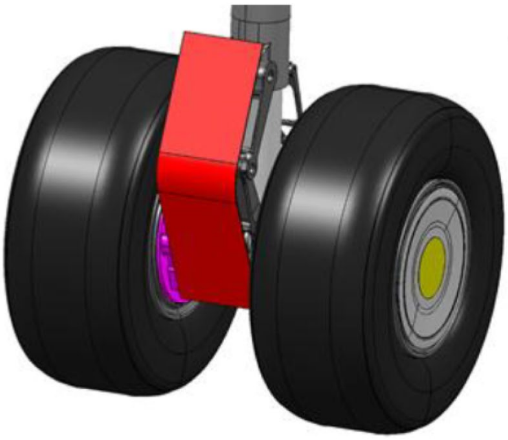
3. AVIATION NOISE AND TECHNOLOGY

3.2.2 Technology Work to reduce Airframe Noise in G1 aircraft

As engine noise has been reduced, then the wing slats/flaps and the undercarriage on the airframe become the next area of opportunity for improvement. Research to provide detailed understanding of these noise sources has allowed a number of low-noise features to be progressively introduced on modern aircraft.

The industry continues to invest in low-noise airframe technologies, i.e. technologies that reduce noise of landing gear and high lift devices, as well as to eliminate noise from cavities, etc. On a more holistic level, noise is now taken into account earlier in the aircraft and systems design process than it used to be. A "design-to-noise" approach, allows low-noise design optimisation through high fidelity computer simulation. For example, Airbus adopts a "design-to-noise" approach for selecting the most promising landing gear noise architecture.

Figure 18 illustrates examples of low noise landing gear and low noise slat/flap technologies. Whereas Figure 19 portrays one example of a cavity noise elimination technology, the Air flow Deflector. This technology was used to suppress the notable tonal noise generated by Fuel over pressure cavities, offering significant noise benefits during the approach phase of flight.



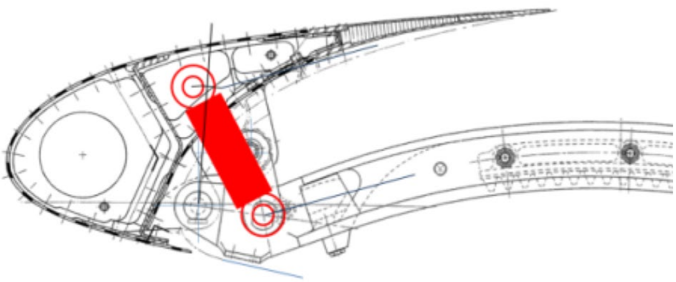


Figure 18: Left: Design of Low Noise Landing Gear. Right: Design of "Adapted" Low Noise slat.

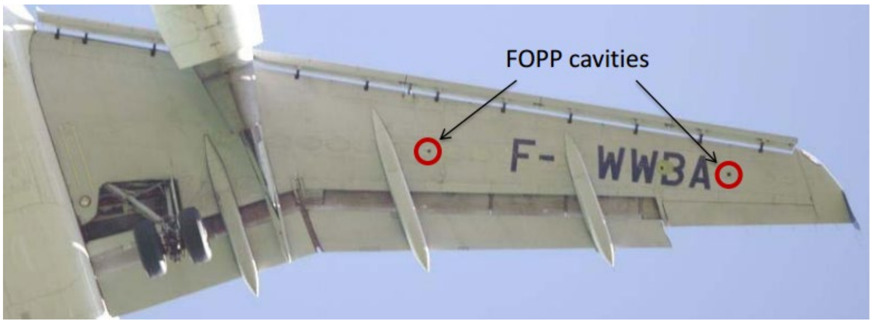


Figure 19: Left: Red circles indicate Fuel Over Pressure Protector (FOPP)cavities locations.
Right: Air flow Deflector installed next to a FOPP cavity, eliminating generation of tonal noise during flight.

3. AVIATION NOISE AND TECHNOLOGY

3.2.3 Future Technology Options and Novel Designs to Reduce Noise

Aircraft, engine and nacelle manufacturers are investing in extensive research programmes to deliver major additional noise improvements in the future. These include collaborative noise research programmes in the UK such as FANTASIA, FLG2 and HEAVEN (part of the EU Clean Aviation Joint undertaking) which are part-funded by the UK Aerospace Technology Institute.

Examples of on-going research topics include extending the acoustic liner further forward in the intake, and multi-disciplinary-optimisation of turbomachinery components to reduce noise and improve fuel burn.

Further significant engine noise reductions can be achieved by simultaneously increasing bypass ratio and slowing the fan rotational speed using an advanced geared configuration such as the Rolls-Royce UltraFan® architecture (Figure 20). This reduces the supersonic noise from the fan at departures to compliment the further reductions in jet noise, resulting in the next phase of engine noise reduction for widebody and narrowbody aircraft applications. Through the choice of its gear ratio, the speed relationships of the fan and the mechanically coupled intermediate speed shaft can be optimised for noise, component efficiency, weight, and other characteristics.

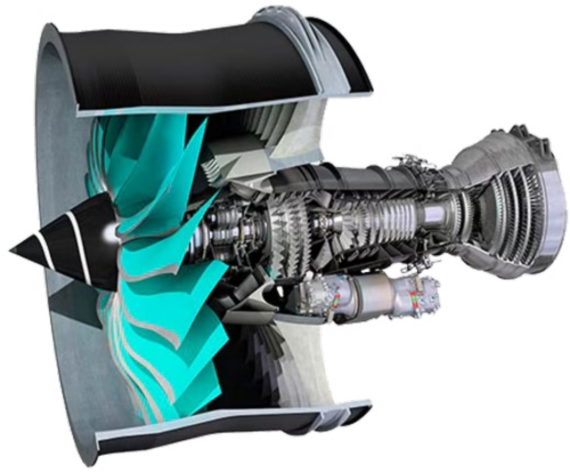


Figure 20: Rolls-Royce UltraFan

Beyond the timescales considered in this study, a breakthrough in noise could come from novel airframe designs such as that shown on the righthand side of Figure 21 that offer the potential improvements not just by reducing airframe noise and reducing and shielding engine noise, but also by reducing the engine thrust required on take-off. However, there are many very significant technical complexities that need to be addressed before any such aircraft enters service.

Novel airframe designs, especially the ones involving novel propeller configurations, should also respect cabin noise requirements. One solution that has been considered for addressing this is the development of active and adaptive control techniques; some of these techniques attempt to modify the air flow to reduce noise at critical phases of the aircraft flight whereas others attempt to use noise cancelling technologies in real time. Some of these technologies have been applied to specific aircraft for interior cabin noise, but they would need extensive development before they could be considered for application in commercial aircraft to also reduce the noise around airports. Key hurdles include: the design, manufacturing and integration complexity, the availability of light and affordable actuators and micro-controllers, in-service reliability and maintenance when components are exposed to the elements.

Figure 21: Airbus concepts for a hydrogen-powered commercial aircraft.

3.3 Interdependencies

The local environment agenda for aviation is driven by noise and increasingly also by local air quality impacts. In addition, the national and international agenda is also focussed on climate change - carbon dioxide emissions and non-carbon climate effects. Addressing these sometimes competing demands is a challenge – achieving an improvement in one area may or may not come at the expense of another[28]. Furthermore, noise solutions must be compatible with all the other design requirements of both engine and aircraft, for example the aircraft performance, the aircraft operating costs, the business needs of the manufacturer and operator, with no compromise with the safe operation of the aircraft (see Figure 21). To best match the different requirements, the aircraft and engine manufacturers work closely together to provide the optimum airframe/engine combination. Not all technologies are optimum on all aircraft, and a total system optimisation has to be conducted, taking into account all the aircraft design requirements.

28 Inter-dependencies between emissions of CO_2, NOx & Noise from aviation, Sustainable Aviation Policy Discussion Paper, September 2010, updated 2017.

3. AVIATION NOISE AND TECHNOLOGY

3.3 Interdependencies (continued)

More stringent noise mitigation on aircraft could lead to fuel-burn penalties arising from increased weight and/or drag from the new design features which result in increased weight and/or drag. Or from the preclusion of technologies that reduce fuel burn but reduce noise less, in the case of traditional gas turbine engines. An example of this trade-off is that extensions to the nacelle cowling around an engine to install additional sound absorption material will reduce the aircraft noise but potentially lead to increased aircraft weight and drag resulting in more fuel being consumed during operation.

However, more extensive liner deployment in a fixed nacelle length, for instance using an intake lip liner or advanced liner technology to obtain larger noise reductions in a fixed nacelle length, could be alternatives with very much less impact on fuel burn and CO_2.

A broader example is where advanced engine architectures are being developed such as Open Fan architecture and advanced geared turbofan architectures, such as the UltraFan® (referred to in section 3.3.2). In both cases there are fuel burn and noise reductions over the previous generation of engines, potentially with a different balance of the two attributes.

It is worth noting that the increasing use of sustainable aviation fuel (SAF) over the period covered by the UK Fleet Noise Model is expected to be a very significant on-going contributor to reducing CO_2 emissions for the G1 and G2 hydrocarbon UK fleets[29]. However, there is no such equivalent 'drop-in' solution for noise. Once a new engine and aircraft design is committed to production there are only modest noise reductions which can be further obtained without a major re-design, development and re-certification programme. So, it is important that future aircraft noise requirements are fully registered at the design stage to provide the required noise reductions as they enter into service in the 2030s in order to continue to offset fleet traffic growth.

3.4 Conclusion

Technology has delivered major reductions in noise with aircraft now entering service demonstrating significant reductions in noise levels compared with those of the early jet age. Aircraft now entering service typically have on average, a noise footprint that is only 50% that of the aircraft they are replacing. Further progress, however, will require sustained investment to reduce the many different complex noise sources that contribute to the aircraft noise signature. Comprehensive international noise research programmes have been launched, involving industry, research establishments and universities, with many promising concepts for reducing noise being developed. Further work is required to prove and develop the ideas for application in the very demanding aircraft flight environment. In addition, noise interdependencies should be considered in the on-going research on decarbonisation. Without government support, these high-risk challenging research activities would not be viable.

29 https://www.sustainableaviation.co.uk/wp-content/uploads/2023/04/SA9572_2023CO2RoadMap_Brochure_v4.pdf

30 https://aviationweek.com/aerospace/cfm-unveils-open-fan-demonstrator-plan-next-gen-engine

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

Key Messages

Operational Improvements relate to how and where aircraft operate. Noise abatement operational procedures form one of the key principles behind the ICAO Balanced Approach to aircraft noise management.

Operational improvements provide an opportunity to influence noise both close to the airport and further away. There is scope to extend the use of noise sharing techniques which may reduce community annoyance with noise. Operational improvements can be expected to offer noise reductions of between 1 and 5 dB(A). Although marginal, various operational procedures can be combined to provide a cumulative effect.

The exact noise improvement will vary for different communities depending on the current noise exposure and local scope for adopting new techniques. Some operational procedures suggested here may not be suitable for all operating environments owing to airspace constructs and aircraft fleet mixes.

Careful consideration needs to be made to balance the effect of noise reductions vs potential increases to emissions, in line with UK regulatory policy and Government policy priorities.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.1 Introduction

Airports, airlines and air traffic control across the UK already employ many operational procedures to mitigate the noise impacts of aircraft on local communities.

Improving the operating environment through implementing different operational procedures is outlined as one of the core principles in ICAO's Balanced Approach to Aircraft Noise Management. Improving operational procedures is seen as a good way to reduce the impact of noise on local communities that can be relatively quickly realised.

A wide range of practice exists to suit local circumstances at each airport. In general, aircraft and airport operators at the busier airports often have many years' experience of applying and monitoring effects of noise reduction operations, while some at the less busy airports may be at an earlier stage in considering what might be done to apply some of the measures discussed in this chapter, especially where community noise impacts are less.

Noise benefits from operational changes will be experienced at varying points along the flight path depending on the measure employed, aircraft type and local population distribution. This point is important since for any given noise reduction technique there will be some areas close to the flight path which will benefit more than others. Understanding the extent and where the benefits of different noise abatement techniques will accrue, will also help identify the appropriate techniques to suit local population distributions.

Not every opportunity discussed here will suit every airport's situation owing to varying operating environments influenced by airspace constructs, flight numbers, traffic mix and local communities. Instead, the intention is to provide an overview of the opportunities for operational noise mitigation and highlight the zones of benefit associated with each measure.

Adoption of operational improvements is expected to offer noise reductions of between 1 to 5 dB(A) by 2030 against a 2010 baseline. The exact noise benefit will vary for different locations depending on the current noise exposure and the local scope for adopting new noise mitigation measures.

It is also important to note that a number of operational techniques will have implications on other environmental factors. For example, any technique that affects the thrust required (e.g. different flap settings for take-off) will have consequences on the emissions of CO2, NOx and local air quality. Examples of these may be found in the Sustainable Aviation paper "Inter-dependencies between emissions of CO_2, NOx & Noise from aviation"[31].

A summary of operational noise mitigation opportunities is given in Table 5. This list is not exhaustive and there are multiple trials happening at airports across the UK to better understand noise propagation through differing practices.

31 http://www.sustainableaviation.co.uk/wp-content/uploads/sa-inter-dependencies-sep-2010.pdf

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.1 Introduction (continued)

	Vertical Noise Mitigation (Effective noise reduction by creating greater distance between noise source and receptor)	Horizontal Noise Mitigation (Opportunity to share noise when there is favourable geographic distribution of population)	Aircraft Operational Practice (Noise reduction at source)
Arrivals	• Continuous descents • Displaced threshold • Steeper approaches and segmented steeper • Approaches • Low Noise Arrival Metric (CAA CAP2302)	• Curved approaches • Adjusted joining point • Runway alternation • Defined Standard Arrivals Routes (STARS) • Runway directional preference	• Low power low drag e.g. • Reduced landing flap • Delayed deployment of landing gear • Managed approach speeds • Avoiding reverse thrust on landing
Departures	• Continuous climb • Climb thrust management • Minimum climb gradients	• Off-set SID departures • Runway alternation • Defined standard instrument departures (SIDs) • Noise preferential routes (NPRs) • Runway directional preference	• Noise management such as NADP1 or NADP2
Airspace Structure	• Single European Sky ATM Research Programme (SESAR) • UK Future Airspace Strategy Implementation South/North	• SESAR • Flexible use of airspace between civil aviation military and general aviation • Route availability improvements, conditional routes through military air zones and procedural improvements • Future Airspace Strategy Implementation South/North	• Use of Performance Based Navigation Multiple Routes for respite SID Balancing
Ground Noise[32]	• N/A	• Siting and design of aircraft engine test facilities at airports	• Reduced engine taxi • Use of Fixed Electrical Ground Power and Pre Conditioned Air
Others	• Airline League Tables - influence airline practices via the Hawthorne Effect - where individuals modify an aspect of their behaviour in response to their awareness of being observed		

Table 5: Summary of noise mitigation opportunities.

Historically the industry has continuously sought ways to improve the efficiency of aircraft operations to and from airports.

32 For more information see industry departures code of practice: http://www.sustainableaviation.co.uk/wp-content/uploads/DCOPractice2012approvedhi-res.pdf

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.1 Introduction (continued)

Operational improvements give the opportunity to influence noise both close to the airport and further away. Examples of operational measures that can have noise benefits closer to the airport, in the range 8 to 0 miles from touch down, include steeper approaches, low power low drag, delayed deployment of landing gear, alternate flap settings and displaced thresholds. Examples of operational measures that can have noise benefits further away from the airport, in the range 8 to 25 miles, include continuous descent approaches, steeper approaches and continuous climb departures. These may provide benefits outside the area of standard 57dBA Leq noise contours.

4.2 Managing Noise from Arriving Aircraft

For arriving traffic, operational improvements can be expected to offer noise reductions of between 1 to 5 decibels. The following section describes examples of operational improvements to mitigate noise from arriving aircraft.

4.2.1 Continuous Descent Operations, Continuous Descent Approaches

Continuous Descent Operations (CDO) relate to continuous descent from cruising altitude. In the UK, CDO is more commonly known as Continuous Descent Approach (CDA), which typically starts from an altitude of 6,000 feet (amsl) and is thus a subset of a CDO.

In contrast to conventional airport approaches, aircraft following CDAs descend continuously from as high as possible (at some airports this is dictated by the level of the bottom of the holding stack). A continuous descent requires less engine thrust than level flight and also provides additional noise attenuation by keeping the aircraft higher for longer.

A study by ERCD[33, 34] for the London Airports suggests CDAs from 7,000ft can offer between 1-5 dB(A) noise reduction at between 10 to 25nm from touchdown. The upper end of this range relates to benefits identified for some larger aircraft types. Benefits towards the lower end may be expected for small to medium aircraft types.

CDAs are already well established in operations at a number of UK airports, as shown. There remains scope to achieve better performance, and airlines and airports working in partnership with NATS are striving to achieve better achievement rates. Current airspace precludes the use of CDAs at some airports; work to deliver improved CDA performance continues, and in some cases further adoption of CDAs will also be supported by new airspace design and the uptake of performance based navigation techniques. There is therefore scope for more CDAs from 6000ft as well as for more CDAs from higher altitudes which offer fuel and emissions savings as well as noise benefits.

Average UK CDA (Source: NATS)	
FY Year	UK CDA %
16/17	77.7
17/18	79.8
18/19	80
19/20	80.3
20/21*	77.5
21/22*	78.1

NOTE - *The COVID-19 pandemic led to a reduction in compliance rates across the UK due to a drop in traffic and less systemisation. As traffic built back, airline crew currency and familiarity played a part in lower rates. However, the industry remains committed to improving CDA rates as the build back occurs to improve noise levels through this operational procedure.

Table 6: UK CDA achievement rates 2016 – 2021.

CAA CAP2302 – A Low Noise Arrival Metric

Since the early 2000s, London airports have regularly reported operational compliance with the CDO definition on a monthly and annual basis The CDA definition is set out in the Code of Practice for Arriving Aircraft. Under the current CDO definition, London airports have reached and maintained high compliance rates.

In 2017, preliminary research performed by CAA ERCD identified that the existing CDO definition was not sufficiently sensitive to provide an effective noise measure.

These insights led to the development of height-based criteria for a low noise arrival metric that would incentivise increased initial/intermediate descent angles, but not to the extent that would necessitate any changes in speed control or aircraft configuration. To better incentivise low noise arrival performance, two height boundary conditions are proposed as illustrated in Table 7, creating three height zones or low noise categories.

33 CAA ERCD, BAA, CDA Briefing Paper, "Noise benefits associated with Continuous Descent Approach Procedures at London Heathrow".

34 DTLR (1999). "Noise from arriving aircraft: Final Report of the ANMAC Technical Working Group," Departments for Transport Local Government and the Regions, December 1999.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

CAA CAP2302 – A Low Noise Arrival Metric (continued)

Testing indicates that the criteria would rate 45-50% of arrivals in the optimum category, with around 15-20% of arrivals in the second category and 35-40% in the lowest category.

The report makes recommendations for monitoring systems to be developed to implement the proposed low noise arrival metric definitions and be appropriately validated. UK Airports are currently considering how this may be used and implemented.

CAP2302: A Low Noise Arrival Metric (caa.co.uk)

4.2.2 Steeper Approaches

It has long been thought that introducing steeper approaches for the final approach section and segmented steeper approaches further out from the airport, may have noise benefits. This fits with the community perception that higher aircraft mean less noise. Frankfurt Airport in Germany was the first European airport to introduce steeper approaches for noise management.

ICAO's Committee on Aviation Environmental Protection tasked Working Group 2 with assessing the **theoretical potential** noise benefits of steeper approaches. The aim was to identify if a potential noise benefit exists and the analysis showed that there are noise benefits of the order of 0.5dB per quarter degree increase in final approach angle. Whilst in decibel terms this seems small, noise contours are sensitive to small decibel changes. Table 7 below, reproduced from the CAEP working paper[36] illustrates the reduction in landing noise footprint area for different final approach angles for three aircraft types.

Aircraft Type	Contour Level (dBA SEL)	3.25 (o)	3.5[37] (o)	3.75 (o)	4 (o)
A340-600	80	-7%	-16%	-26%	-35%
	90	-10%	-19%	-26%	-32%
B737-800	80	-9%	-17%	-24%	-30%
	90	-9%	-17%	-24%	-29%
B777-200	80	-6%	-12%	-17%	-21%
	90	-5%	-9%	-12%	-15%

Source: ICAO, CAEP/8, WP/40, 2010, Initial Assessment of the Potential Changes in Noise Exposure Associated with Steeper Approaches.
Table 7: Theoretical reduction in contour area as a function of final approach phase angle.

It is important to recognise that Table 7 above, represents the theoretical noise benefits at various descent angles. However, if the approach is too steep the flight crew response may be to lower the landing gear early in order to maintain a stable approach speed.This would be counterproductive in noise terms.

There are a number of regulatory and operational challenges that need to be overcome prior to investigating the suitability of steeper approaches at any airport. International regulation precludes the use of steeper approaches for anything other than obstacle or terrain avoidance which is the main reason for a 5.5 degree approach into London City Airport. London City also requires a certain level of crew competency to fly a steep approach and the aircraft may require modification to flaps etc. However, it was determined that approaches of up to 3.2degrees were outside the scope of these considerations.

Operationally, any approach beyond 3 degrees may be only viable during category (CAT) conditions means they would not be possible during low visibility, causing potential delays or disruptions to flights.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

Case Study - Slightly Steeper Approaches into London Heathrow Airport

Beginning in 2014, in conjunction with Sustainable Aviation, Heathrow began trialling a suite of slightly steeper approaches. A vertical path angle of 3.2degrees was chosen to make it accessible for all and avoid the need for aircraft/crews to be certified to fly steeper angles. Heathrow decided to trial this on their RNAV procedure and leave the ILS approach at 3 degrees for resilience purposes.

Two separate trials commenced, and the airport gathered a multitude of data including noise monitoring, safety and operational metrics and more. An Airspace Change Proposal was submitted in 2021 with a permanent RNP approach procedure implemented in December 2021.

The trial noted noise improvements of up to 1.5dB for some approaches, with an average reduction of 0.6dB with no operational disbenefits and no negative feedback from airlines.

heathrow.co/noise

4.2.3 Displaced Thresholds

The runway threshold is the point on the runway which aircraft cross at 50 feet, just prior to touch down. A 'displaced threshold' means that this point is moved further along the runway. From a noise perspective this means that planes are higher, and therefore quieter, when they fly over areas near the airport. Displaced thresholds may offer scope to move the noise footprint of arriving aircraft closer to the airport by the same distance as the displacement. They are already in place on runways at several UK airports; some examples are given in Table 8.

Airport	Runway Direction	Threshold Displacement	Runway Direction	Threshold Displacement
Birmingham (EGBB)	RWY 15	300 m	RWY 33	300 m
Edinburgh (EGPH)	RWY 06	213 m	RWY 24	213 m
Farnborough (EGLF)	RWY 06	540 m	RWY 24	640 m
Leeds Bradford (EGNM)	RWY 14	311 m	N/A	N/A
London Gatwick (EGKK)	RWY 08L	427 m	RWY 08R	393 m
London Gatwick (EGKK)	RWY 26L	424 m	RWY 26R	417 m
London Heathrow (EGLL)	RWY 09L	306 m	RWY 09R	307 m
London Stansted (EGSS)	RWY 04	300 m	N/A	N/A
Newcastle (EGNT)	RWY 07	120 m	RWY 25	137 m
Prestwick (EGPK)	RWY 03	166 m	RWY 13	243 m
Southampton (EGHI)	RWY 02	73 m	RWY 20	45 m

Table 8: Examples of UK Airport Displaced Thresholds.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.2.3 Displaced Thresholds (continued)

It should be noted that the main operational reason for displaced thresholds is to increase the vertical distance between an approaching aircraft and any close in obstacles underneath the final approach. The airports listed above operate with displaced thresholds for this reason.

Where there is sufficient runway length, appropriate runway and taxiway infrastructure combined with population centres that would benefit from the adjusted footprint, displaced thresholds may be worth considering. They can offer significant benefits for both the number of people and the area affected. Results of work carried out by the CAA[35] are presented in Table 9 for one aerodrome example; the changes in Leq contour area and population exposed will vary for different airports.

Leq Level	Reduction in noise exposure for 1000m displacement	
	Area	Population
>57	2%	5%
>60	2%	8%
>63	1%	12%
>66	2%	31%
>69	3%	47%
>72	4%	66%

Source: CAA. Change in area and population affected by noise disturbance (various levels)[36]

Table 9

4.2.4 Low Power Low Drag

Low Power Low Drag refers to a noise abatement technique for arriving aircraft in which the pilot delays the extension of wing flaps and undercarriage until the final stages of the approach, subject to compliance with ATC speed control requirements and the safe operation of the aircraft. Low power low drag techniques in the initial and intermediate approach may be able to offer 1 to 3 dBA SEL in the region of 20 to 12nm from touchdown[37].

4.2.5 Managed approach speeds

Managing aircraft approach speed is critical for aircraft stability during the descent and also for ensuring the appropriate minimum arrival spacing between successive aircraft. Achieving the correct aircraft configuration to minimise noise requires a balance to be struck between minimum drag (see above) and minimum speed. For safety reasons, pilots are required to maintain a minimum margin between the aircraft's speed and the legal minimum set for each flap/slat configuration.

An Airbus[38] study demonstrated that the noise benefits of reduced drag outweighed the extra noise generated by slightly faster speeds.

35 CAA Insight Note 2, 2011, Aviation Policy for the Environment. http://www.caa.co.uk/docs/589/CAA_InsightNote2_Aviation_Policy_For_The_Environment.pdf)

36 Changes in Leq areas may be different for different airports.

37 DfT, 1999, Noise from Arriving Aircraft, Final Report, 6.1.3.

38 Airbus, Getting to grips with aircraft noise, 2003, http://www.captainpilot.com/files/AIRBUS/AircraftNoise.pdf

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.2.5 Managed approach speeds (continued)

Air traffic controllers deliver required airport and runway capacity by careful sequencing of aircraft types using lateral vectoring and the application of rigid speed control. Speed control can influence noise profiles, requiring the aircraft to be flown in a particular configuration, and there is opportunity for airports, ATC and airlines to work together to identify the optimum speed profile for a given airport and aircraft fleet mix. Typical final approach speed profiles in the UK are 160 knots to 4 miles (5 miles for Airbus A380) or 170 knots to 5 miles.

4.2.6 Reduced landing flap

Aircraft are normally designed to offer a number of final flap settings for landing. The "full flap" positions allow the aircraft to fly at the slowest speeds compatible with safety and offer benefits in reducing the landing distance and touchdown speeds required. Thus, full flap offers safety and operational advantages on shorter runways or where there is reduced braking efficiency due to a wet, icy, slippery or contaminated runway.

However, in many cases these conditions do not apply and a reduced landing flap position can offer advantages in reducing noise and fuel burn. Regarding noise, it should be noted that with reduced flap the aircraft approach speed will be slightly higher than normal, requiring more runway length and occasional use of increased reverse thrust.

Even when taking this into account there is normally an overall noise benefit in flying the approach and landing with reduced flap. A study by Boeing suggests that the noise benefit for an individual aircraft in adopting reduced landing flap is a reduction of almost 1dBA SEL.

4.2.7 Delayed deployment of landing gear

Deployment of landing gear will normally be initiated at around 2000ft, to ensure the aircraft meets the requirement to be fully stabilised in the landing configuration by 1000ft in preparation for landing. A British Airways trial showed it was possible to delay this procedure until around 1500ft, providing a zone of approximately 1.5nm of noise reduction at between 6 and 4 miles from touchdown. This example offers scope to reduce approach noise by up to 2dBA SEL for A320 aircraft[39].

Some airports do carry out studies which look at airline behaviour. These studies allow airports and airlines to cross reference the findings with the airline Standard Operating Procedures. However, it should be noted that there are no easy ways to monitor gear deployment across a wide time frame. Camera technology and Artificial Intelligence algorithms could provide a suitable method of observing airline patterns, but this technology is in it's infancy. A small number of UK airports are investigating the potential applications, likely to be a world first.

4.3 Benefits of combining several operational noise management techniques

A 3.3 degree steeper approach combined with alternate landing flap and a displaced threshold (in this example c.600m/2000ft) can together amount to between 2.8 and 4 decibel reduction in noise. If realised, this could offer a perceptible reduction in noise for those most affected close to the airport.

Furthermore, these noise benefits can be derived purely from operational improvements, offering benefits equivalent to those of a significant step change in technology which might take many years to realise. More research is needed to explore the practical steps required to apply some of these techniques more widely in the UK.

4.4 Managing Noise from Departing Aircraft

Managing noise from departing aircraft requires careful consideration of other potential effects on fuel burn, carbon emissions and local air quality effects. In 2012 the industry published, *'Reducing the Environmental Impacts of Ground Operations and Departing Aircraft - An Industry Code of Practice'*[40]. The industry is currently seeking to implement the recommendations within this Code to reduce aircraft noise on the ground. The remainder of this section focuses on further opportunities for operational measures to mitigate noise. Principally these relate to improving aircraft climb profiles and establishing routes which minimise population exposure.

39 BA and Airbus, 2010, Arrivals Noise Study, using simulator runs and noise modelling of A320 aircraft.
40 http://www.sustainableaviation.co.uk/wp-content/uploads/DCOPractice2012approvedhi-res.pdf

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.4.1 Continuous climb operations

Continuous climb operations, (CCOs), where aircraft climb continuously to their cruise altitude, have always been and continue to be the default practice for airlines and air traffic controllers where airspace structures and traffic conditions allow. However, stepped climbs i.e. climbs with periods of level flight, are often required to maintain safe separation between aircraft where there are crossing flows of air traffic. Removing these steps in an aircraft climb profile through airspace redesign and revised procedures should enable more continuous climbs and will offer significant fuel and emissions savings and may also offer a small noise benefit.

Table 10 shows the results of a NATS study of UK achievement of Continuous Climb Operations in 2006 and 2012.

Year	Performance
2006	48% of all departures achieved CCO at 11 London FIR airports where NATS provides the ATC service.
2012	57% of all departures achieved CCO at 11 London FIR airports where NATS provides the ATC service.
2012	63% of all departures achieved CCO at 15 UK airports where NATS provides the ATC service.
Definition of CCO for this study was Ground – FL100 with level offs <0.5nm ignored. Data is sourced from NATS Flight Profile Monitor which analyses radar data from all flights in UK controlled airspace.	

Source: NATS Flight Profile Monitor, 2012.

Table 10: UK Continuous Climb achievement rates 2006 and 2012.

The fuel burn and noise penalty of stepped climbs is greatest at lower altitudes so eliminating level flight at low altitudes may have the multiple benefits of reducing fuel burn, emissions and noise. While the ideal outcome is to remove any level flight in the climb phase, fuel, emissions and noise benefits may also be achieved by relocating any necessary level flight to higher altitudes.

Airbus performed an assessment of the relative impact on noise profiles of flying take-off procedures involving level sections of various lengths (10, 20, 30 NM) at 6000ft altitude for A320, A330 and A380 (9 scenarios). The study was based on data initially developed under the ERAT European research programme looking at Heathrow departures. The exact pattern and noise effect will vary depending on the aircraft type, the flight profile flown and ambient conditions on the day.

In any case it is likely that the effects of continuous climbs on noise profiles are small as their effect can be some distance from the airfield and at altitudes where the noise change may not be perceptible. There may nevertheless be localised opportunities where noise benefit can be derived, and these should be pursued where appropriate. The greatest manifestation of continuous climbs is likely however to be in their scope for significant reductions in fuel burn and CO_2 emissions.

Sustainable Aviation is actively promoting the wider application of CCO. In the short term, this means raising awareness of the benefits and seeking opportunities to make procedural or tactical changes to enable more CCOs where airspace and traffic conditions allow. For the mid to long term, achieving more CCOs requires structural changes to airspace and further investment in Air Traffic Control (ATC) and aircraft technology. Investment in Area Navigation (RNAV), Standard Instrument Departures (SIDs), are already enabling more CCOs in the UK. Further major airspace changes will enable greater implementation of CCOs in future.

4.4.2 Noise Abatement Departure Procedures

ICAO/CAEP commissioned a study into the effects of noise abatement departure procedures on noise and gaseous emissions for eight commercial transport jet aircraft. The study evaluated two variations of the NADP 1 and two NADP 2 ICAO noise abatement departure procedures. The analysis confirmed that NADP 1 minimises noise in a zone relatively close to the airport, whereas NADP 2 minimises noise in a zone further away from the airport. The crossover point between noise benefits and increases between NADP1 and NADP 2 was shown to be between 5.5 to 11 NM distance from brake release for regional and wide-body aircraft.

41 ICAO Circular 317 AT/136, 2008, Effects of PANS-OPS Noise Abatement Departure Procedures on Noise and Gaseous Emissions.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.4.2 Noise Abatement Departure Procedures (continued)

The study confirmed that no single departure procedure minimises overall noise and emissions simultaneously. Depending on local airport requirements, trade-offs must be made between close-in versus further out noise, NOx versus CO_2 emissions and, finally, noise versus gaseous emissions. For safety reasons, international law requires that a maximum of two departure procedures are allowed for each aircraft type for the whole of an airline's route network, which must be approved by the regulating authority. As a result, the decision on which departure procedure to fly rests ultimately with the airline flight operations department in conjunction with the Flight Operations Inspectorate of the CAA.

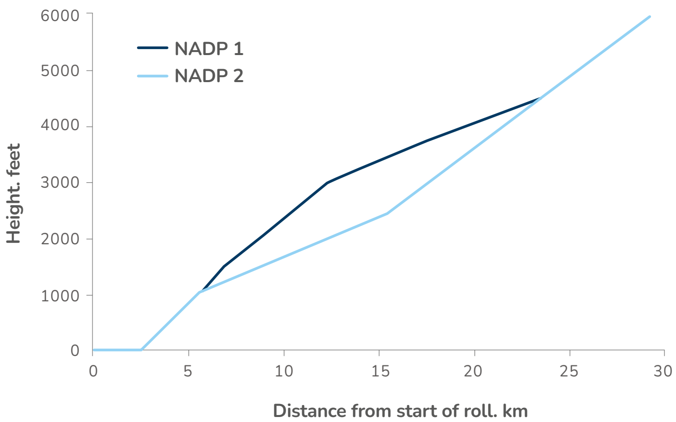


Figure 22: Noise Abatement Departure Procedures

Case Study - NADP Trial - London Luton

Similar to all other UK airports, airlines departing London Luton airport utilise both NADP1 and NADP2 procedures in line with airline Standard Operating Procedures (SOP's) As part of the Luton Noise Action Plan, the airport committed to conduct a review of which procedure airlines are using.

In August 2022, Luton conducted a trial (still to report) where operators were asked to use each NADP procedure for a period of one-month. Noise readings will then be collected by both fixed and portable noise monitors deployed for this trial. A mix of Airbus and Boeing aircraft were used.

The noise monitors will provide departure LASmax and SEL noise results, which will be compared between movements. In addition, data on radar tracks, flight profiles and aircraft load will also be gathered. In addition, the trial considered NOx emissions and fuel usage to understand the interdependencies.

This trial will allow LLA to understand if there are noise and air quality benefits associated to certain NADP procedures with a view to recommend the use of one procedure. The trial results will be shared with industry.

4.5 Predictable Respite from Noise

Predictable respite from noise means that airport operators are able to inform communities about when and where they can expect to hear aircraft noise, enabling them to plan for periods of respite. Predictable respite from noise, and noise sharing practices, may offer scope to reduce the impact of noise to local communities. New performance based navigation techniques (PBN) mean that aircraft can fly with greater accuracy over pre-determined tracks.

The ability to offer communities predictable periods of noise respite has long been applied in the UK, for example through operating restrictions to enable runway alternation. Further opportunities and innovative concepts for predictable respite are being explored by the airport operators at Heathrow and Gatwick.

The effect of some measures will be to reduce the overall area that is most impacted by aircraft noise but increase the intensity of noise for those below the defined aircraft routes – noise concentration, which is current Government policy for managing the impact of aircraft noise. Other measures will result in noise dispersal, reducing the intensity of noise by sharing the distribution of aircraft tracks (see section below for more on this).

We also note that there can be trade-offs in measures to manage noise, between reducing the number of people affected and spreading the burden of noise in a way that may affect a slightly greater number of people but is seen by local communities to be preferable. For example, one of the noise abatement measures used in the UK is Government-defined 'specified departure routes known as Noise Preferential Routes (NPRs). These NPRs are 3km wide, but the industry has worked hard to improve its 'track-keeping' performance, such that the majority of aircraft now fly very accurately along the centre of each NPR. While that does reduce the number of people affected in absolute terms, it also means that those living directly under the centre of an NPR have more aircraft flying directly above them.

Operational noise mitigation should, where possible, be tailored to the specific desired outcomes of communities around individual airports, within the legal and safety constraints of what is allowable. No solution fits all. Decisions on noise concentration or dispersal, for example, can only be answered by agreeing the desired outcome for each airport community[42].

42 See Stansted NPR case study in appendix 7, annex F.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

Case Study - Runway Alternation - London Heathrow

Communities around Heathrow place great importance on the alternation system and every effort is made to adhere to it. The alternation pattern means that for part of the day, one runway is in use for landings and the other for take-offs, then halfway through the day at 15:00, it switches. At the end of each week the rotation switches completely. This is so that communities get respite from planes in the morning one week and in the evening the next.

To help communities plan ahead, the airport publishes an annual schedule of runway use. It tells communities which runway will be in use any day or night of the year. The schedule covers landings only because that's where runway alternation makes the biggest difference.

4.6 Airspace

Airspace modernisation has the potential to improve significantly the noise performance of aircraft operations. In many cases, the ability to fly continuous descents and continuous climbs, for example, is compromised by the complexity of interacting traffic flows. Airspace redesign can simplify structures that in many cases have evolved over decades to ensure modern requirements for safety, capacity and environmental standards are achieved. It may also allow the more modern automatic flight systems available on today's aircraft to be utilised, fully enabling novel approaches to noise mitigation.

NATS' on-going programme of airspace improvement includes rigorous assessment and mitigation of noise effects. Government has an important role to play in clarifying the regions for priority between noise and emissions management, defining policy on noise dispersal and noise concentration and also in ensuring that the regulatory procedures for airspace change are efficient in allowing airspace improvement to progress quickly.

In the near future, greater aircraft navigation accuracy will mean there is new scope for more innovative noise mitigation techniques. For example, SA members are already exploring the feasibility of designating multiple flight paths within an NPR.

Government should support the industry in researching and consulting public opinion on these innovative noise mitigation measures.

4.7 Concentration versus Dispersal

The adoption of performance based navigation (PBN) will increase the likelihood of aircraft following a particular route adhering more consistently to the centreline. This will result in more concentration of impact for the same number of routes. It will reduce the extent of the areas where local impacts are most keenly felt, but at the cost of focussing the impacts on the areas directly below route centrelines.

Government must recognise that increased concentration around NPR centrelines is an inevitable consequence of performance based navigation (PBN) and is the key to the safety and capacity benefits that a PBN network can bring.

However, PBN also allows more innovative approaches to noise dispersion by providing greater certainty of an aircraft's position and 4D flight path. For example, by allowing aircraft to fly a number of different standard arrival routes (STARS), using performance based navigation (PBN); noise from arriving aircraft can be distributed between a number of arrival routes, rather than concentrated on one single route, whilst at the same time ensuring that safety and adequate separation are maintained. The industry is researching innovative ways, at airports where this is expected to be beneficial, to capitalise on improved navigation accuracy to deliver predictable respite from noise.

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

Case Study - RNP Departures - London Stansted

In response to local community feedback, Stansted Airport, along with the CAA, the Airport Consultative Committee, NATS and Airline operators investigated how aircraft could fly more accurately along a departure route.

With aircraft following the existing conventional SID, the majority flew wide around the turn and directly overflew a local community. A project team designed a route to replicate the conventional SID by designing a GNSS procedure called RNP1 (RF) , one of a suite of Performance Based Navigation (PBN) technologies, to enable aircraft to utilise their onboard navigation systems to fly a route more accurately.

Following an initial trial period, the results were presented to the local communities affected and it was decided to adopt the procedures permanently and London Stansted commenced a scaled Airspace Change Proposal.

The stated objective was "to reduce the number people directly over-flown by departing aircraft by improving navigational accuracy immediately after take-off".

The results show how accurately aircraft can fly, with over 95% of aircraft now having RNP1 (RF) capability. These procedures reduce the number of people directly overflown by 85% and the consultation received a large majority in support.

The procedures have now been adopted permanently since August 2017 following the outcome of the public consultation and approval from the CAA.

4.7.1 Noise Preferential Routes (NPRs)

As previously stated, NPRs for conventional navigation are 3km wide and this could be reduced for PBN departures. However, where PBN departures have yet to be implemented, issues can arise as a result of some aircraft not being able to follow either the noise abatement procedures and/or NPRs accurately, as both the noise abatement procedures and NPRs have, in many cases, been in place for many years[43] while aircraft performance characteristics and technologies have progressed.

4.8 Airline League Tables

Airline league tables are now being used at multiple airports around the UK. The first UK league table was published in 2013 as part of Heathrow Airport's "Fly Quiet" programme. Now in its 10th year and following multiple refreshes to consider changing industry priorities, the league table ranks airlines based on their environmental performance. It considers noise and emissions metrics and aims to drive airline performance by ranking them against other Heathrow operators. By publishing the league table and placing it in the public domain, it encourages airlines to improve on their operational metrics and also facilitates engagement between the airline and airport. Heathrow has seen some real shift changes in the way airlines operate via the "Hawthorne Effect," which considers behaviour changes when the subject knows that they are being observed.

Each metric is weighted depending on the ability and speed in which an airline can change behaviours. Metrics which can lead to better performance through operational changes (such as CDA) have heavier weightings to reflect the fact that airlines have more control and can amend things quicker. Whereas metrics which rely on an airline to invest in their fleet (e.g. CAEP scores) carry less of a weighting to recognise that these rely on longer term strategic investment through fleet replacement.

Case Study - Quiet Flight Performance Report - Manchester Airports Group

Manchester Airport Group have also recently developed their own Quiet Flight Performance Report for East Midlands Airport. This report used the Noise Abatement Compliance report already in place at Stansted and developed it further into a league table concept for airline operators. The content has been developed in collaboration with the local consultative committee subgroup at East Midlands Airport to create the Quiet Flight Performance Report. This went through a process of discussion with the Independent Consultative Committee subgroup as to the key topics and metrics that they would like reported in the league table and time scales for updates. This process was very well received by the community's representatives and operators, with a number of operators reaching out to investigate ways they can improve their operational performance and ranking in the league table. Following the success at East Midlands Airport this is now being replicated at Manchester Airport using the same format of discussion through the Consultative Committee technical subgroup, this will also then be implemented at Stansted to align with the other two airports.

https://www.eastmidlandsairport.com/community/environment/managing-our-environment/reporting-and-resources/

43 For instance, the state sponsored NPRs at Heathrow have not been fundamentally altered since 1973 (there were minor changes in the early 1990's).

4. OPERATIONAL IMPROVEMENT OPPORTUNITIES

4.9 Conclusions

There is significant scope to mitigate aircraft noise by adopting appropriate operational procedures. These improvements can be delivered relatively rapidly and in a cost effective fashion, complementing and increasing the impact of noise reductions derived from airframe and engine technology improvements.

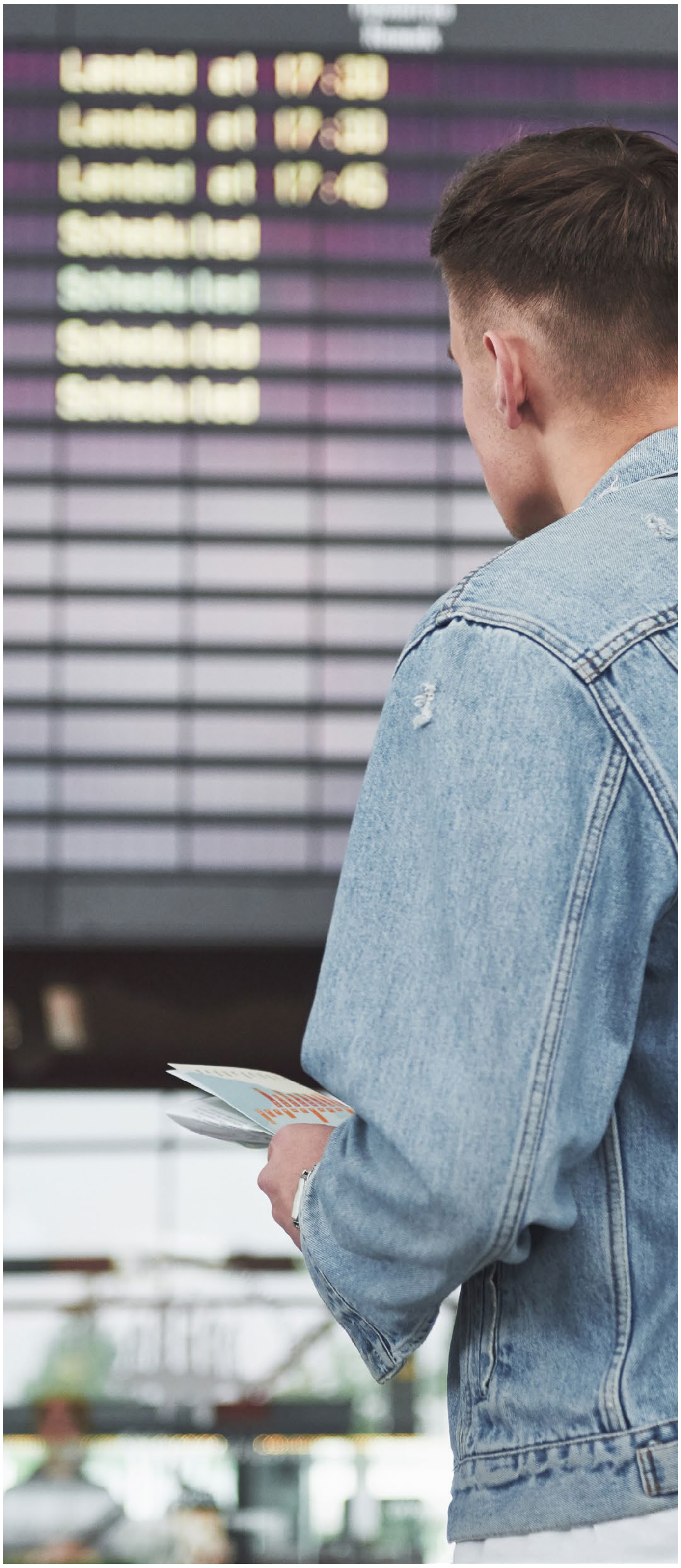
The wider adoption of long-established techniques along with new uptake of innovative procedures can deliver an average of between 1 to 5 dBA noise reduction at various points along the arrivals flight path. Options for operational noise mitigation on departures are fewer but predictable noise respite and more CCOs, for example, offer the ability to redistribute noise and may reduce intolerance to noise.

The industry is committed to increasing the use of existing operational techniques that reduce noise where safe and feasible. The industry is also committed to working with others to explore and develop new operational techniques that reduce noise where safe and feasible.

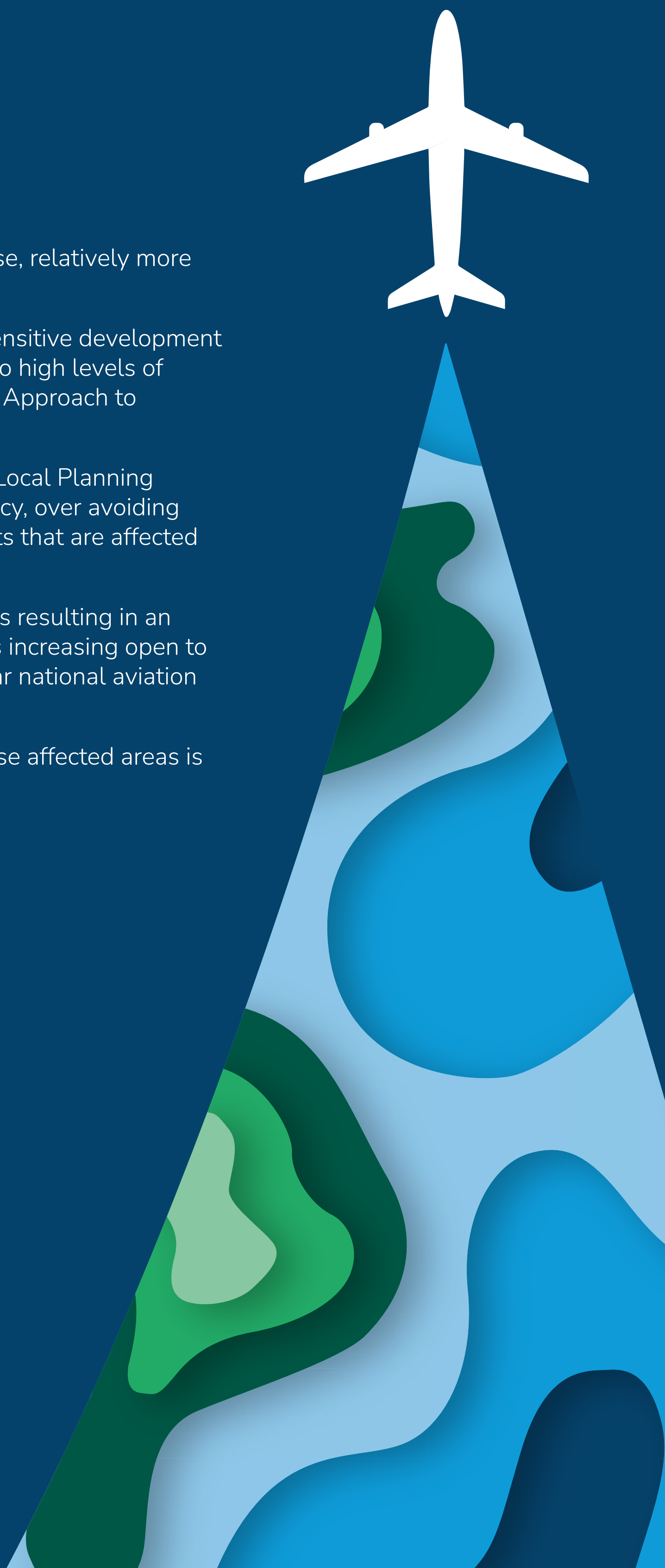
Policy makers should be aware that in many cases it is necessary to achieve a balance between the need to mitigate noise and other aircraft effects such as fuel burn (emissions) and airport capacity. For example, achieving noise reduction through low level CDAs (from 6000ft) can sometimes require longer track mileage to be flown, increasing fuel burn and CO_2 emissions. It is therefore necessary to consider all implications of adopting new operational practices before proceeding.

SA would welcome Government support for research into innovative solutions to mitigate noise, including operational trials and airspace changes where these are required to prove the concepts of new and emerging techniques. Regulation should also be streamlined to allow airports to trial procedures that may have a positive impact on the noise environment.

In addition, SA recommends that policy regarding NPRs, noise dispersion versus concentration and noise versus emissions is updated to be clear and compatible with the changes to the airspace structure required to take account of modern aircraft navigation technology. Government must also work with the industry to ensure that the available technology on today's and future aircraft, airspace and procedures can be used to help improve the noise impact of aircraft operations on local communities.



5. LAND USE PLANNING OPPORTUNITIES



Key Messages

As and when more housing is built in areas affected by aircraft noise, relatively more people will become impacted and suffer disturbance.

Implementing effective land use planning policies to deter noise sensitive development and prevent unmanaged housing growth in areas already subject to high levels of aircraft noise is a part of the internationally agreed ICAO Balanced Approach to managing aviation noise impacts.

The pressure to meet housing development needs meaning more Local Planning Authorities are prioritising residential development in land use policy, over avoiding encroachment of residential development into areas around airports that are affected by high levels of aircraft noise.

The lack of an appropriate planning policy and planning guidance is resulting in an inconsistent approach applied by Local Planning Authorities that is increasing open to challenge. There is scope to manage this better, but it requires clear national aviation and planning policy and guidance.

Airports have a role to play in this work, ensuring the nature of noise affected areas is well understood.

5. LAND USE PLANNING OPPORTUNITIES

5.1 Introduction

The ICAO Balanced Approach[44] sets out that there are four key components to an effective noise management strategy which are sequential in nature. This means that, for example, the reduction of noise at source should come first, followed by the implementation of effective land use planning and management, then the use of specific operational procedures, and that the imposition of operating restrictions should be as a last resort.

The previous sections of this Road-Map have been concerned with reducing aircraft noise at source and operating aircraft so that they are as far away from local populations (in height as well as distance) as possible, commensurate with safety and the capabilities of aircraft and navigation systems. This section considers land use planning.

ICAO's guidance on land-use planning and management is in Annex 16, Volume I, Part IV and in the Airport Planning Manual, Part 2 — Land Use and Environmental Control (ICAO, 2014). This recognises that not only can the exposure to aircraft noise be reduced through technological improvements, but that there is scope to manage consequences of the noise on the ground. This can be through effective land use planning and management that can help to ensure that future land use and development is not affected or impacted by aviation activity. Land use controls in areas surrounding airports can be an effective method for limiting the number of people that are affected by aircraft noise now, and in the future as an airport grows. This involves identifying areas affected by higher levels of aircraft noise and then restricting the land use and type of buildings that can be constructed in those areas, e.g., noise sensitive dwellings, hospitals etc. In many cases, there is also a requirement that any structures built are fitted with noise insulation.

Effective land-use planning can be used to prevent encroachment into areas that are affected by aircraft noise which might otherwise lead to an increase in the number of people affected and in turn may act as an impediment to airport growth and development. It should be recognised that land use planning is a long-term strategy and, where possible, be based on both current and future noise contour maps. There is a continued need to take future levels of aircraft activity at an airport into account at all stages of the planning process, including national guidance, Local Plan policy and development management.

ICAO's Guidance on the Balanced Approach to Aircraft Noise Management identifies three categories, or *tools*, for land use planning and management. These are:

- **Planning Instruments:** comprehensive planning, noise zoning, property sub-division regulations, transfer of development rights and land and property acquisition.
- **Mitigation Instruments:** building regulations, sound insulation grant schemes, land acquisition and relocation, transaction assistance, local property searches, physical mitigation measures.
- **Financial Instruments:** capital improvements, tax incentives, noise-related charges, and funding for mitigation and community initiatives.

This chapter lays out the planning policy and guidance relevant to land use planning around UK airports; it assesses the current approach to land use planning; and it presents Sustainable Aviation's view and recommendations of how this might be improved.

5.2 Governance and Measures

5.2.1 Planning Legislation

The purpose of the UK planning system is to balance economic development, environmental quality, and contribute to the achievement of sustainable development. Planning in the UK is plan-led, and the overall approach is in national policy that is:

- The Town and Country Planning Act (1990), applying to the majority of development consents, which are dealt with at a local level.
- The Planning Act (2008), that established the process of Nationally Significant infrastructure Projects (NSIP) and Development Consent Orders (DCO). National Policy Statements establish projects that are considered to be of national significance (NSIP) with the DCO process considers the proposals and issuing the consents.
- The National Planning Policy Framework (NPPF) 2021 sets out the planning policies for England and how these should be applied. It provides a framework within which local authorities prepare Local Plans.

44 ICAO's Guidance on the Balanced Approach to Noise Management, 2008, revised 2010.

5. LAND USE PLANNING OPPORTUNITIES

5.2.2 Planning Policy

Whilst the legislation in the Town and Country Planning Act sets out the laws that dictate procedures and the standards that should be followed, national planning policy then consists of guidance and duties that Local Planning Authorities must follow and adhere to.

The National Planning Policy Framework (2021) was a result of Government reforms from 2011 to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth. The National Planning Policy Framework (NPPF) sets out the Government's economic, environmental, and social planning principles, which should guide the actions taken to achieve the proposed planning goal. The three pillars of sustainable development – economic, environment, and social underpin the core principle in the NPPF which is 'the presumption in favour of sustainable development'. This is intended to provide greater certainty and the speedier determination of planning applications. The policies set out in the NPPF also apply to the preparation of Local Plans, Neighbourhood Plans, and decisions on planning applications.

The NPPF also replaced and consolidated a large series of Planning Policy Statements, and Planning Policy Guidance documents (including some relating to noise). A series of revisions to the NPPF by the Department for Levelling Up, Housing and Community (DLUHC) have been undertaken since 2011, with the most recent version issued in 2023, following extensive consultation, as part of the Levelling-up and Regeneration Bill. The NPPF is augmented by a series of Planning Practice Guidance notes (including guidance on noise). These guidance notes should be read alongside the policies in the NPPF.

5.2.2.1 Planning Reform

Various national planning policy reform proposals have been made by Government since 2019, causing uncertainty amongst local authorities and associated stakeholders. The Levelling Up and Regeneration Act came into force in October 2023 and is intended to strengthen the Government's commitment to development and regeneration and to speed up the planning process. It is hoped the enactment of the legislation can give greater certainty to local planning authorities and allow Local Plans to be pursued and enacted effectively.

The housing sector is hungry for clarity, consistency, and certainty over Government's national planning policy. There is however also pressure for a national review of the purpose of the Green Belt land, which should assess circumstances in which brownfield sites within the Green Belt should be considered for development. If conducted correctly, in conjunction existing resident businesses such as airports, this could go some way to tackle residential development encroachment in noise sensitive zones. Conversely however if done without sensitivity to exiting noise issues it could open up pressure to develop housing in noise affected areas. This is again being reviewed by the latest Government with the proposed Housebuilding Bill.

If housing growth is not managed properly, we may continue to see population growth in noise affected area, increasing the number of people affected by aviation noise relative to what could be achieved using the other tools in the Balanced Approach.

5.2.3 Aviation Policy

The lack of clarity in the NPPF and the reliance on Planning Practice Guidance has removed and weakened the approach to noise in planning policy and how it is considered in development proposals. Paragraphs 174 and 185 of the NPPF both refer to the need to consider noise, but focus is on conservation and the natural environment.

The Aviation Policy Framework (APF) was published in 2013. Its overarching policy is to, 'limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise as part of a policy of sharing benefits of noise reduction with industry in support of sustainable development' (APF, 2013). A more recent policy statement on aircraft noise was published in March 2023.'The government's overall policy on aircraft noise is to balance the economic and customer benefits of aviation against their social and health implications in line with the International Civil Aviation Organisation's Balanced Approach to Aircraft Noise Management. This should take into account the local and national context of both passenger and freight operations and recognise the additional health impacts of night flights.'

The APF set out the Government's approach 'that aviation needs to grow, delivering the benefits essential to our economic wellbeing, whilst respecting the environment and protecting quality of life' (APF, 2013). The APF set out the policy to allow the aviation sector to continue making significant contributions to the country's economic growth, whilst safeguarding its long-term economic prosperity.

The APF served as a baseline for the Airports Commission in their consideration of airport capacity in the South East to 'take account on important issues such as aircraft noise and climate change' (uk.gov, 2013).

5. LAND USE PLANNING OPPORTUNITIES

5.2.3 Aviation Policy (continued)

Following the 2013 the Aviation Policy Framework , the Government published a 'stronger and clearer' updated framework in 2018, Aviation 2050: The future of UK aviation . This was a strategic framework ahead of a new national policy, with intention of replacing the APF. The Government's intention in Aviation 2050: The future of UK aviation was to ensure that, 'industry is sufficiently incentivised to reduce noise, or to put mitigation measures in place where reductions are not possible' and to set out how this was intended to be done. This included setting up an independent commission on civil aviation noise (ICCAN), which has now been wound up with its functions moved to the CAA.

Area of Focus	Focused Measure	Degree to which LUP is affected by measure
Key Objective Measures	Setting a new objective to limit, and where possible, reduce total adverse effects on health and quality of life from aviation noise.	
	Developing a new national indicator to track the long-term performance of the sector in reducing noise.	
	Routinely setting noise caps as part of planning approvals (for increase in passengers or flights).	
	Requiring all major airports to set out a plan which commits to future noise reduction, and to review this periodically.	
New measure for people living near the airport	Developing tailored guidance for housebuilding in noise sensitive areas near airports.	
	Improving flight path information for prospective home buyers so that they can make better informed decisions.	
Airport Operations	Proposing new measures to ensure better noise outcomes from the way aircraft operate, by increasing uptake of best practice operating procedures and improving compliance with mandatory controls.	
Considering compliance and enforcement as a priority work area	Look into creating new statutory enforcement powers for ICCAN or CAA if other measures prove insufficient to drive the outcomes it wants.	
Noise Insulation Measures	To extend the noise insulation policy threshold beyond the current 63dB LAeq 16hr contour to 60dB LAeq 16hr.	
	To require all airports to review the effectiveness of existing schemes. This should include how effective the insulation is and whether other factors (such as ventilation) need to be considered, and also whether levels of contributions are affecting take-up.	
	The government or ICCAN to issue new guidance to airports on best practice for noise insulation schemes, to improve consistency.	
	For airspace changes which lead to significantly increased overflight, to set a new minimum threshold of an increase of 3dB LAeq, which leaves a household in the 54dB LAeq 16hr contour or above as a new eligibility criterion for assistance with noise insulation.	

Directly Affected | Indirectly Affected | Affect Filters Down | Not at all Affected

Table 11: Aviation 2050, Towards a Stronger Noise Policy 3.113-3.122.

5. LAND USE PLANNING OPPORTUNITIES

5.2.3 Aviation Policy (continued)

The extract from Aviation 2050 above uses colour coding to set out the extent to which the measures of the Government's aviation policy directly, or otherwise, considers land use planning around airports. These measures were included in the public consultation on Aviation 2050 as part of the approach to the development of a new national aviation policy that would replace the APF. Whilst the Government published its response to the public consultation and set out legislation for the national airspace change programme, further consultation on national policy was delayed by the COVID-19 pandemic.

Whilst the 2013 Aviation Policy Framework states that the Government will ensure that the national policy remains relevant and up-to-date, further updates have yet to be published. *The 2018 Aviation 2050: The future of UK aviation*, and the subsequent *Flightpath* to the future remain as guidance rather than national policy.

5.2.3.1 Airports National Policy Statement

Alongside examining the scale and timing of requirement for additional UK aviation capacity particularly in the South East of England, the 2012 Airports Commission, was also required to look at how to make best use of existing airport infrastructure, before any new capacity becomes operational.

In its Final Report in July 2015, the Airports Commission concluded that the proposal for a Northwest Runway at Heathrow Airport, combined with a significant package of measures to address its environmental and community impacts, presented the strongest case, and offered the greatest strategic and economic benefits. The new runway, however, would not open for at least 10 years, and therefore there was a need for existing UK airports, other than Heathrow and Gatwick to understand how to make best use of the capacity of their existing runways.[46]

In 2015, the Government began developing an Airports National Policy Statement (ANPS) to set out a planning framework for a new runway in the South-East of England. Under the 2008 Planning Act any future runway proposals would be classed as an nationally significant infrastructure projects NSIP and subject to the Development Consent Order DCO process. With this in mind, the Government suggested that the ANPS was the most appropriate method for delivering Heathrow's Northwest runway, including the requirement for additional work on air quality, noise, carbon, and mitigating impacts on affected local communities. This work should provide the primary basis for decision making on the DCO. The ANPS would be an important and relevant consideration for the DCO Examining Authority, and decisions by the Secretary of State, as well as any further applications for new runway capacity and other airport (NSIP) in London and the South-East of England.

5.3 The Current State of Land Use Planning Around UK Airports

Over the last decade there has been a limited systematic evaluation of the use and success of land use planning tools to minimise noise impact in the areas around UK airports, since the ICAO/CAEP 5 work programme on Airport Planning and Land Use Planning[47]. The development of land near and within areas of high aircraft noise areas around airports for noise-sensitive uses, including residential development continues to be, a major challenge that many UK airports are facing. Many of the measures in the ICAO Balanced Approach are in place at UK airports and are incorporated in airport Noise Action Plans. However, the effectiveness of airport and airline noise control measures can be compromised by competing demands on the planning system to deliver residential development in noise sensitive areas, Some Local Planning Authorities have been forced to prioritise housing targets over exposure to aircraft noise. This has resulted in residential development encroaching in areas around airports that are subject to higher levels of aircraft noise.

ICAO's Committee on Aviation Environmental Protection (CAEP) produced their 2022 Environmental Report, in which there was a focus on the need for better land use planning as a top-down approach. The report highlighted the need for governments to understand the local issues and nuances around individual airports, which may present planning challenges when addressing encroachment into an airport's noise contour areas. The following recommendations were provided for governments, local authorities, and airports in working to overcome these challenges:

- It is important to maintain dialogue with communities and local governments or other stakeholders, including educating or informing on the issues of encroachment and its impacts.
- Airports and the relevant authorities should work together to ensure correct application of land-use planning techniques in development of airports.
- Airports should strive to have a comprehensive noise management plan or strategy.
- New guidelines or requirements developed by the relevant authorities should be based on technically robust and up-to-date scientific evidence and coordinated with relevant stakeholders.
- Additional development of procedures and metrics considering local issues may facilitate the measurement of encroachment.
- Having a single authority to enforce the continuity of noise zoning regulations across several local government areas within the airport noise contours may alleviate the problem of multi-jurisdictional interests.

46 Beyond the Horizon – The future of UK aviation – Making best use of existing runways. June 2018.

47 Raje et al, 2022.

5. LAND USE PLANNING OPPORTUNITIES

5.3.1 The Challenges

The areas of the noise contours around UK airports have been shrinking over time. This is as a result of the airlines' use of increasingly quieter aircraft, and the measures in airport Noise Action Plans. Noise contours are typically measured using an LAeq-16hr metric, which is a long-term averaged aggregated measurement focuses more on the average noise output across movements, rather than the number of movements.

Airport noise contours, along with the Noise Exposure Hierarchy Table (NEHT) are used by planning authorities to help determine noise sensitive zones around airports. Whilst the NEHT has many uses, it could be argued that it gives noise sensitive zone planning more flexibility when setting development perimeters; for example, if the planning authority determines that Significant Observed Adverse Effect Level (SOAEL) defines a noise sensitive zone, rather than Lowest Observed Adverse Effect Level (LOAEL), the difference in the area affected by noise, the potential development land, and the population newly affected, may be vast.

5.4 Airport planning conditions and agreements

To help mitigate some of the challenges faced by airports due to the encroachment of noise sensitive developments, Airports have a suite of measures as a result of planning consents and Town & Country Planning Act Section 106 Agreements. These agreements enable additional capacity at the UK's major airports (Heathrow Terminal 5, Stansted increase in movements from the existing runway, Manchester Second Runway, Birmingham Runway Extension, etc.). The types of controls included in these agreements to enable additional capacity and growth in ATM's whilst maintaining are:

- Fixed limits on noise contour area size
- Night aircraft movement limits and Quota Count limits
- Aircraft noise and track monitoring systems with associated analysis and reporting
- Preferential runway use away from noise sensitive areas
- Restrictions on particular aircraft types or categories
- Annual limits on passenger and aircraft movement numbers
- Restrictions on aircraft engine testing and ground operations
- Providing sound insulation grant schemes and aircraft wake vortex[48] repair schemes

In addition, the various Section 106 Agreements include obligations relating to the operation of mitigation measures (Sound Insulation and Vortex), and community compensation schemes and surface access obligations. Whilst there is a general consistency of approach to planning conditions and Section 106 Agreements, these measures have been developed on an individual airport basis (with consequent variations in scope and intensity of the measures).

There are also differences in the noise levels that are applied in various planning conditions and Section 106 Agreements. These include the areas of LAeq contours (typically 57 LAeq and 60 LAeq). Some agreements are based on the area of a typical Single Event Contour – LAmax. Additionally, noise contours in Noise Action Plans are presented as Lden contours.

While SA recognises the need for noise metrics to be relevant to those concerned about aircraft noise locally, consistency of approach is needed in the use of noise metrics for planning at airports in order to maintain a common method for setting performance criteria. This could be defined within statements of national aviation policy or within agreed industry 'best-practice' guides. This would provide better comparisons of trends at individual airports and between airports and give greater transparency to local authorities and local communities.

5.5 Noise Action Plans

Some UK airports are also required to prepare a Noise Action Plan, A Noise Action Plan is a five-year plan to assess, consider and manage aircraft noise at the airport, to reduce impacts on communities living around the Airport. It is a key part of delivering broader UK Government noise objectives that are to limit and, where possible, reduce the number of people in the UK significantly affected by aircraft noise. The Noise Action planning process operates in five-yearly cycles. The aim is for each subsequent Noise Action Plan to build on existing progress to manage the effects of aircraft noise on people.

The Noise Action Plan is an airport strategy for managing aircraft noise to reduce impacts on communities living around the Airport. The plan includes specific measures or actions, which provide the airport with a clear plan to ensure that the noise impact of its operations is reduced where possible or limited. Noise Action Plans are a legal requirement under European Union Directive 2002/49/EC relating to the Assessment and Management of Environmental Noise. This Directive is commonly referred to as the Environmental Noise Directive or END. The requirements of the END are transposed by the UK Government in the Environmental Noise (England) Regulations 2006 as amended.

48 Wake vortex is the disturbance of air caused by aircraft, creating turbulent air which can result in damage to some buildings close to the airport.

5. LAND USE PLANNING OPPORTUNITIES

5.5 Noise Action Plans (continued)

Noise Action Plans undergo a public consultation before being agreed and implemented through DEFRA. Consulted stakeholders include the public, Airport Consultative Committees, Airlines, Airport Operators, Local Authorities and other key local representatives.

5.6 Sound Insulation Grant Schemes

UK airport operators offer a range of schemes to mitigate the impact of aircraft noise on local communities. The principal mitigation measure is the provision of acoustic insulation, generally double or secondary glazing. Sound Insulation Grant Schemes can be required on a statutory basis under Section 79 of the Civil Aviation Act, such as for Heathrow and Gatwick; schemes are generally provided on a voluntary basis, although some are formalised through local planning agreements such as Section 106 Agreements.

Sound Insulation Grant Schemes are in place at all of the UK's major airports. The scheme boundaries are generally derived from LAeq noise contours (typically 63 LAeq) although some variations to suit local circumstances do exist (90 dB SEL for the night scheme at Heathrow). The schemes generally provide for the installation of Secondary or Double Glazing and loft insulation in properties that are particularly affected by aircraft noise. The scope of a Grant Scheme (usually residential properties) varies depending on the extent of the noise contour and the number of properties within it. There are also difficulties in providing sound insulation for particular types of buildings, notably listed or historic buildings and properties in multiple occupation. It should also be recognised that such schemes have been in place for many years, and as the noise contours have reduced in area, there are properties that have received insulation but now lie outside the areas that are currently eligible.

5.7 Other Measures

A number of other measures are in place at and around UK airports that are intended to mitigate aircraft noise or reduce the numbers of people affected by it. These include land and property acquisition in areas of particularly high levels of noise or assistance to residents relocating from noisy to quieter areas. Airports also provide a wide range of material to local communities and to potential property purchasers to ensure that as much information as possible is available on the local noise environment. Community engagement is considered in greater depth in Chapter 6 of this document. Airports have also constructed noise mitigation measures within their sites. These can include noise barriers or noise bunds and engine test pens that mitigate the effect of aircraft engine testing.

5.8 Conclusions

Housing growth in noise affected areas, alongside growth in ATMs, would be the main potential factor increasing the number of people affected by noise, and so must be managed successfully.

Overall housing and land use planning in the UK is currently in a state of flux. Allied to this is the lack of detailed consideration about planning issues that affect the airport industry in the most recent reforms, and identified gaps and conflictions in policy that could lead to further residential encroachment around airports.

The aviation industry, and airports in particular, should play an active role in contributing to and shaping local planning policy to ensure that, where possible, development in noise sensitive areas, and population encroachment into previously noisy areas, are prevented. Any planning controls or agreements should be related to the area of an airport's noise contour rather than the population within it.

UK airports should continue to prepare long-term Masterplans that provide details of future development and forecasts of future impacts (including forecast noise contours). The Masterplan process should be consistent with the Noise Action Plan and be incorporated within local planning policy. There is an Industry commitment to work with Government, local authorities and local communities to achieve improvements required. SA recommends that the Government review of planning policy works to tidy up current uncertainties regarding how development in noise sensitive areas should be responsibly managed, alongside house building targets.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

Key Messages

Over the past few decades, the aviation industry has invested billions of pounds into improving noise abatement techniques, particularly through investment in the technological development of aircraft and operational improvements. However, perceptions of noise by local communities have not always improved in line with these developments. How noise impacts people is affected to some degree by the understanding and perception by those people of noise being made.

The challenge facing airports is that communities and stakeholders represent a diverse and sometimes conflicting range of perspectives. As a result, airport engagement seeks to cater to a range of views and must be tailored to the local circumstances; a one-size-fits-all approach is not appropriate.

Aircraft noise is a complex subject to engage upon in an open, clear, and transparent way and the historic challenge for all airports is to ensure that engagement activities are underpinned by information and noise metrics that communities can easily understand and relate to. Since the last edition of the SA Noise Road-Map the industry has made progress in the range and type of communication and engagement with a broader spectrum of stakeholders, particularly on the issues of airport development and airspace change.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.1 Introduction

Many activities in day to day life generate noise, this includes the transportation systems we use. By their very nature, transport interchanges for road, rail and air are generally located close to areas of population. The population density close to airports will vary based on the communities and regions that they serve. What is common to all airports is the need and desire to engage effectively with local communities and those affected by aviation noise.

How noise impacts human beings can be affected by the understanding and perception of noise being made. In simple terms for example, if it is believed that a noise being made is the result of rule-breaking by an operator it may cause more effects on the person than if it is understood as a legitimate operation.These contextual issues are known as 'non-acoustic factors'.

Airport operators are generally the primary contact between those living around airports and the wider aviation industry. Over the years UK airports have developed a range of communication and community engagement channels to address specific circumstances and local issues. This work is regularly reviewed in detail and at least every 5 years when major UK airports develop their noise action plans[49].

Taking this into account, airports, with support from the wider aviation industry look to ensure that appropriate engagement strategies are in place and continually seek to improve engagement where possible. Good quality engagement, high levels of understanding and a positive impression of the airport can affect how residents experience noise – these issues are also known as 'non-acoustic factors'.

The challenge facing airports is that communities and stakeholders represent a diverse and sometimes conflicting range of perspectives. As a result, airport engagement seeks to cater to a range of views and must be tailored to the local circumstances; a one-size-fits-all approach is not appropriate. Airports can use Sustainable Aviation to share best practice successes and learnings where applicable, and equally highlight communication channels that have not been as successful. Common aspects of an airport's engagement strategy can include a community engagement forum such as an airport consultative committee and their technical subgroups. However, the structure, membership, roles, and responsibilities of these committees can vary greatly.

This section will review changes in community engagement methods since the original Noise Road-Map and highlight further opportunities for improvement.

49 Under the UK Environmental Noise (England) Regulations 2006 (as amended), airports with over 50,000 movements per year are required to produce Noise Action Plans.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.1 Introduction (continued)

Review of our INDUSTRY COMMITMENTS:

	Commitment	Update/Progress
1	**To work with Government and other stakeholders to identify and resolve research gaps.**	The industry has responded to several Government, CAA and whilst in existence ICCAN consultations on this matter calling for more research across a range of issues. These have been summarised in an ACI Noise Research Road-Map publication. Examples of research undertaken include: • Noise respite • Performance based navigation • The effectiveness of noise insulation
2	**To promote open and transparent engagement with communities affected by noise.**	New online tools and systems have been introduced at many airports to promote open and transparent engagement. For example, Insightful at Gatwick, Webtrak and Xplane at Heathrow and the development of virtual airspace consultation techniques at Luton Airport. Industry has extended the range of published metrics used to describe noise and its impacts beyond those used in policy or to calculate health impacts. Examples include the increasing use of 'number above' contours and overflight maps in aircraft noise assessments and reports. More transparent accountability has been introduced. For example, in the CAP 1616 process for airspace change, stakeholders are now involved from the start of the change process rather than just towards the end after publication of the environmental assessment. In 2019, Heathrow received the Noise Abatement Society's John Connell award for its innovative sound demonstrations that were used to support consultation on airspace change. Gathering broader perspectives by engaging groups with different demographics and views. For example, the use of focus groups such as Manchester Airport Group's work establishing Youth Forums. Also, the appointment of independent chairs or expert advisory roles to Airport Consultative Committees.
3	**To present the best practice engagement mechanisms from the Road-Map to local stakeholders through channels such as consultative committees to help airport operators better evaluate their engagement techniques.**	ICCAN (2020) Review of Noise metrics and Measurement. In 2019, Heathrow utilised the SA best practice engagement mechanisms and the ICCAN report on noise metrics in a review of its engagement forums. This resulted in a new structure for engagement with community groups.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.1 Introduction (continued)

Review of our INDUSTRY COMMITMENTS:

	Commitment	Update/Progress
4	**Ensure that any changes to noise impacts or noise mitigation efforts are clearly communicated through agreed channels in a timely and non-technical manner.**	Industry's progress falls into two broad categories: (a) Traditional reporting such as annual noise contour reports, noise monitoring reports, Noise Action Plan progress reports or audits. These are typically made available on airport websites and flagged with community members in engagement groups. (b) Real-time updates of operational issues or changes impacting noise. For example, Newcastle Airport's use of social media to advise communities of changes in runway usage due to weather conditions.
5	**SA requested that Government leads further independent research on:** **a) community perception of aircraft noise, in particular the issue of noise annoyance vs. noise acceptability.** **b) the various noise metrics that are available and evaluate their parameters, in order to establish an appropriate metric that recognises what marks the onset of major community annoyance.**	Some progress has been made in this area, including: (a) DfT's 2014 Survey of Noise Attitudes, including further planned studies. (b) ICCAN's 2020 report on noise metrics and measurement. (c) CAA's work on the definition of overflight and summary updates on noise health effects. SA looks forward to working with DfT, CAA and research organisation to continue this important workstream.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.1 Introduction (continued)

One notable area of change since publication of the last SA Road-Map is the UK government's establishment of the Independent Commission on Civil Aviation Noise (ICCAN) in January 2019. ICCAN was formed to act as an impartial and independent voice on aviation noise and how it affects communities. Following a review by DfT in 2021, ICCAN was dissolved, and its functions transferred to the CAA.

SA recognises the value placed by communities on the functions undertaken by ICCAN and we look forward to working with the CAA to continue building the sound foundations established by ICCAN. Industry would welcome initiatives that can help increase trust, transparency, and clarity in the aviation noise debate and in particular the development of guidance on a core set of noise metrics for airports that communities can understand and relate to.

6.2 Current Noise Communication and Community Engagement Mechanisms

Over recent years, as per ICAO Balanced Approach recommendation to maintain the dialogue and communication, the industry has worked with local communities to establish a variety of engagement techniques, in many cases modified to suit local demands; these are generally most successful where this has been achieved in consultation with local community representatives, these engagement mechanisms are outlined below.

6.2.1 Information Reporting

Aircraft noise performance reporting is very important to local communities and many airports have developed targeted community engagement reports. These include various methods such as annual reports, targeted briefings, news bulletins and updates, and regular updates to local communities providing information about airport operations and developments.

Online flight tracking has been a significant step forward in terms of transparency of information for local communities, enabling people to map the location of aircraft in their area. Most UK airports have developed this type of system which is accessible through their main airport website. Some airports also have an online system enabling residents to undertake small scale analysis and comparisons for their location and also provide access to noise monitoring and track keeping information, allowing local residents to monitor individual aircraft movements and historic trends. Feedback from local residents on these systems has been extremely positive. Industry continues to explore new techniques to improve their online information.

6.2.2 Noise contours

Using noise contours allows for a visual representation that can be shared with the local communities of the areas most affected by noise and can be split into different sound levels and times of day. These contours can then be used to inform community support in the form of programmes such as sound insulation grant schemes.

The challenge for airport operators when enhancing noise management is to choose a suite of noise metrics that are understandable to the target audience. Alongside primary noise metrics such as LAeq, which is used in national noise policy, trend analysis and health effects determination, industry has been developing its use of supplementary noise metrics in partnership with their local community representative to assist with community engagement and understanding. Examples include the increasing use of 'number above' contours and overflight maps in airport noise assessments and reports.

Supplementary Noise Metrics Case Study: Stansted Airport

Stansted Airport completed a research study with their local communities as to which noise contour metrics best described their experience on the ground. From these discussions with local community representatives, it was noted that LAeq contours did not best convey what communities felt they experienced. Generally, LAeq contours are used as the standard metric for reporting, tracking longer term trends and often form part of local planning agreements. The outcomes of this study suggested that there is not a one-metric fits all approach that can be used for noise contours, and a range of different metrics would be better to reflect the local community's perception of aircraft noise. Following this study, Stansted Airport now publishes 'Number Above Contours', which show the number of operations per day in an area that are likely to exceed a given dB level.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.2.3 Airport Consultative Committees (ACCs) and Consultative Groups

Under Section 35 of the Civil Aviation Act 1982 there are 51 airports and aerodromes in England and Wales that have been designated to make available adequate facilities for consultation on airport matters.[50]

ACCs and similar groups can play an important role in the engagement between airport and community. ACCs are generally comprised of Local Authority members, local interest groups and industry stakeholders. They meet at least three times a year to discuss current and future activities taking place at the airport.[51] They will have some form of constitution with terms of reference.

A consultative committee aims to provide:

- An opportunity for information exchange between an aerodrome and interested parties.
- A structured forum for discussion so as to make recommendations to the aerodrome management and other bodies when appropriate.
- The opportunity to reach common understanding between interested groups about the nature of aerodrome operation, thereby increasing the scope for issues to be resolved amicably.
- Greater understanding about aerodrome operations more widely, through sharing of relevant information by committee members; and
- Improved understanding by the aerodrome operator of the nature of its impacts on local communities and businesses.

Since the publication of the first Noise Road-Map a number of airports have reviewed their ACC arrangements.

Engagement Committee Case Study: Heathrow Airport

In 2022, Heathrow launched a new forum, the Committee for the Independent Scrutiny of Heathrow Airport (CISHA) to fulfil the functions of the former Heathrow Airport Consultative Committee. This was the result of an extensive review and stakeholder consultation exercise during 2020 and 2021 which identified a compelling case to make engagement more effective, transparent, and efficient. This new oversight body provides umbrella oversight over Heathrow's existing five community engagement forums and coordinates discussion, response, and action.

6.2.4 Local Engagement and Airport Outreach Programmes

Outreach programmes have long been the foundation of engagement for airport operators, giving local residents the opportunity to meet with the operator and air their views on current issues.

Noise Action Plans (NAPs) have become a primary vehicle for engagement for airports. These plans continually evolve but provide a clear basis for engagement on noise issues. Outreach programmes require consistent input from all members involved in a transparent manner to ensure they are the most effective at supporting communities' concerns. Examples of these engagements can be found in 6.3, showing examples of examples of Stansted, East Midlands and Manchester Airports working collaboratively with local communities in outreach programmes to address noise concerns.

6.2.5 Airport Master Plans

Airport Master Plans (AMPs) detail the airport operator's objectives for future development. Although the plans do not have a statutory status, the Government recommends that airports continue to produce them, and that they are updated at least once every five years.

AMPs also provide a useful opportunity for airport operators to put forward detailed projections for how they expect to grow over a five-year timeframe. Consultation processes can also be structured and designed as a means of communicating information on the environmental impacts of any growth, including noise impacts.

Furthermore, AMPs are seen as a move towards a more open community engagement process allowing for greater certainty about airport development.

Many airports developing their Master Plans carry out extensive consultations with their local communities on their vision for the airport. Local stakeholders are encouraged to find out more and participate in more detail into these consultations. Engagement mechanisms have included public exhibitions, dedicated websites, and focused workshops.

50 http://www.legislation.gov.uk/ukpga/1982/16/section/35?timeline=true

51 Committees are able to meet less than three times a year if this deemed sufficient.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.2.6 Airport Airspace Modernisation Plans

Much of the UK's airspace has barely changed since the 1960s, yet we have twice as many aircraft in the skies. The airspace was designed for an age when aircraft were fewer and less efficient, and navigation was much less sophisticated. For these reasons, the UK's airspace needs to be brought up to date – that is why the Government has embarked on its "Airspace Modernisaton Strategy" (AMS) to modernise the UK's airspace. The AMS is intended to provide greater operational resilience, ensure the highest standards of safety, and realise improvements in efficiency and environmental impact. This presents us with an opportunity to address some of the wider impacts of aviation such as noise and emissions. The AMS will require all UK airports to modernise, as well as the network that sits above these airports which is known as enroute airspace. AMS is also part of a Europe-wide modernisation project, called the Single European Sky, to make the skies above Europe more efficient.

For any airspace change, the appropriate sponsor must follow the process in CAP1616 Airspace Design Guidance on the regulatory process for changing airspace design, including community engagement requirements. Similarly, in the event of the approval of any airspace change which affects the existing noise situation, an Airport Noise Action Plan would be reviewed and reissued to take any new noise mitigation measures into account.

Airspace Change Case Study: Manchester Airports Group

At all of the MAG airports, Manchester, East Midlands and Stansted each have dedicated webpages relating to their Airspace Modernisation Programmes. Regular updates are provided and minutes for the airports stakeholder reference groups are published. The stakeholder reference group is formed of interested parties, including local community groups to allow them to have oversight, frequent input, and updates on the progress of the project. The website also has the ability for members of the public to sign up for updates on the airspace programme at all three of the airports and includes links to the CAA's airspace change portal, where more information can be found.

6.2.7 Aircraft Noise Management Advisory Committee

The Aircraft Noise Management Advisory Committee (ANMAC) was established to advise the Department for Transport (DfT) on technical and policy aspects of aircraft noise mitigation and track keeping policies at Heathrow, Gatwick, and Stansted Airports. ANMAC's advice is available for Ministers and the airports when formulating and implementing their noise mitigation policies. ANMAC is made up of members of the DfT, NATS and representatives from the airport operators, ACCs, and Scheduling Committees at each of the three 'designated' airports. The CAA's Environmental Research and Consultancy Department (ERCD) provides technical noise support to the ANMAC, and other specialists are invited to speak and advise the group when required.

Summaries of meetings are made publicly available so that the issues pertaining to the "designated" airports can be made available to other airports and ACCs.

ANMAC has become largely dormant in recent years with the Airspace and Noise Engagement Group providing the most frequent interaction between DfT and stakeholders. In previous decades, ANMAC carried out a great deal of authoritative work on aircraft noise including arrivals noise, the night restrictions QC regime and noise abatement procedures. SA welcomes the role undertaken by ANMAC and would like to see it reinstated as a technical forum for exploring noise abatement opportunities with industry experts.

6.2.8 Airspace and Noise Engagement Group

The Airspace and Noise Engagement Group (ANEG) was established by government to act as a formal channel of communication between the Department for Transport (DfT) and airspace and airport noise stakeholders.

The ANEG covers all aspects of national airspace and airport noise policy development. It acts as a sounding board to identify, discuss and, where possible, resolve airspace and airport noise issues that impact on the work of the department. Discussions are at a strategic policy level. The ANEG does not debate or attempt to resolve individual local issues. The ANEG is also an open forum for members to share their own relevant airspace and airport noise projects. It meets two to three times each year and notes of the discussions are made publicly available on DfT's website.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.2.8 Airspace and Noise Engagement Group (continued)

ANEG members include representatives from each of:

- Air navigation service providers
- Airlines
- Airports
- Aviation Environment Federation
- Civil Aviation Authority
- Community groups representing those affected by noise
- Express delivery industry
- General aviation
- Local authorities
- Aerospace manufacturers
- Passenger organisations
- Sustainable Aviation
- UK airport consultative committees

6.3 Airport Case Studies

This section sets out three examples of good practice work done by airports.

Stansted Airport: Working with communities collaboratively to address noise concerns with Helicopter Operations

Some local communities in very close proximity to London Stansted raised some concerns relating to the operation of helicopters to/from the airport. Helicopters operate to/from London Stansted using visual flight rules and at much lower levels than commercial fixed wing operations and can create significant noise impacts. The airport noise management team attended a local council meeting to hear and understand the concerns of local residents who had been submitting regular complaints. Having agreed to investigate further, the airport worked closely with NATS and the based helicopter operators to find a solution to the issues raised. What was found to be lacking was any accurate definition of a preferred arrival and departure area, which could minimise the overflight of these local communities. After testing a preferred option with an operator, adding a defined waypoint to their navigation system enabled helicopters to route over fields between the two local communities. The results were presented to the local communities at two separate council meetings. Both communities were fully supportive of the initiative, so the CAA were presented with the background evidence, along with feedback from communities and operators, to endorse the solution.

As a result of a positive outcome, changes were made to the AIP, listing additional no fly zones, a new published Visual Refence Point, updated charts for helicopter routings detailing the new waypoint and revised ATC instructions for helicopter operations.

East Midlands Airport: Launch of Schools' Eco-Garden Competition through the Community Fund.

During the pandemic, East Midlands Airport (EMA) saw an increase in cargo operations due to change in circumstance, and a reduction in the passenger operations at other airports. This led to an increase in louder QC4 aircraft, most notable the Boeing 747-400. This was noticed by the communities and lead to a significant increase in the number of complaints received. As a result of this the airport set up a surcharge for operators operating these larger noisier aircraft out of EMA during the night period, this money was collected and invested in the airports Community Fund. Since its implementation in April 2021 the surcharges have raised significant funds for the local community, which has allowed for some larger community engagement projects in the local area.

With the money raised from this surcharge, EMA launched a project to encourage schools to design and ultimately create eco-gardens. Participating schools were asked to submit designs for gardens or green space that substantially improve biodiversity. The submissions judged to have the most positive environmental impact were awarded funds to turn designs into reality. It was open to any school within the community fund 'area of benefit' which covers approximately a radius of 8-10 miles from the airport. These are the communities that are most overflown by aircraft approaching and departing EMA.

The money has been made available from EMA's Community Fund which was established in April 2002 to support initiatives in places which are most affected by the airport's operation. To date, over £1.3m has been awarded to more than 1,500 community groups, supporting initiatives such as equipment for sports clubs and village halls to heritage restoration projects such as church clocks.

A key aim of the project is to create a lasting legacy that can be enjoyed by generations of children to come as well as the wider community and the project was so successful this has now been rolled out to all three MAG airports, using money from their Community Fund.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.3 Airport Case Studies (continued)

Manchester Airport: Reducing the number of non-standard departures to improve community noise impact

In October 2021, Manchester experienced an outage of it's Very High Frequency Omni-Directional Radio Range and Distance Measuring Equipment (MCT- VOR/DME). Without this navigational equipment aircraft were unable to fly the Standard instrument Departure (SID) and stay within Preferred Noise Routes on departure. Aircraft were instead instructed to follow Non-Standard Departures and as a result, flights were temporarily routed differently, resulting in them passing over locations that would not normally experience such frequent air traffic.

This event lasted over several days and led to a significant increase in the number of complaints and enquiries from the local communities around the airport. This increased in complaints led to internal investigation into the process in place for such an event.

At the time, the standard practise in the case of an outage of this equipment was that all departing flights would be provided a Non-Standard Departure (NSD) order. This resulted in aircraft flying straight out when departing from the airport regardless of if the SID being operated had been impacted by the outage.

Manchester Airport worked with NATs to change the procedure in the case of an outage of the MCT VOR/DME, going forward NSD's would only be issued to aircraft operating on the SID that the MCT is related to. Consequently, a much smaller proportion of operations are required to use the NSD code, and the airport has seen considerably fewer complaints when the MCT is out of service and much less disturbance for the local communities.

6.4 Opportunities for Improvement in Community Engagement

Despite the number of positive community engagement mechanisms previously identified, there can still be a number of areas between communities and the airports, at times, where agreement cannot be reached This would benefit from further research and development.

6.4.1 Balancing Diverse Views Across Stakeholder Groups and Demographics

For some airports, the highest volume of complaints about aircraft noise do not always come from the areas subject to the highest levels of noise. Some communities closest to the airport may benefit from economic advantages such as employment which can offset the social impact of aircraft noise; others that do not directly benefit from the economic advantages (even though they may benefit indirectly), may consider these outweighed by the social and environmental implications of aviation. To balance the differing views of the local communities, it is up to the airport to try to find the right balance of engagement geographically; this may for example look to specific engagement in areas with higher rates of complaints for aircraft noise.

Airports in particular are mindful of these engagement challenges and continue to review their community engagement techniques, seeking improvements where practicable.

6.4.2 Improving Communication Channels and Knowledge Sharing

To promote open communication, airports must provide clear and effective communication channels, whether it be by direct communication with the airport, through the ACC or its noise/technical sub-groups. These communication channels allow for an open and transparent means of communication with local communities, building trust between airport and the local communities. These channels should be reviewed regularly to ensure they meet the needs of local communities and ACCs alike.

Often, community representatives on ACCs have limited mandates with specific geographical areas of focus. This is less of an issue when communicating on broad policy issues, but when doing so about matters which have geographic noise exposure aspects (for example, operational changes), then communication through ACCs may need to be supported with additional locally focused forums.

It is important that UK aviation stakeholders continue to build their understanding of the key noise concerns of their local communities. Through engagement and effective knowledge sharing, industry can help build consensus on the practicable measures it can take to address community noise concerns.

The technical and complex nature of aircraft noise requires messaging to be simplified in order to facilitate discussion more easily to a wider audience. If information is too technical, this can lead to a lack of understanding with stakeholders. SA recognises that there is a need for the industry to simplify these technical issues in a way that is accessible to a wider audience.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.4.3 Interpretation of Government policy and interdependencies with other policies

It is possible that individual communities may reach differing interpretations of government policy on noise, which may lead to polarised views. This needs to be addressed through building a better basis for the interpretation of policy along with clear guidance notes from Government as to how any future policy should be interpreted.

Interdependencies with other policies such as climate change also needs to be recognised and clearly articulated in the form of guidance. For example, clear up to date guidance on government altitude based environmental priorities to inform aircraft operations and airspace change processes.

6.4.4 Future Engagement

Direct engagement with local residents and local groups could be widened beyond the airport operator alone. The wider industry including airlines, manufactures, ANSPs and other stakeholders could have a role to play, helping develop a greater sense of trust in the engagement process over the long term.

There is a clear need to ensure that the social, economic, and environmental impacts of aviation are discussed, so that the appropriate balance is in place to examine positives alongside area that require improvement. There is potential for the industry to take a more pro-active approach to community engagement with local residents, groups and wider stakeholders alike through:

- Greater clarity of airport noise objectives, measures and expectation of change.
- Working together with Government, local authorities, academic institutions and community representatives to develop and deliver a prioritised programme of independent research to better understand individuals' reactions to aircraft noise events and ways to reduce negative reactions.
- Targeted outreach programmes so that the airport operator is effectively reaching those concerned about aircraft noise issues from the airport.
- Ensuring that there is support and structure for ACCs so that there are tangible/agreed outputs, and that their role around addressing and finding solutions for noise issues is properly understood.
- Widening the awareness/information on what channels are available for local residents to provide feedback.

6.4.5 Key learnings and benchmark for future engagement

Based on the best practice engagement mechanisms highlighted, SA has developed a benchmark level for community engagement across the UK for application at major UK airports. This seeks to define a range of targeted top-level community engagement objectives and practices that are widely agreed upon across UK airports.

It is important to highlight that a 'one size fits all' approach to community engagement will not be effective or practical for all airport and local communities. However, a benchmarking approach will allow airports to tailor engagement suggestions to fit their local needs as well as allowing local residents to better trust the engagement process. The benchmark established here should not be viewed as the preferred engagement solution for all airports but more as an optimal baseline for engagement practices.

6.4.6 Recommendations to Industry on Community Engagement

Sustainable Aviation recommends to its members the following:

Airport operators to review and evaluate airport engagement practices against those presented in this Road-Map. This includes:

- Maintaining a range of information resources through communication channels that are appropriate for the community.
- Ensuring that communications channels are easily accessible to the local community.
- Operating an open and transparent engagement process with the local community.
- Ensuring that local community concerns are reflected as far as possible in an airport's noise strategy or communication efforts; and
- Ensuring all public consultations are targeted at the relevant stakeholder, with the final outcomes published through recognised channels.

Where an airport operator has identified gaps in its engagement techniques against those best practices presented in this Road-Map and determined that the gap is relevant to its operations,; the operator should plan to implement the solution in a suitable timeframe. This should be in conjunction with the ACC and may include consulting with relevant stakeholders on whether or not this would add further value.

Air Navigation Service Providers, Airlines and Manufacturers should regularly review ways to improve their effectiveness in supporting airport operators in community engagement activities.

6. NOISE COMMUNICATION AND COMMUNITY ENGAGEMENT OPPORTUNITIES

6.5 Conclusion

There are opportunities to shape how residents feel about noise from aviation based on how they understand what noise they are experiencing and why, how operations contribute to the local, regional and national economy, and whether the airport is a good partner to the local community.

As noted above, the challenge facing airports is that communities and stakeholders represent a diverse and sometimes conflicting range of perspectives. As a result, airport engagement seeks to cater to a range of views and must be tailored to the local circumstances; a one-size-fits-all approach is not appropriate. Airports can use Sustainable Aviation to share best practice successes and learnings where applicable, and equally highlight communication channels that have not been as successful. . Common aspects of an airport's engagement strategy can include a community engagement forum such as an airport consultative committee and their technical subgroups. However, the structure, membership, roles, and responsibilities of these committees can vary greatly.

SA will work with members to support their local efforts aimed at enabling initiatives such as:

- Positive open forums of discussion established between all stakeholders
- ACCs directly engaging with their stakeholders and communicating effectively with concerns
- Improved accessibility and information provision for local residents; and
- Sharing and applying best practice for community engagement.

It is hoped that the above would be accomplished through:

- Ensuring that debates are underpinned by a solid evidence base;
- Balanced discussion, ensuring that noise and wider environmental issues are discussed in the round along with social and economic impacts;
- Robust projections of future noise changes to better inform the debate on issues such as increasing capacity.

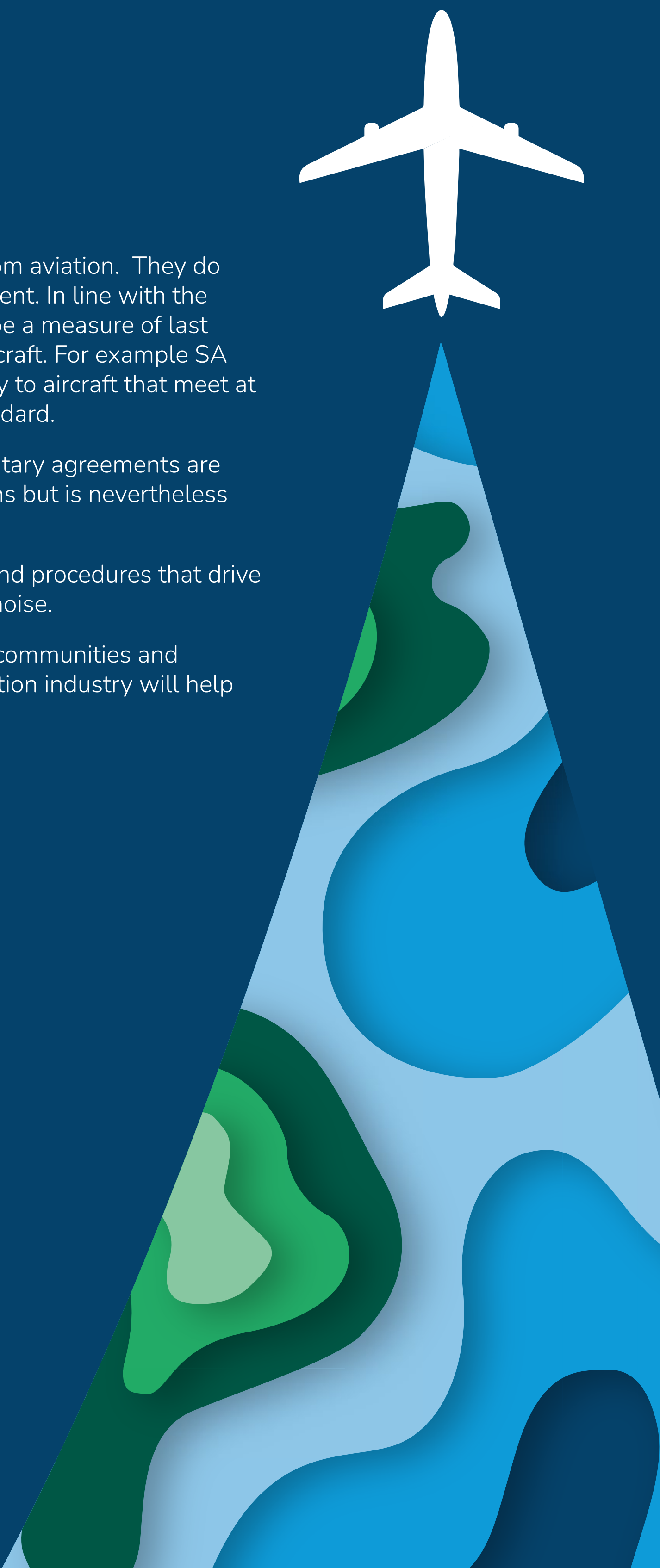
The industry is committed to:

- Promote open and transparent engagement with communities affected by noise, to better understand their concerns and priorities, and to raise awareness on the progress realised on reduce aircraft noise;
- Ensure that any changes to noise impacts or noise mitigation efforts are clearly communicated through agreed channels in a timely and non-technical manner
- Present the best practice engagement recommendations from the Road-Map to local stakeholders through channels such as consultative committees to help airport operators better evaluate their engagement techniques.

SA requests the Government continues to support research on:

- Community perceptions of aircraft noise, in particular the issue of noise annoyance vs. noise acceptability and the role of non-acoustic factors;
- The various noise metrics that are available and evaluate their parameters. In particular, the proportion of populations located under specific noise exposure bands that are classified as 'highly annoyed' by aircraft noise. The outcomes of this research would be expected to inform government aviation noise policy
- The effectiveness on health and wellbeing of noise mitigation interventions such as noise insulation. The outcomes of this research would help inform engagement between airports and noise affected communities.

7. OPERATING RESTRICTIONS



Key Messages

Operating restrictions are a blunt way of reducing noise impacts from aviation. They do not encourage progressive holistic improvement in noise management. In line with the ICAO balanced approach, SA considers operational restrictions to be a measure of last resort. Where used they should focus on the noisiest remaining aircraft. For example SA supports the ICAO view that operating restrictions should not apply to aircraft that meet at least the requirements of 'Chapter 4' aircraft noise certification standard.

The aviation industry believes that collaborative working and voluntary agreements are a more effective and responsive approach than operating restrictions but is nevertheless committed to meeting these wherever they apply.

The industry wants to work with Government to develop policies and procedures that drive a move to more proactive ways of managing the impact of aircraft noise.

The benefits of introducing modern aircraft are significant for local communities and remain a win-win for all stakeholders. A vibrant and profitable aviation industry will help accelerate progress in upgrading to these aircraft.

7. OPERATING RESTRICTIONS

7.1 Introduction

In line with ICAO's Balanced Approach, SA believes operational restrictions should be considered only as a last resort in managing impacts from aircraft noise. Noise management should prioritise the other aspects of the ICAO Balanced Approach specifically reduction of aircraft noise at source, land-use planning and management, and noise abatement operational procedures ahead of operating restrictions. Taking this approach will ensure noise management actions are applied in a consistent way with a view to addressing the noise problem in the most cost-effective way on an airport-by-airport basis. Noise-related operating restrictions should be introduced only when other Balanced Approach measures are not sufficient to attain the specific noise abatement objectives.

Within the EU, regulation (EU) No 598/2014 was published, which defines the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions within a Balanced Approach, repealing Directive 2002/30.SA will continue to support the concept of a consistent and structured approach to the potential introduction of operating restrictions.

The EU 598 Directive, which is the origin of UK rules, defines an operating restriction as:

- *a noise-related action that limits access to or reduces the operational capacity of an airport, including operating restrictions aimed at the withdrawal from operations of marginally compliant aircraft at specific airports as well as operating restrictions of a partial nature, which for example, apply for an identified period of time during the day or only for certain runways at the airport.*

The Directive also sets out a clear process for implementing operating restrictions and establishes a number of important principles to take account of when assessing a cost-effective noise-related operating restriction, for example:

- *the foreseeable effect of a reduction of aircraft noise at source.*
- *When considering operating restrictions, the competent authorities shall take into account the likely costs and benefits of the various measures available as well as airport-specific characteristics.*
- *Not applying operating restrictions as a first resort, but only after consideration of the other measures of the Balanced Approach.*
- *Decisions on noise-related operating restrictions shall be based on the noise performance of the aircraft as determined by the certification procedure conducted in accordance with Volume 1 of Annex 16 to the Chicago Convention, sixth edition of March 2011.*
- *Measures or a combination of measures taken in accordance with this Regulation for a given airport shall not be more restrictive than is necessary in order to achieve the environmental noise abatement objectives set for that airport. Operating restrictions shall be non-discriminatory, in particular on grounds of nationality or identity, and shall not be arbitrary.*

The Directive also states that operating restrictions which take the form of the withdrawal of marginally compliant aircraft from airport operations shall not affect civil subsonic aircraft that comply, through either original certification or re-certification, with the noise standard laid down in Volume 1, Part II, Chapter 4 of Annex 16 to the Chicago Convention.

7.2 Operating Restrictions Currently in place

To date, a range of operating restrictions have been implemented.The list below provides a summary of the type of restrictions in already place at many UK Airports:

- Night Movement Limits
- Night Noise Quota Limits
- Noise Contour Area Limits
- Annual Movement Limits
- Runway use restrictions / preferential runway
- Aircraft type scheduling/operating restrictions
- Ground movement/stand activity/engine testing restrictions
- Planning Conditions (inc S106 agreements)

However, it is important to understand the unintended consequences that could arise as a result. For example, restricting the time and operating mode of a runway can alter community noise exposure and the size and shape of noise contours, or compound delays which result in operations occurring at more sensitive times. A pragmatic approach is therefore important, for example to enable recovery from periods of disruption or to avoid the build-up of delays. Examples of current restrictions A pragmatic approach include runway alternation at Heathrow, preferred runway direction (subject to tail wind limitations) and night restrictions at Gatwick, Heathrow and Stansted.[52]

Additionally, scheduling restrictions are already in place at most airports that restrict the time of operation of the very noisiest types of aircraft, usually quantified by the aircraft noise chapter certification or quota count (QC) rating in the UK night flying restrictions policy.

52 These are regularly reviewed by the UK government, with the latest details available here - https://www.gov.uk/government/consultations/night-flight-restrictions-at-heathrow-gatwick-and-stansted-airports-between-2022-and-2024-plus-future-night-flight-policy/night-flight-restrictions

7. OPERATING RESTRICTIONS

7.2 Operating Restrictions Currently in place (continued)

These restrictions are already in place at many airports. Some are there to provide assurance of noise levels for the future, such as a defined contour area or annual movement limits. However, some can be seen as unreflective of the improvements made with the introduction of ever quieter aircraft. For example, recent aircraft noise improvements have led the introduction of a lower QC 0.125 band to accommodate aircraft that would otherwise have been exempt from night noise restrictions. Combinations of restrictions also don't lend themselves to an improving noise climate, such as Night Movement and Quota Limits. There is no incentive for an operator to grow their operation by introducing quieter aircraft, when there is a movement limit in place at night that still restricts it.

Many airports apply operating restrictions as part of their day-to-day management of noise and these are defined within an Airports Noise Action Plan.

SA believes it is important to share the noise benefit of latest generation quieter aircraft with airport communities and allowing more operational freedom for those operators who choose to invest accordingly.

7.3 Noise Action Plans

Under the Environmental Noise Regulations 2006, UK airports are required to develop, consult upon and publish Noise Action Plans (NAPs), to be adopted by DEFRA. These NAPs are developed locally and provide a framework for managing and improving, where possible, the noise climate at an airport. NAPS are developed with key local stakeholders, Airport Consultative Committee and local interest groups and take account of issues that are best addressed locally. NAP's are updated every 5 years, or sooner depending on airport developments, to take account of changing local circumstances and provide a mechanism for transparency and delivery.

SA believes NAP's remain the best mechanism to ensure delivery of noise management under the principles of the ICAO balaned approach. NAPs are a well established, and appropriate way, to review and refine operating restrictions, given they have been in use across UK airports for many years, and are now on their fourth iteration.

7.4 Discussion on Operating Restrictions

SA appreciates that local communities can view operating restrictions as a means of ensuring that aircraft noise is addressed by the industry - such measures are simple to understand and seen as reliable. However sometimes leads to a position where operating restrictions are themselves seen as the objective, as opposed to holistic noise impact reduction through the full range of methods at our disposal.

The challenge for the aviation industry is to ensure that future growth can be delivered whilst still providing a positive environment on noise for local communities.

SA believes that greater focus on how restrictions incentivise and enable the aviation industry to develop and implement quieter aircraft should be given priority over restrictions that weaken the ability of the industry to invest in quieter aircraft.

This Road-Map has already discussed how ineffective land use planning controls have not dissuaded local authorities from permitting developments within noise sensitive areas.

We call on the Government to step up and lead this debate.

7.5 Conclusion

In summary SA believes that operating restrictions can be an effective tool in aircraft noise management, under some circumstances. But they should be used proportionately and in direct response to an established environmental objective. They should also only be used after other measures have been pursued in line with ICAO's Balanced Approach.

Key criteria for operating restrictions is that they should be:

- cost effective and help stimulate growth in a sustainable way;
- considered and implemented in line with the appropriate EU Directive regulation (EU) No 598/2014;
- introduced with reasonable lead times to give the industry time to adapt
- framed so as to encourage and reward progressive improvement in local noise impacts.

8. CONCLUSIONS - THE WAY FORWARD

Key Messages

SA is committed to developing ways to limit and where possible reduce the number of people adversely affected by aircraft noise. SA believes further growth of the aviation sector, at a level projected by the DfT, can be achieved whilst effectively meeting this commitment.

This Road-Map is a toolkit to help all parts of the UK aviation industry assess and implement strategies to reduce noise from aircraft operations. But the aviation industry cannot tackle noise on its own; support and guidance are also required from Government and other stakeholders.

Continued noise improvement research by UK industry, supported by government, is required to ensure the downward trend for aviation noise continues from the mid-2030's onwards. This work needs to be done in conjunction with delivering a reduction in Greenhouse Gas and local air quality emissions within the aircraft fleet.

8. CONCLUSIONS - THE WAY FORWARD

8.1 Industry Commitments

To achieve the vision outlined in this Road-Map SA signatory companies commit to the following:

- The industry is committed to increasing the use of existing operational techniques that reduce noise where safe and feasible.
- The industry is committed to working with others to explore and develop new operational techniques that reduce noise where safe and feasible.
- SA members will use this Road-Map to develop best practice noise management strategies for the future.
- The Aerospace sector will continue to invest in aircraft technology research programmes.
- The Aerospace sector will work towards the visionary noise goals of Flightpath 2050 and CLEEN.
- Industry commits to continue to upgrade aircraft fleets over time, which will mean newer, quieter aircraft are in use.
- The industry will actively contribute to improving aircraft noise guidance in local planning policy.
- Airports will review masterplans to ensure they are consistent with Noise Action Plans.
- Airports will work with Government, local authorities and local communities to achieve identified land use planning improvements.
- The industry will promote open and transparent engagement with communities affected by noise, to better understand their concerns and priorities.
- The industry will ensure that any changes to noise impacts or noise mitigation efforts are clearly communicated through agreed channels in a timely and non-technical manner.
- The industry will present the best practice engagement recommendations from the Road-Map to local stakeholders through channels, such as consultative committees, to help airport operators better evaluate their engagement techniques.

8.2 Industry Requests for Support

8.2.1 Government

SA requests the following support from the UK Government.

- Maintain support for research and development in aerospace technology (for example through the support of the ATI) to ensure the downward trend for aviation noise continues beyond the mid 2030's and the right incentives are in place to enable uptake by the industry. This work needs to be done in conjunction with delivering a reduction in greenhouse gas and local air quality emission from aircraft.
- Maintain, and where possible accelerate, the delivery of UK airspace modernisation to enable use of noise reducing operational initiatives
- Support research into operational trials using innovative solutions to mitigate noise
- Work with the industry to deliver independent research to improve our understanding of the noise challenge and how people react to aircraft noise events.
- Work with the industry, local authorities and communities to optimise noise communication, monitoring and reporting processes.
- Urgently review current planning polices to ensure they enable local authorities to minimise and, where required, control development of additional noise sensitiive dwellings around airports
- Ensure that operational restrictions are employed only as a final resort after full consideration has been given to the other three dimensions of the ICAO Balanced Approach, namely:
  - Reduction of noise at source
  - Land use planning and management
  - Noise abatement operational procedures
  - Operating restrictions on aircraft

8. CONCLUSIONS - THE WAY FORWARD

8.2.1 Government (continued)

SA recommends the Government commission further independent research on:

- Community perceptions of aircraft noise, in particular the issue of noise annoyance vs. noise acceptability and the role of non-acoustic factors.
- the various noise metrics that are available and evaluate their parameters. In particular, the proportion of populations located under specific noise exposure bands that are classified as 'highly annoyed' by aircraft noise. The outcomes of this research would be expected to inform government aviation noise policy.
- the effectiveness on health and wellbeing of noise mitigation interventions such as noise insulation. The outcomes of this research would help inform engagement between airports and noise affected communities.

8.2.2 Other Stakeholders

SA seeks assurance from local authorities, local communities and other community support organisations that they will:

- Work with the aviation industry to achieve a successful outcome.
- Share relevant information in a timely manner with their constituents.
- Acknowledge successes achieved by the industry as well as highlighting areas for improvement.

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