THE SA NOISE ROAD-MAP

A BLUEPRINT FOR MANAGING NOISE FROM AVIATION SOURCES TO 2050

SUSTAINABLE AVIATION

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Executive Summary

Sustainable Aviation (SA) is committed to developing ways to limit and where possible reduce the number of people affected by aircraft noise[1].

We have developed a Noise Road-Map showing how we believe aviation can manage noise from aircraft operations between now and 2050 as the industry maintains sustainable growth.

This Road-Map is structured as a toolkit for individual areas of the UK aviation industry to assess and implement measures to reduce noise from aircraft operations. It also helps inform stakeholders, including those making future strategic decisions in which aircraft noise is an issue.

This document sets out Sustainable Aviation's projection of aircraft noise impacts from UK aviation. Our projection is based on the UK Government forecasts of aviation demand-growth published in 2013, together with our own assumptions concerning the deployment of technology, operational measures, land use planning, communication, community engagement activities and, where necessary, the use of operating restrictions.

The UK aviation industry is committed to reducing the noise impact of aircraft operations. Based on a review of current noise contour information at Heathrow, Gatwick, Manchester, Stansted, Birmingham and Luton airports between 1998 and 2010, despite an increase of over 5% in air transport movements at those airports, the number of people inside the UK Government's standard 57 dbA Leq noise contour has reduced by nearly 40%[2]. This has been achieved as a result of significant development and investment by the industry in quieter aircraft and operating procedures.

One of the most significant challenges in producing this Road-Map is 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 a complex problem. Based purely on 57 Leq noise contour data, the reduction in aircraft noise achieved by the industry over the last half century has resulted in fewer people being significantly affected by noise. However based on regular stakeholder feedback received by the industry and reinforced in the UK Aviation Policy Framework, it is apparent that noise from aircraft operations remains a real source of tension between airports and local communities. Many local communities believe that current noise metrics, including the use of average noise contours, do not fully reflect their experience of aircraft noise.

Sustainable Aviation believes that the number of people adversely affected by aircraft noise is influenced by a number of complex variables which combine to generate the total result as illustrated in figure 1.

[1] The Sustainable Aviation strategy established in 2005 sets a series of goals – the noise goal is to limit and, where possible, reduce the impact of aircraft noise.
[2] See glossary

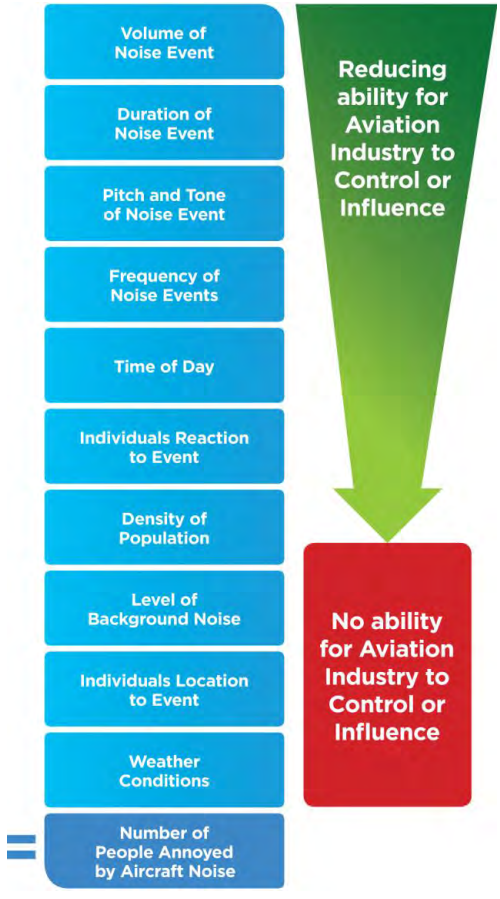


Figure 1: The Noise Challenge in reducing the number of people affected by aircraft noise

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.

In addition to these complexities, the nature of the noise problem can often change over time, even as a result of attempts to reduce its impact. For example, noise from departing aircraft was at one time the key area of concern among local communities. Technology solutions were developed to reduce departure noise, only for this to make arrival noise much more noticeable. Similarly, reducing the source noise of aircraft engines created a new focus on airframe noise, as that source then became dominant. These unintended consequences of initiatives to reduce noise impact are common. There can be other unintended outcomes; a drive to concentrate noise impact on as few people as possible will obviously be better for those who escape it, but worse for the smaller

communities that experience all of the noise. Reducing engine source noise often makes the engine heavier and therefore leads to additional fuel burn and emissions.

This dynamic nature of noise problems, together with the risk of trade-offs and unintended consequences is at the forefront of the industry's mind in developing technologies and initiatives to limit and reduce noise impacts.

It makes the job of measuring, managing and reducing the number of people adversely affected by noise from aircraft very challenging. Unlike SA's Carbon Road-Map which used carbon dioxide emissions (CO_2), which are both easily measurable and with definable outcomes, measuring noise is more complex because of the multiplicity of noise metrics and human responses. This Noise Road-Map therefore seeks to define future scenarios where best practice approaches can be used to limit and, where possible, reduce the number of people exposed to aircraft noise.

To that end, the SA Noise Road-Map has been designed to identify and advocate best practice approaches to factors such as improved land use planning controls and community engagement as well as technology and operational advancements .

W**e conclude that UK aviation is able to accommodate significant growth in air transport movements to 2050 and at the same time achieve a potential reduction to UK aviation's total noise output compared to 2010.**

Figure 2 shows how the introduction of imminent and future aircraft and engine technology offers the potential to reduce UK aviation noise output by 2050 compared to 2010. Without this technology, given the forecast growth in demand for air transport, UK aviation's noise output would almost double.

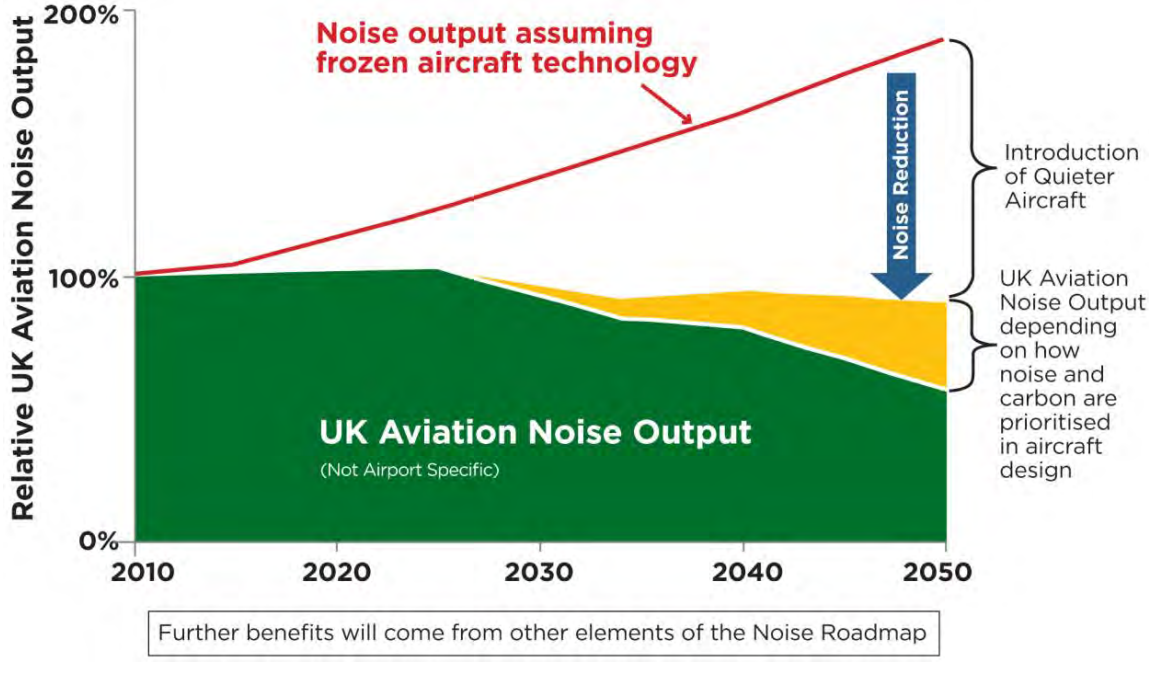


Figure 2: Sustainable Aviation Noise Road-Map

The graph shows an aggregated UK picture of noise output and how this is predicted to change between 2010 and 2050. The graph is not airport specific and cannot be read as the projection of noise output for any particular airport. This will depend on the aircraft types and rates of penetration of newer aircraft at individual airports[3].

Further improvements can be achieved through the wider implementation of operational improvements in the use of airspace and flying techniques and through better land use planning in the immediate vicinity of airports.

Developing the tools discussed in this Road-Map will require wide collaboration, co-ordinating efforts across the UK aviation industry, local and national Government and national and local community groups.

Responding to this, the SA signatory companies[4] make the following commitments:

- 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 to achieve the visionary noise goals of Flightpath 2050 and CLEEN[5].
- The industry will increase the use of existing operational techniques that reduce noise where safe and feasible.
- The industry will collaborate to explore and develop new operational techniques that reduce noise where safe and feasible.
- 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 and to establish trust in the engagement process.
- 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 mechanisms from the Road-Map to local stakeholders through channels such as consultative committees to help airport operators better evaluate their engagement techniques.

[3] In line with current UK Government aviation forecast assumptions, the graph assumes that no new runways are built at UK airports. The use of DfT forecasts does not imply Sustainable Aviation support for those assumptions. If that policy changes and individual airports develop proposals for new runways, they would need to develop their own projections of noise output.

[4] Details on the SA website (http://www.sustainableaviation.co.uk/about/signatories/)

[5] EU and US aviation research programmes. The EU Flightpath 2050 programme seeks to achieve a 65% reduction in perceived noise, or 15dB, from aircraft by 2050 compared to 2000.

- The industry will work with Government and other stakeholders to identify and resolve research gaps in:
    - how the variables in the 'Noise Challenge' diagram are weighted and consult on whether a more accurate model can be developed to predict the number of people annoyed by aircraft noise under various 'what if' scenarios,
    - understanding of individual reactions to aircraft noise,
    - noise acceptability vs. noise annoyance and
    - a basis for better noise metrics.

SA will use this Road-Map to develop action plans, ensure we deliver to our commitments and continue to expand and improve on our existing noise management practices. Action plans will be on two separate scales:

- **Noise Road-Map Delivery Action Plan –** Developed by SA members to monitor and manage common industry actions.
- **SA Member Specific Action Plan** – Developed for specific airlines and airport sites with their relevant stakeholder groups to incorporate the principles defined in this Road-Map into existing noise strategies such as airport Noise Action Plans or similar.

SA requests the UK Government to:

- support research and development in aerospace technology ensuring the right incentives are in place to enable uptake by the industry,
- work with the aviation industry to clarify relative environmental impacts between reducing noise and CO_2 emissions to enable future aeronautical design priorities.
- strengthen and support local authorities' ability to enforce land use planning controls around airports,
- implement improved airspace structures and operational procedures through the CAA,
- work with the industry to support independent research to improve our understanding of the noise challenge and how people react to aircraft noise events and
- work with the industry, local authorities and communities to optimise noise communication, monitoring and reporting processes.
- Ensure that operating restrictions are employed only as a last resort after full consideration has been given to the other dimensions of the ICAO Balanced Approach, namely:
    - Reduction of noise at source
    - Land use planning and management
    - Noise abatement operational procedures

Contents

Glossary of terms

Note that in some cases a descriptive explanation of terms is given, rather than the official technical definition, in order to help understanding.

ABTA	Association of British Travel Agents
ACARE	Advisory Council for Aviation Research and Innovation in Europe
ACC	Airport Consultative Committee
ADS	The UK trade organisation for the Aerospace, Defence and Security industries
AIP	Aeronautical Information Publication; colloquially known as the Air Pilot
AMP	Airport Master Plan
ANCON	Aircraft Noise CONtour model, developed by ERCD
ANMAC	Aircraft Noise Management Advisory Committee
ANOMS	Aircraft Noise and Operations Monitoring System
ANSP	Air Navigation Service Provider
APF	DfT Draft Aviation Policy Framework
APU	Auxiliary Power Unit
ATC	Air Traffic Control
ATF	Air Transport Forum
ATM	Air Transport Movement
BATA	British Air Transport Association
CAA	Civil Aviation Authority – the UK's independent specialist aviation regulator.
CAEP	ICAO's Committee on Aviation Environmental Protection
CCO	Continuous Climb Operations
CDA	Continuous Descent Approach – a method of avoiding unnecessary periods of level flight on approach, thus reducing engine thrust, fuel burn, emissions and noise
CDO	Continuous Descent Operations
Chapter 2, 3, 4 and 14.	ICAO Annex 16 chapters containing noise certification standards and limits for subsonic jet aircraft.
CO_2	Carbon Dioxide – a key Green House Gas (GHG) contributing to climate change
dB	Decibel units describing sound level or changes of sound level.
dBA	Units of sound level on the A-weighted scale, which incorporates a frequency weighting approximating the characteristics of human hearing.
DCLG	Department for Communities and Local Government
DEFRA	Department of Environment Food and Rural Affairs (UK Government)
DfT	Department for Transport (UK Government).
EASA	European Aviation Safety Agency
ECAC	European Civil Aviation Conference
EIS	Entry Into Service
EPNdB	Equivalent Perceived Noise dB used for aircraft certification
ERAT	Effective-to-Real Address Translation?
ERCD	Environmental Research and Consultancy Department of the Civil Aviation Authority.
EU	European Union
FAA	Federal Aviation Administration (USA)
FAS	Future Use of Airspace Strategy (UK CAA)
FASIIG	FAS Industry Implementation Group
FEGP	Fixed Electrical Ground Power – provided from an airport terminal source

FIR	Flight Information Region
FL	Flight Level, altitude in 100's of feet, e.g. FL100 = 10,000 ft reference to 1013.25 mb
Ft	Feet (used to measure height or altitude)
GDP	Gross Domestic Product (of the UK in this document)
GPU	Ground Power unit – a ground-based mobile generator
GTMC	The Guild of Travel Management Companies
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation, the UN body dealing with civil aviation
iFACTS	Interim Future Area Control Tool Support –provides decision-making support and helps air traffic controllers manage their routine workload, increasing the amount of traffic they can comfortably handle and improving opportunities for aircraft climb and descent clearances
ILS	Instrument Landing System.
INM	Integrated Noise Model, developed by the FAA
LAMP	London Airspace Management Plan
Leq	Equivalent sound level of noise, often called 'equivalent continuous sound level'. In this document, 'Leq' has been used to denote the UK Government's measure of 'A' weighted Leq over a 16 hour period, that are published as contours that measure the area and population exposed to noise. The level of 57 decibels over the course of the day, has been identified by the UK Government's ANIS study to represent the 'onset of significant community annoyance'. These contours are based on the daily average movements that take place within the 16-hour period (0700-2300 local time) over the 92-day summer period from 16 June to 15 September inclusive. It is measured during the summer as this is when airports have historically been busier and when people are more likely to be outside.
LPLD	Low Power/Low Drag
NADP	Noise Abatement Departure Procedure
NAP	Noise Action Plan (in this case for UK Airports)
NATS	National Air Traffic Service (primary air traffic control provider in the UK)
NEC	Noise Exposure Category
NGO	Non-Governmental Organisation
NM	Nautical Mile: A measurement of distance used in aviation. One nautical mile equates to 1,852 metres.
Noise Output	The amount of noise generated by aircraft. In this report we have aggregated this to a UK level based on the number of annual air transport movements forecast by the DfT multiplied by the noise each aircraft type generates.
NOx	Oxides of nitrogen, a combination of NO and NO2
NPR	Noise Preferential Route (a fixed departure route for aircraft seeking to minimise people over flown)
PBN	Performance Based Navigation
PCA	Pre-Conditioned Air – provided from an airport terminal source
PNL	Perceived Noise Level
PPG24	Historic UK Planning Policy Guidance Note 24
RJ	Regional Jets
QC	"Quota Count" system often used for the noise classification of aircraft for night restriction schemes
RNAV	A navigation system which permits aircraft operation on any desired flight path within the coverage of station referenced navigation aids (such as DME or GPS) or

	within the limits of the capability of self-contained aids (such as inertial navigation systems), or a combination of these. An RNAV system may be included as part of a Flight Management System (FMS)
RPK	Revenue Passenger Kilometre
SA	Single Aisle Aircraft
SA	Sustainable Aviation
SEL	The Sound Exposure Level generated by a single aircraft at the measurement point, measured in dBA. This noise metric accounts for the duration of the sound as well as its intensity.
SENEL	Single Event Noise Exposure Level
SESAR	The Single European Sky Air Traffic Management Research Programme
SID	Standard Instrument Departure – a standard departure routeing which defines both the lateral and vertical profile for aircraft to fly
SIGS	Sound Insulation Grant Schemes
SOP	Standard Operating Procedure or Practice
STAR	Standard Arrival Route – a standard arrival routing which defines both the lateral and vertical profile for aircraft to fly
TA	Twin Aisle Aircraft
UN	United Nations
VLA	Very Large Aircraft

1 Introduction

1.1 Context

The Sustainable Aviation Noise Road-Map is published in the context of a noise debate that is focusing on the nature and acceptability of aircraft noise. Issues such as noise dispersion vs. concentration, the economic benefits and social acceptability of night flights, the noise level at which communities become annoyed and the location of future runway capacity are all addressed. The Government's Aviation Policy Framework is core to this debate; so, too is the establishment of the Airports Commission to examine and make recommendations on hub connectivity. This Noise Road-Map seeks to set out an evidence-based set of future scenarios (with options for industry actions to reduce noise) to inform that debate.

This Road-Map also serves as a toolkit for individual parts of the UK aviation industry to assess and implement options for reducing noise from aircraft operations. While it seeks to present an overview of aircraft noise at a UK level it does not provide specific details for every location. Actions or noise forecasts for individual UK air navigation service providers, airlines, airports or manufacturers will be developed independently following the publication of this document.

1.2 Sustainable Aviation

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 is 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.

1.3 UK Aviation's Economic Value

Aviation brings economic benefits to society as a whole and to the UK in particular, supporting trade, investment and employment. In 2011, the combined activities of airlines, airports, ground services and aerospace directly contributed £49 billion to UK GDP and £8 billion to UK tax revenues whilst directly supporting 921,000 jobs in the UK. The aviation sector's supply chain contributed a further £16.6 billion to UK GDP in the same year according to the Oxford Economics 2011 study of the economic benefits from air transport in the UK.

The UK's aerospace manufacturing sector is the world's second largest, directly employing 105,000 people and directly generating £10.3 billion of UK GDP in 2009, with a further £7.6 billion of UK GDP being generated by the aerospace sector's supply chain[6]. The sector brings further economic benefits through the generation of intellectual property which frequently has spin-off benefits in other sectors.

[6] Oxford Economics 2011 Economic Benefits from Air Transport in the UK

1.4 Aviation and the Environment – Our Track Record on noise

1.4.1 Technology

Over the past 50 years, the aviation industry has delivered dramatic improvements in reducing noise from aircraft. In the last 15 years alone Rolls Royce and other engine manufacturers have continued to improve aircraft engine design, resulting in a sustained reduction in noise each time a new aircraft engine is introduced, as illustrated in figure 3.

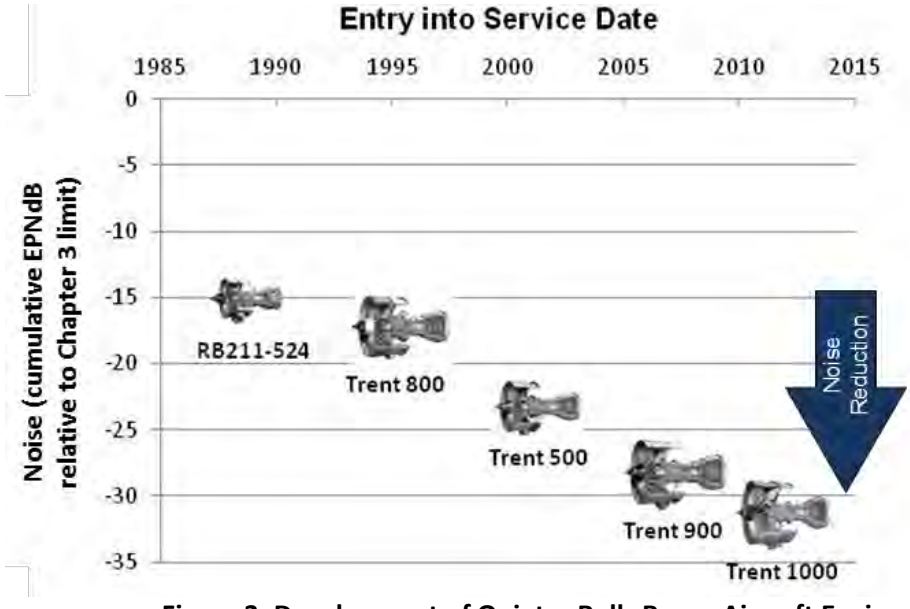


Figure 3: Development of Quieter Rolls Royce Aircraft Engines

In November 2012 the UK's national noise reduction charity, the Noise Abatement Society, presented one of their top awards - the "John Connell Silent Approach Award" to Airbus for the A380 at their annual award ceremony recognising the company's work that resulted in "a remarkably quiet aircraft, which delivers unprecedented certified noise levels" leading to reduced noise around airport communities.

Furthermore, the new Boeing 787 Dreamliner has a noise footprint that is 60% smaller than today's similarly-sized aircraft.

As a result of the industry's innovation, aircraft produced today are 75% quieter than those of 50 years ago[7]. SA members are now looking at how further reductions in noise over the next 40 years can be achieved.

[7] ICAO, 2010. International Civil Aviation Organisation Environmental Report 2010.

1.4.2 Changes to Airport Noise Contours

The DfT Aviation Policy Framework document acknowledges the reductions in aircraft noise that have been achieved by the aviation industry over the last 30 years through introduction of new aircraft and improved operational procedures[8].

Using the annual DfT 57 dBA LAeq 16 hr noise contours[9] produced by the CAA for the four largest UK airports, (Heathrow, Gatwick, Manchester and Stansted), the benefits to local communities of airlines introducing quieter aircraft technology are shown in Table 1.

	1998			2011		
Airport	**Number of Aircraft Movements**	**Area of 57dBA contour (km2)**	**Population within 57dBA contour**	**Number of Aircraft Movements**	**Area of 57dBA contour (km2)**	**Population within 57dBA contour**
Heathrow	441,200	163.7	341,000	480,906	108.8	243,300
Gatwick	240,200	76.8	9,000	251,067	40.4	3,060
Manchester	161,800	53.5	44,700	158,300	30.2	27,500
Stansted	102,200	64.5	7,600	148,317	21.2	1,300
TOTALS	**945,400**	**358.5**	**402,300**	**1,038,590**	**200.6**	**275,160**

Source: CAA Annual Noise Exposure Contour reports

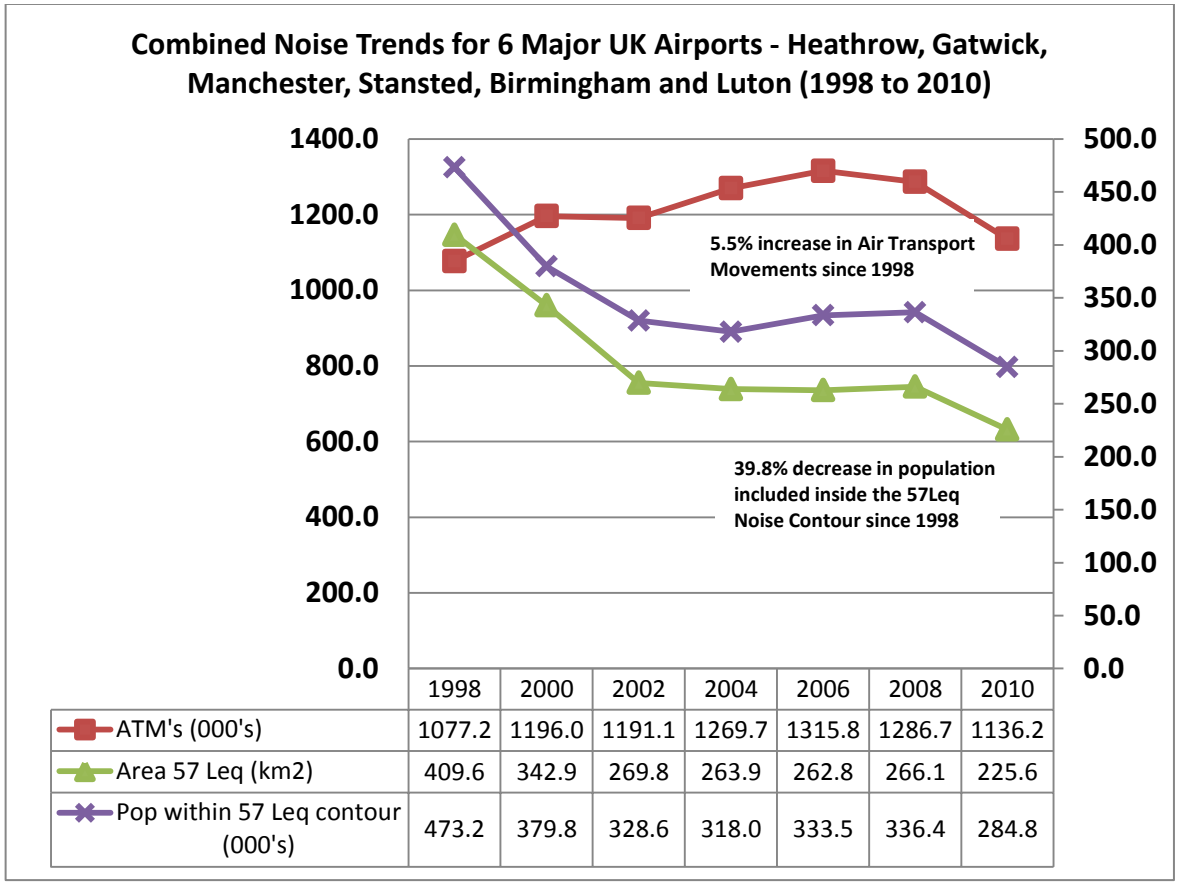
Table 1: Changes to Designated Airport Noise Contours

In this case, over the last 14 years, despite an additional 93,190 (+9.8%) aircraft movements across the four airports, there has been a reduction of over 127,000 (-31.6%) people included within the 57dBA LAeq 16 hour noise contour.

Figure 4 expands on this and shows how combined noise trends for six UK airports, Heathrow, Gatwick, Manchester, Stansted, Birmingham and Luton, have changed between 1998 and 2010. Whilst air transport movements at these six airports have increased by 5.5% over this time, the number of people included within the 57Leq noise contour has dropped by 188,400, or almost 40%.

[8] See DfT Aviation Policy Framework, https://www.gov.uk/government/publications/aviation-policy-framework

[9] SA believes that average noise contours are an important tool for noise measurement and management, but equally understands that average noise contours do not reflect the totality of community concerns around noise. We have used 57 LAeq contours in this Road-Map as they provide the only consistent noise metric to enable relative changes over time to be measured. We support further work to identify additional metrics that can supplement noise contours.



	1998	2000	2002	2004	2006	2008	2010
ATM's (000's)	1077.2	1196.0	1191.1	1269.7	1315.8	1286.7	1136.2
Area 57 Leq (km2)	409.6	342.9	269.8	263.9	262.8	266.1	225.6
Pop within 57 Leq contour (000's)	473.2	379.8	328.6	318.0	333.5	336.4	284.8

Figure 4

Source: Derived from DEFRA/DfT historic noise contour information and data from Birmingham and Luton Airports

This demonstrates how the industry has enabled growth whilst at the same time reducing the size of airport noise contours and the number of people living within them, as a result of the phasing out of older, noisier aircraft and the introduction of newer, quieter aircraft. The work reported in this document projects that this relationship will continue until at least 2050.

1.5 The Noise Challenge

While noise contours have played and will continue to play an important role in representing 'area-wide' changes in noise exposure, 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 a complex problem. 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 remains a real source of tension between airports and local communities. Many local communities believe that current noise metrics, including the use of average noise contours, do not fully reflect their experience of aircraft noise. Consequently, SA 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 5.

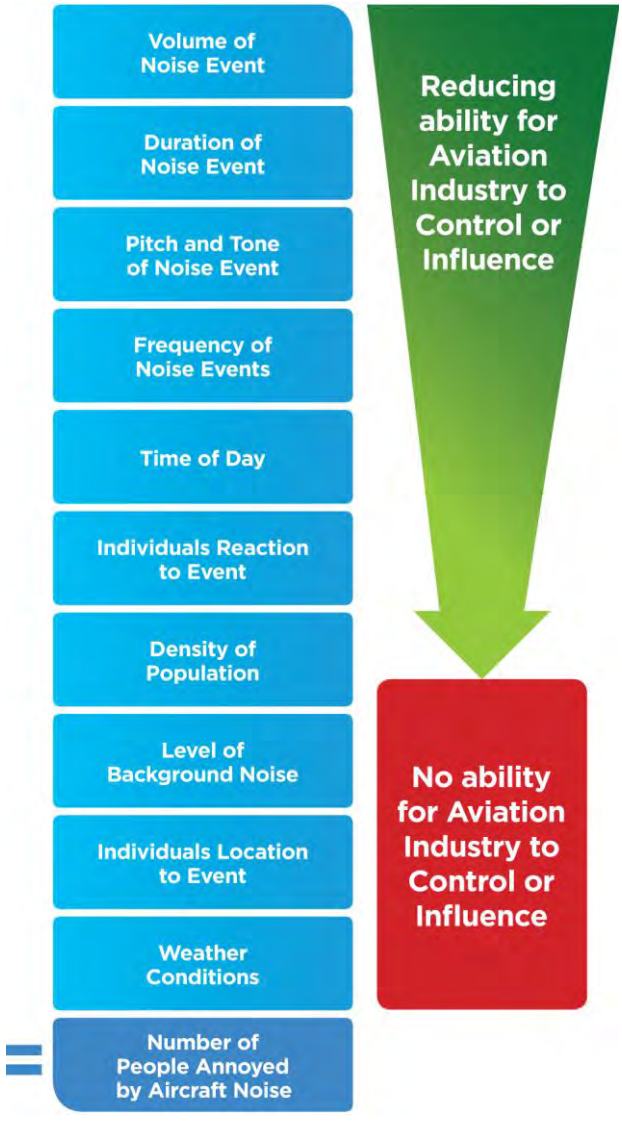


Figure 5: The Noise Challenge in reducing the number of people affected

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, unlike our Carbon Road-Map, 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 from aircraft operations.

In addition to the complexities outlined in Figure 5 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 are common. 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.

INDUSTRY COMMITMENT:
To support research into understanding how people become annoyed by aircraft noise and how this relates to actual aircraft noise levels.

1.6 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 primary scope of this document is noise from aircraft in flight as noise from aircraft on the ground was the addressed in the aviation industry Departures Code of Practice published in June 2012[10].

The Noise Road-Map therefore addresses the management of noise generated by aircraft movements arriving and departing UK airports using existing runway infrastructure between 2013 and 2050. This is intended to make the document consistent with the findings of the most recent Government aviation growth and infrastructure forecasts published in 2013. Clearly this is under review by the Airports Commission and Department for Transport at the current time. The consideration of additional runway

[10] http://www.sustainableaviation.co.uk/wp-content/uploads/DCOPractice2012approvedhi-res.pdf

infrastructure would be a matter for individual airports to address, but the concepts and noise mitigation options included in this Road-Map remain valid in that context.

Figure 6 summarises how we have considered 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.

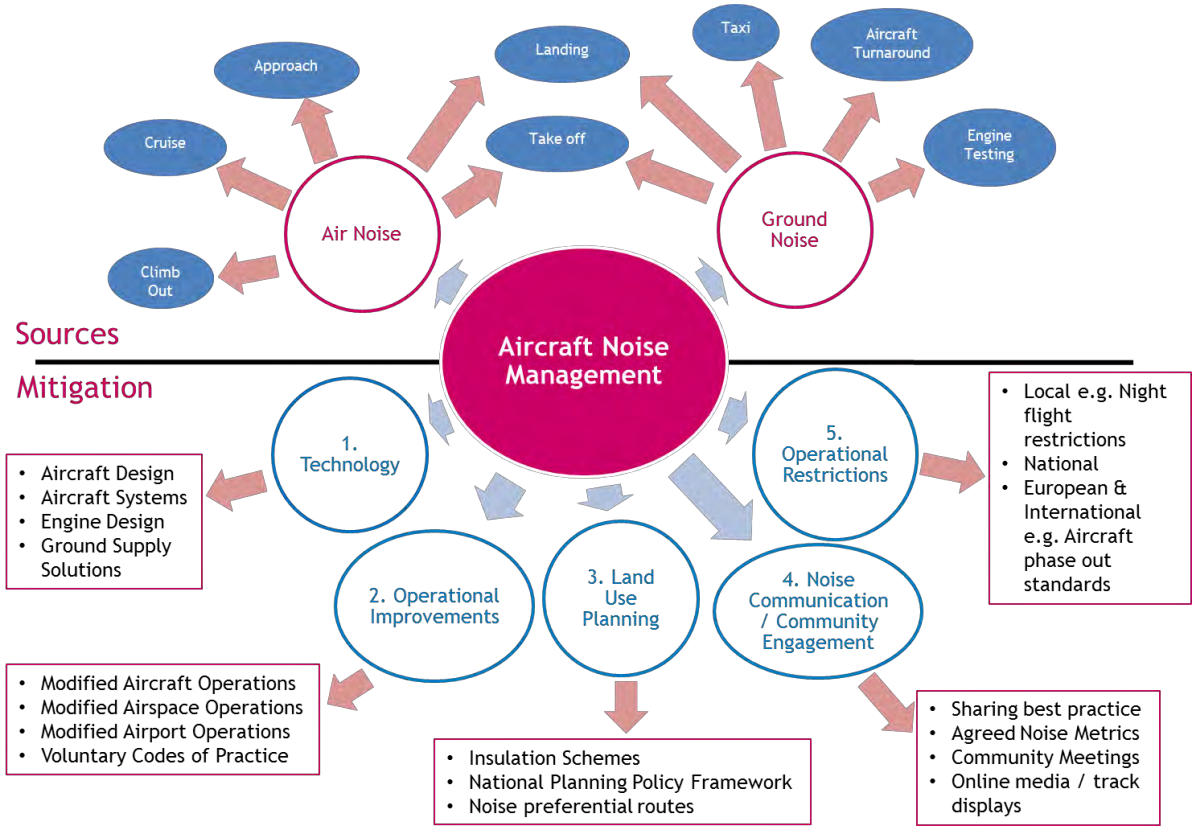


Figure 6: Sources and Mitigation of Aircraft Noise around Airports

Our noise forecast work in the Road-Map is based on UK Department of Transport aviation forecasts produced in 2013 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.

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 7 with a more detailed schematic shown in Appendix 1.

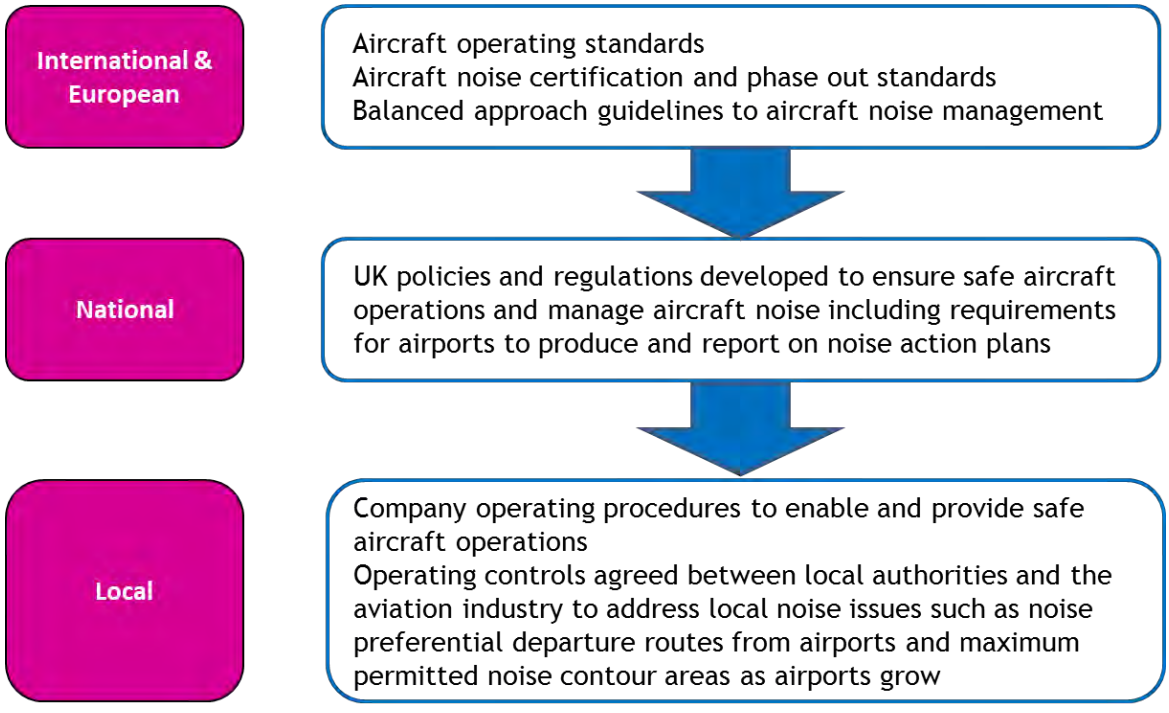


Figure 7 – Hierarchy of regulation relating to Aircraft Noise

The consequences of these regulations are considered further in Chapters 5 and 7.

1.7 Methodology to our Noise Road-Map

The approach taken to develop our Road-Map is founded on the ICAO Balanced Approach to aircraft noise[11]. 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 guidance on '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, 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.

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

- 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.

Within this framework we also consider how changes to aircraft noise performance are linked to changes in carbon dioxide emissions. As the SA paper on interdependencies identified, it is not always possible to achieve reductions in all these issues at the same time[12].

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.

INDUSTRY COMMITMENT:
Sustainable Aviation members will use this Road-Map to develop best practice noise management strategies for the future.

1.8 Summary

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 annoyed by aircraft noise in the future will require collaborative multi-stakeholder participation.

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

2 Hypothetical "No-Improvements" Scenario

2.1 Introduction

In this section we identify the hypothetical trajectory that UK aviation's noise emissions might be expected to follow in the absence of any action to improve the industry's current performance, with the same mix of technology as in the aircraft types operating today. This "no-improvements" trajectory provides a benchmark against which the potential impact of our anticipated improvement activities can be assessed.

It is worth pointing out that this scenario does not correspond to a "business as usual" scenario, which involves the regular replacement of older with newer, quieter aircraft as airlines seek to meet customer expectations, operating restrictions at airports and avoid escalating operating costs of older aircraft.

2.2 Demand Growth Projections

We have used the DfT 2013 Aviation constrained forecasts as published in January 2013[13]. These forecasts are based on the following assumptions:

- no new runways are built in the UK;
- airport schemes already in the planning system and airport masterplans are implemented by 2020;
- incremental growth to full potential long-term capacity by 2030 taking account of the airports' own longer term plans, physical site constraints and upto 13% capacity gain (where possible) through operational and technological improvement;
- terminal capacity increased incrementally to service additional runway capacity; and
- no changes after 2030.

Key changes at UK airports that are included in this are:

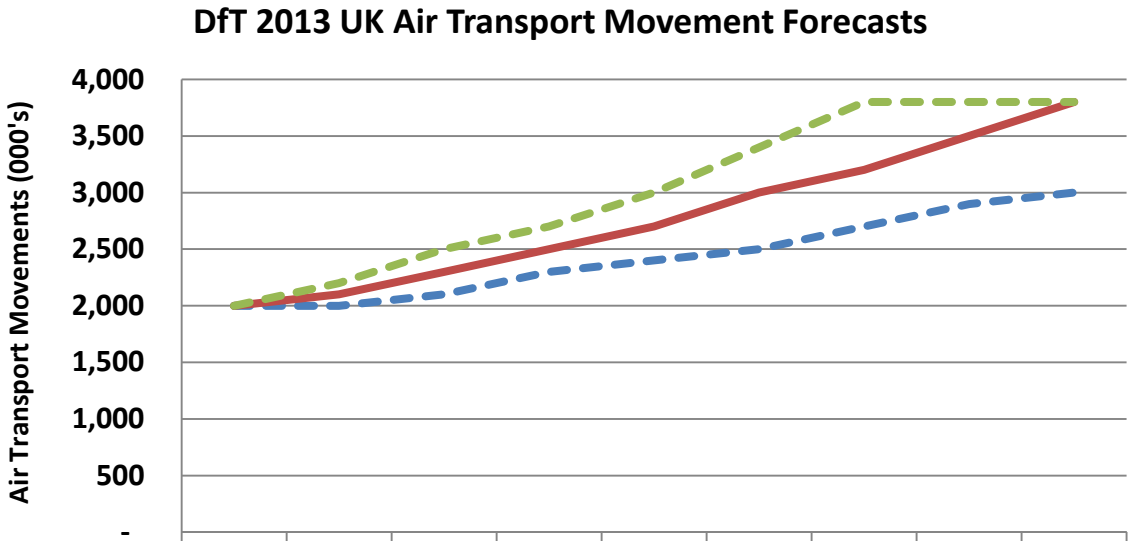
- Birmingham Airport runway extension adds 9% capacity and allows new destinations to be reached
- Luton Airport adds 35% to its runway capacity and 70% to its terminal capacity
- Manchester Airport moves to independently operating its two runways and increases passenger capacity from 30m to 56m

The DfT forecasts use a central, low and high rate for air transport movements (ATM's) growth[14] calculated using the DfT's ATM demand model. The results predict an increase in ATM's of between 1 and 1.8 million by 2050 compared to 2010. Figure 8 shows how this is predicted by DfT.

Using the central case it is assumed that there is a 90% increase of air transport movements in the UK by 2050 compared to 2010. On average this equates to a growth of over 2% per annum.

[13] https://www.gov.uk/government/publications/uk-aviation-forecasts-2013. In line with current UK Government policy, the forecasts assume that no new runways are built at UK airports. The use of DfT forecasts does not imply SA support for that policy. If that policy changes and individual airports develop proposals for new runways, they would need to develop their own projections of noise output.

[14] The DfT model states that ATMs exclude general aviation, air taxis, positional, diplomatic, military and other miscellaneous flights.



	2010	2015	2020	2025	2030	2035	2040	2045	2050
Low	2,000	2,000	2,100	2,300	2,400	2,500	2,700	2,900	3,000
Central	2,000	2,100	2,300	2,500	2,700	3,000	3,200	3,500	3,800
High	2,000	2,200	2,500	2,700	3,000	3,400	3,800	3,800	3,800

Source: DfT 2013 Aviation Forecasts (ATMs rounded to the nearest 10,000)

Figure 8

The type of aircraft movements predicted by the DfT, using the central, maximum use constrained capacity forecast is shown in table 2.

Year/ ATM's (000's)	Intl. Scheduled	Intl. Charter	Domestic	Freight	Total
2010	1,294	101	550	51	**1,996**
2015	1,370	91	561	55	**2,077**
2020	1,514	104	602	55	**2,274**
2025	1,678	116	661	56	**2,511**
2030	1,844	127	695	59	**2,724**
2035	2,024	139	742	59	**2,964**
2040	2,216	150	788	61	**3,215**
2045	2,485	164	816	59	**3,525**
2050	2,676	174	858	60	**3,768**

Notes:

1. ATMs are counted at the 31 UK airports included in the DfT model.
2. All figures are modelled, including 2010.
4. ATMs exclude general aviation, air taxis, positional, diplomatic, military and other miscellaneous flights.
5. ATMs rounded to the nearest 10,000, total may not sum due to this rounding.

Table 2: Copied from Annex Table F.1 from the DfT 2013 Aviation Forecast

Further details of how these figures break down across the specific UK airports can be found in appendix H to the 2013 DfT Aviation Forecast.

2.3 Hypothetical 'No Improvement' Noise Forecast

To determine the baseline noise level between 2010 and 2050 total UK aviation noise output was calculated using the central forecast ATM information.

For this baseline it is assumed there is no transition to quieter aircraft types and as such the growth in ATMs results in a direct increase in total UK aviation noise output.

Applying this approach figure 9 shows how the noise output would change between 2010 and 2050.

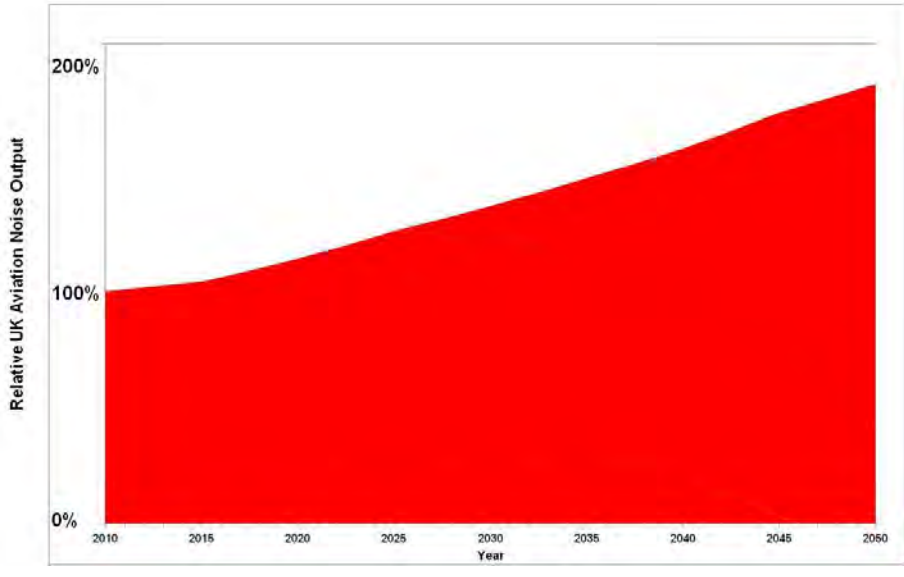


Figure 9: Baseline Increase in Noise Output to 2050

This clearly shows that with ATMs almost doubling over the period 2010 to 2050, use of current aircraft to deliver this growth would result in the noise output also increasing by over 80%.

The following chapters will explore the opportunities that can be utilised to ensure this increase in noise output does not occur.

3 Aircraft and Engine Technology Opportunities

3.1 Key Messages

The overall noise exposure at UK airports will depend on the growth in operations, the rate of penetration into the fleet of 'Imminent' aircraft (e.g. A380, B787, A350, A320neo, B747-8 and B737-MAX) and 'Future' aircraft (entering service sometime after 2025), the noise levels of individual aircraft designs, and airport-specific factors.

Aircraft and engine manufacturers have been aggressively researching low-noise technology for the past 50 years resulting in the dramatically reduced noise levels exhibited by aircraft now entering service. These aircraft typically output half the noise of the aircraft they are replacing, so air traffic movements can double without increasing the total noise output. In more detail, our work predicts that as current aircraft are replaced by 'Imminent' and 'Future' aircraft, the noise output from UK aviation reduces by around 20%, as shown graphically in Figure 10.

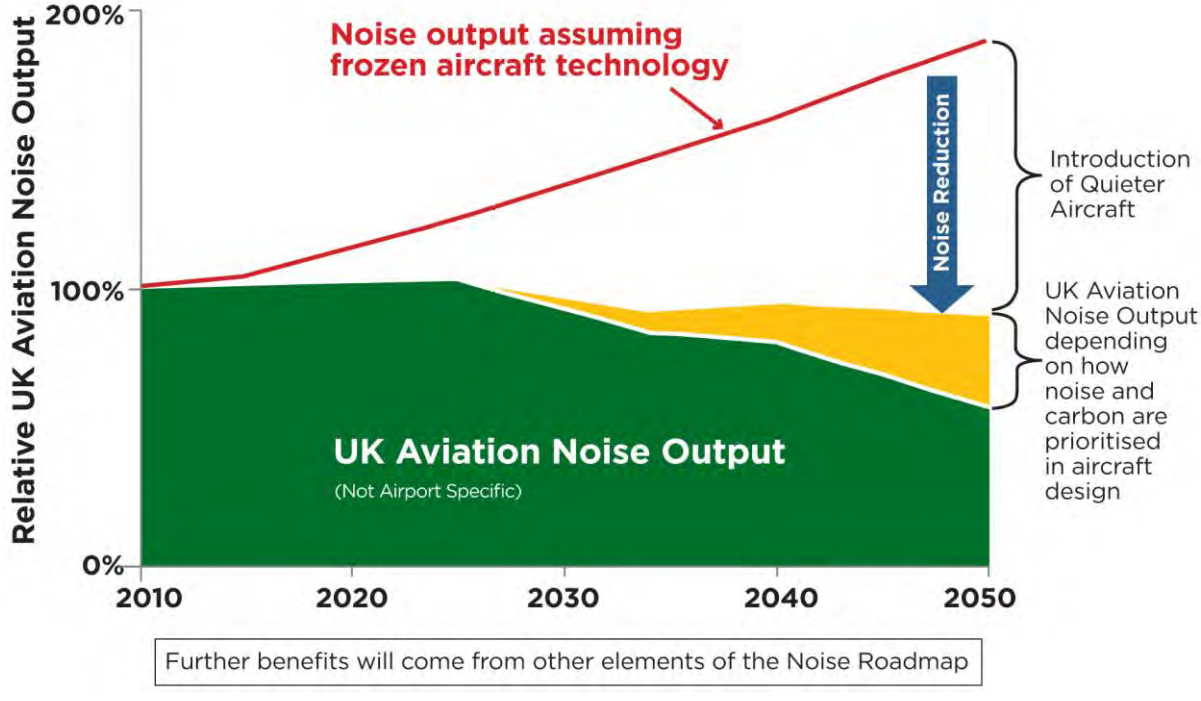


Figure 10: Forecast Changes in UK Aviation Noise Output between 2010 and 2050

The actual noise output will vary by airport, depending on the fleet mix, route structure, number of runways, operating restrictions and the scope for adopting new operational procedures to reduce noise. 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 airports are committed to develop their own noise roadmaps based on the information provided by this Road-Map.

Much of the technology and knowledge in both airframe and engine design to achieve these 'Future' low-noise aircraft is yet to be acquired, so manufacturers are engaged in extensive noise research programmes - financial support from Government is essential for such high risk programmes.

3.2 Introduction

This section sets out our view of the potential for reducing aircraft noise at source to limit and where possible reduce UK airport noise. We detail in turn:

- technology options for reducing aircraft noise;
- the evidence base and our assumptions concerning past, imminent and potential future improvements;
- our assumptions concerning the noise of 'imminent' and 'future' aircraft;
- our assumptions about aviation growth in the UK;
- our assumptions concerning the rate at which new aircraft enter the fleet;
- our calculations, based upon these assumptions on how UK aviation noise output will reduce as quieter aircraft are introduced.

3.3 Noise Technology Options for Reducing Aircraft Noise

3.3.1 Airframe and Engine Noise – Background

Aircraft and engine manufacturers have been aggressively researching low-noise technology for the past 50 years resulting in aircraft with dramatically reduced noise levels now entering service. Compared with the first jet aircraft, the noise output from modern aircraft has been reduced by 97% on departure (a 15dB reduction) and 94% on arrival (a 12dB reduction). 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[15] and 97% noise energy reduction means 33 modern aircraft departing simultaneously from an airport produce together the noise of one jet aircraft of the same size departing in the 1960s.

Both the engine and airframe designs are important in determining the total aircraft noise, the relevant design features being illustrated in Figure 11.

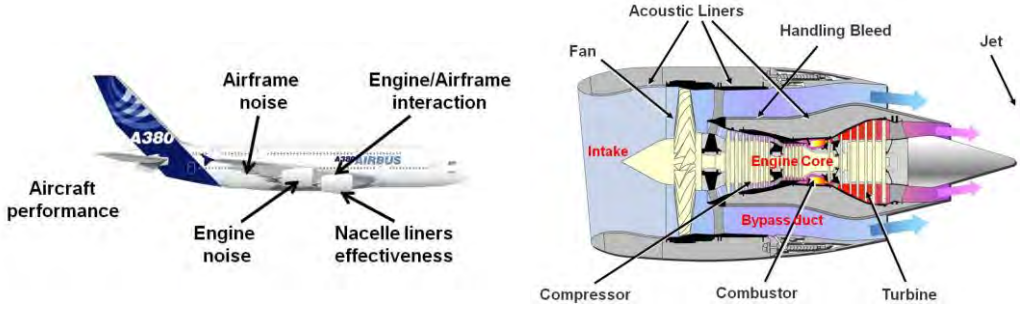


Figure 11: Features of the Aircraft and the Jet Engine that influence noise

- The engine has traditionally been the major source of noise (jet noise and fan/turbine/compressor turbo machinery noise have been predominant, with other engine noise

[15] ICAO Annexe 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%.

sources such as combustors and handling bleeds now becoming significant). Engine noise has been significantly reduced as the bypass-ratio of the engine[16] has increased.

- Acoustic liners in the nacelle are important in reducing the noise from engine internal sources as it propagates along and out of the intake, bypass duct or core duct.
- On modern aircraft the noise due to turbulence caused by the airframe moving through the sky (the noise of a glider) is almost as important as the engine noise for aircraft landing.
- The aircraft take-off and climb performance has an important influence on departure noise since the thrust required and altitude gained greatly affect the noise heard on the ground.

3.3.2 Overview of Technology Options to reduce Airframe and Engine Noise

The pure turbojets and early turbofans of the 1960s were dominated by high jet exhaust noise. However, the modern very-high-bypass-ratio turbofans, such as recent members of the Rolls-Royce Trent family of engines, have significantly reduced jet velocities for the same thrust and consequently make much less noise (see Figure 12)[17]. Advances in materials and manufacturing technology have allowed these very-high-bypass-ratio engines to avoid incurring unacceptable weight and drag penalties on the aircraft, in fact delivering reduced aircraft noise whilst simultaneously reducing fuel burn.

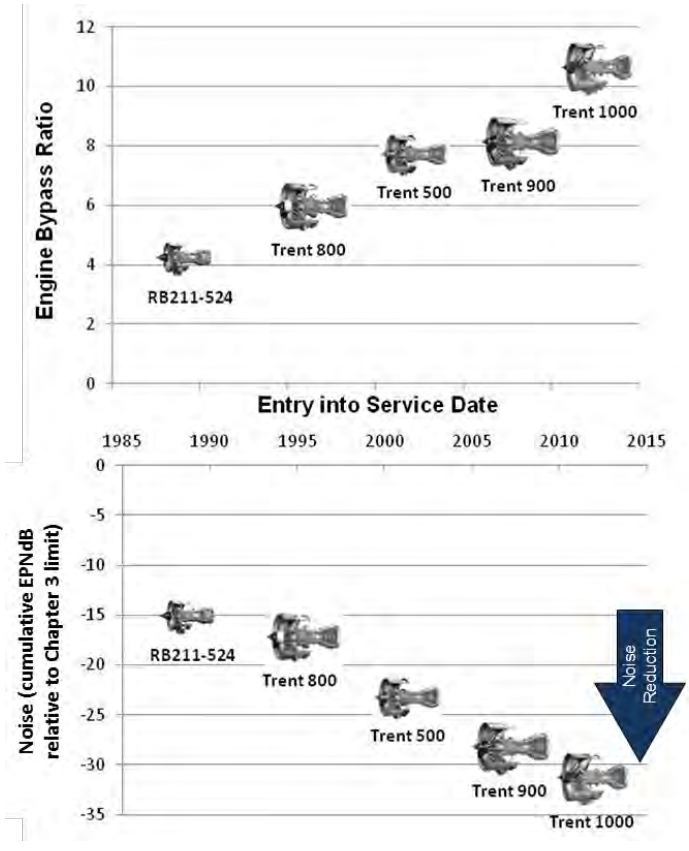


Figure 12: Rolls-Royce large engines: bypass ratios and noise levels

[16] The bypass ratio is the ratio of the flow through the engine bypass duct to the flow through the engine core
[17] This noise reduction is mirrored by other aero engine manufacturers like GE Aviation shown in appendix 2.

Historically increasing the engine bypass ratio has delivered very significant reductions in aircraft noise. However, increasing the bypass ratio further, whilst delivering additional jet noise reductions, would not deliver such significant reductions in aircraft noise due to other noise sources (especially fan noise) becoming dominant. Such ultra-high-bypass-ratios introduce additional design challenges including the increased engine installation drag and weight, the mechanical design of the fan, and the aerodynamic performance of the fan, compressor and low-pressure turbine.

Techniques for reducing jet noise without increasing 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. Nozzle lip treatments (such as the serrations featured in the flight testing of the Rolls-Royce/Boeing Quiet Technology Demonstrator (figure 13) and the Rolls-Royce/Airbus 'low interior noise fan nozzle' research programme (figure 14)) are now entering service on various aircraft including the Boeing 787 powered by the Rolls-Royce Trent 1000.

Figure 13: Quiet Technology Demonstrator

Figure 14: Low interior noise fan nozzle programme

With the reduction in jet noise, fan noise is becoming the dominant source of aircraft noise. Design features of the fan system for minimum noise, include choice in the number of rotating blades and static vanes, the distance between these two rows of blades/vanes, detailed geometries of the rotor blades and stator vanes (including sweep) and the rotor rotational speed. Key issues are the fan aerodynamic and mechanical performance, stability and stall margin, and the manufacturing complexity and cost. Similar techniques are employed to reduce other turbomachinery noise sources (i.e. turbine and compressor noise sources). The overall system is optimised by harnessing the power of modern computers to model the detailed aerodynamic flow over the blades and their mechanical vibration (see figure 15).

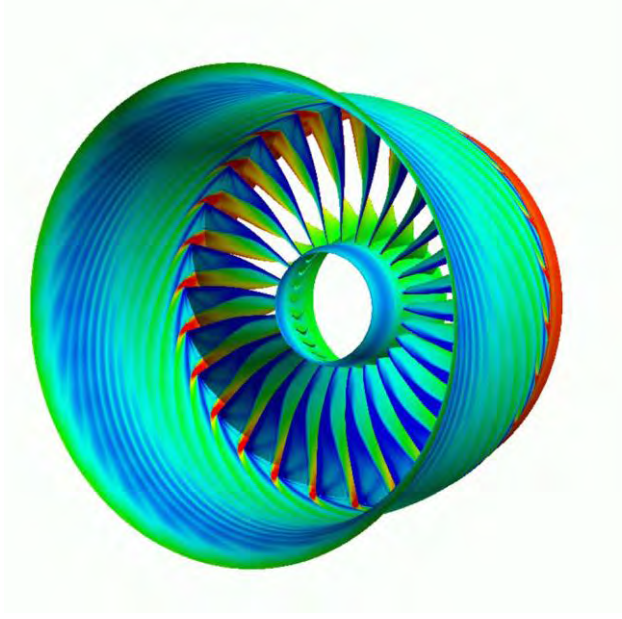


Figure 15: Computational Fluid Dynamics model of fan rotor noise

Acoustic liners in the nacelle play a very important role in reducing turbomachinery noise before it escapes from the engine, as the acoustic energy is converted into very small amounts of heat as the sound wave passes over the acoustic liner. 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. Attention to detail 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 16) has been very effective in reducing fan noise at aircraft departure, far greater than one would expect for a relatively small increase in acoustic liner area.

Figure 16: Industry first 100% acoustic inlet on A380 / Trent 900

As jet noise and turbomachinery noise has been reduced, other noise sources (such as the combustor and the handling bleeds on the engine, and the wing slats/flaps and the undercarriage on the airframe) become relatively more important. Research to provide detailed understanding of these noise sources has allowed a number of low-noise features to be progressively introduced on modern aircraft.

Industry is committed to reducing aircraft noise even further. Aircraft, engine and nacelle manufacturers are investing in extensive research programmes to deliver major additional improvements in the future. These include collaborative Aircraft Noise research programmes, such as SILENCE(R) (£90M) and OPENAIR (£25M) partly funded by the EU, and ANDANTE (£3.3M), SYMPHONY (£5M) and HARMONY (£4M) partly funded by the UK Technology Strategy Board.

INDUSTRY COMMITMENT:
The Aerospace sector is committed to continuing its investment in aircraft technology research programmes.

A breakthrough in noise could come from novel airframe designs (for example, see Figures 17 and 18) that offer the potential for significantly reducing noise, not just by reducing airframe noise and by reducing and shielding engine noise, but also by reducing the engine thrust required on take-off. However, there are many very significant technical issues that need to be addressed before any such aircraft enters service.

Figure 17: Study single-aisle aircraft demonstrating engine noise shielding by fuselage and tail plane

Figure 18: The 'Silent' Aircraft or blended-wing-body aircraft

In addition to step-changes in noise as a result of major aircraft configurational changes, research programmes continue to target individual component noise. Examples include the negative scarf inlet that redirects fan noise away from the ground (though a major challenge is its lower aerodynamic performance), extending the acoustic liner further forward in the intake (though advanced anti-icing

systems would be required), and multi-disciplinary-optimisation of turbomachinery components to reduce noise and improve fuel burn.

Active and adaptive control techniques for reducing noise have been considered for some time. Some techniques attempt to modify the air flow to reduce noise at critical phases of the aircraft flight; others attempt to generate anti-noise with opposite phase controlled in real time. These technologies have been applied to aircraft cabin noise, but they still need considerable development before they would be ready for application in commercial aircraft to reduce the noise around airports; key issues are the design, manufacturing and integration complexity, the availability of light and affordable actuators and micro-controllers, and in-service reliability and maintenance.

In summary, technology has delivered major reductions in noise with aircraft now entering service demonstrating dramatic reductions in noise levels compared with those of the early jet age. Aircraft now entering into service typically output half the noise of the aircraft they are replacing. Further progress, however, will require sustained investment in order 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, and many promising concepts for reducing noise are being developed, but further work is required to prove and develop the ideas for application in the very demanding aircraft flight environment. Without government support, these high-risk challenging research activities would not be viable.

3.4 Environmental Interdependencies

The local environment agenda for aviation is driven largely by noise and occasionally by local air quality impacts, whereas the national and international agenda is primarily focussed on climate change and carbon dioxide emissions. Addressing these often-competing demands is a constant challenge – achieving an improvement in one area may come at the expense of another.[18] 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, and the safe operation of the aircraft (see Figure 19). 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.

[18] Inter-dependencies between emissions of CO2, NOx & Noise from aviation, Sustainable Aviation Policy Discussion Paper, September 2010

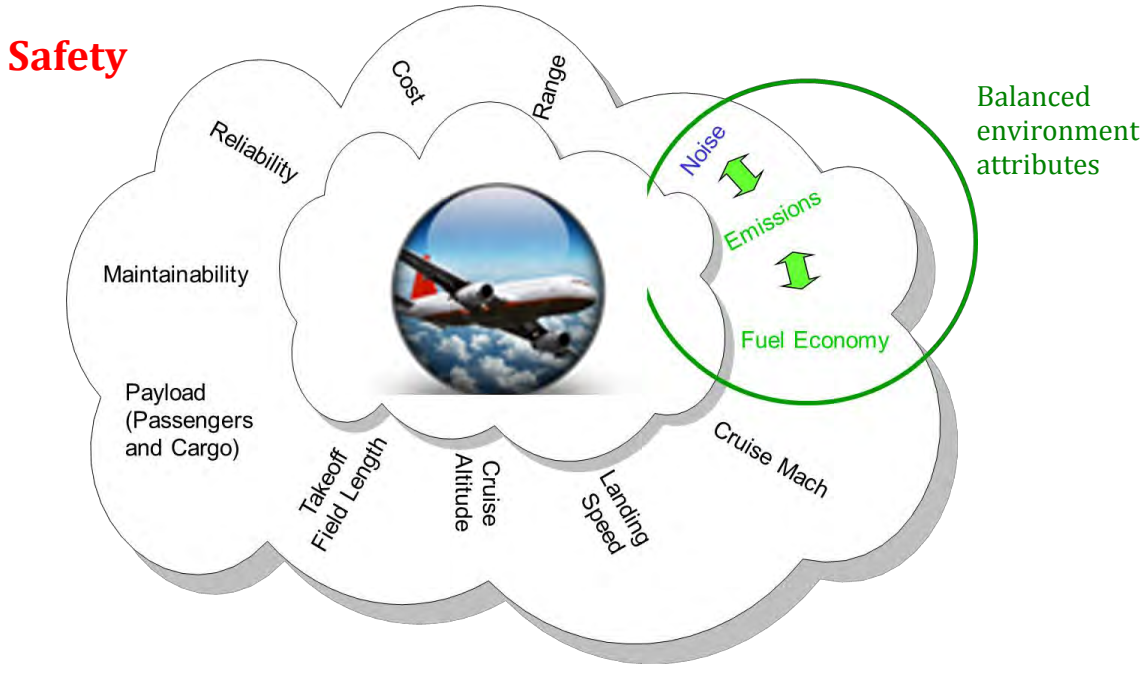


Figure 19: Besides safety, aircraft design results from a balance of requirements including the environment

More stringent noise regulations could lead to fuel-burn penalties arising from the need to incorporate additional noise-reduction design features which result in increased weight and/or drag, or from the preclusion of technologies that reduce fuel burn but reduce noise less. Noise requirements strongly influence the design of engines, effectively narrowing the design space and impacting on fuel-burn.

- For example, engine design parameters for the Airbus A380 were influenced by the requirement to meet QC 2 departure noise levels at London airports, to the slight detriment of fuel-burn and thus CO_2 emissions. (The Airbus A380 is still significantly more fuel efficient than the aircraft it replaces)

- Another example is that large extensions to the 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 used in operation.

- A third example is the open-rotor engine architecture (see Figure 20), which offers significant potential for reduced fuel-burn and CO_2 emissions. Although open-rotor engines are likely to be quieter than today's turbofans, a trade-off exists between their fuel-burn advantages and the noise-reduction potential of future turbofan designs.

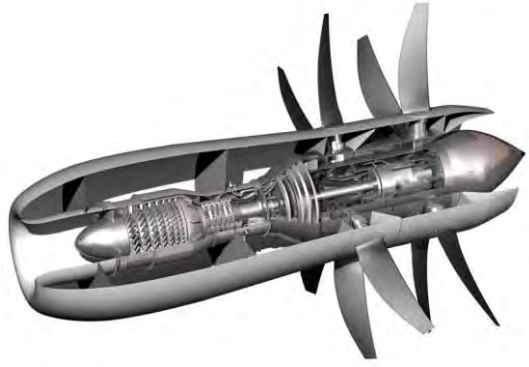


Figure 20: Open-Rotor Engine

3.5 Noise Benefits of Technology Improvements

3.5.1 Previous Performance

Reducing engine and airframe noise has formed a key element of UK aerospace manufacturers' design criteria since the introduction of jet aircraft in the early 1960s. Figure 21 shows the reduction in aircraft noise since the 1960s in terms of cumulative noise levels relative to Chapter 3. Two trends are evident: significant step-change reductions in noise associated with increases in engine bypass ratio, and smaller year-on-year reductions in noise associated with continuing improvements in noise reduction technologies at broadly constant engine bypass ratio. The 'evolutionary' developments in airframe and engine noise reduction technologies have delivered typically 0.1dB reduction in noise per year both on arrival and on departure, while the periodic 'revolutionary' increases in engine bypass ratio have delivered step-changes in noise, such that overall a reduction in aircraft noise of about 0.3dB per year has been achieved both on arrival and on departure. These values of 0.1dB and 0.3dB annual improvements in noise are used in the noise Road-Map to predict trends in future aircraft noise.

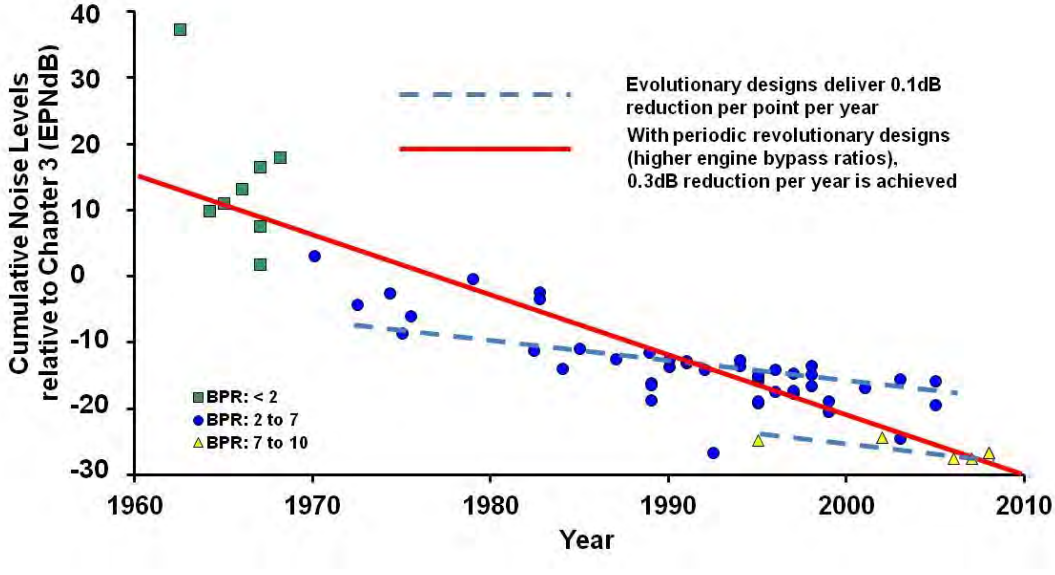


Figure 21: Historic trend in aircraft noise reduction
(Presented to CAEP Independent Experts' Review of Aircraft Noise)

3.5.2 Recent Advances in Noise Technology

Recent aircraft such as the Airbus A380 powered by the Rolls-Royce Trent 900 and the Boeing 787 powered by the Rolls-Royce Trent 1000 have demonstrated significant noise reductions compared with their predecessors (see Figure 22). These aircraft feature technologies that have been developed through extensive noise and other enabling research over many years; sustained company, national and European funding has been essential. The technologies include increased engine bypass ratios, nacelles with zero-splice intake liners, advances in aircraft and engine component design, reduced aircraft weight and improved aircraft performance. These aircraft are typical of the 'Imminent' aircraft entering service over the next few years and deliver significantly reduced noise footprints.

Figure 22: The A380 has similar noise levels to much smaller current aircraft

3.5.3 Future Noise Goals

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

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 that would 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 in noise by 2050 relative to year 2000 technology (the equivalent of a 0.3dB improvement per aircraft operation per year).

In the US, the FAA's Continuous Lower Energy, Emissions and Noise (CLEEN) program has among its goals to develop and demonstrate by 2015 aircraft technology that reduces noise levels by 42 dB cumulative relative to the Chapter 3 standard.

Achieving these goals will be very challenging and will require further 'revolutionary' developments in low-noise technology, probably associated with novel aircraft configurations since the benefits from further increases in engine bypass ratio are expected to be small.

INDUSTRY COMMITMENT:
The Aerospace sector is committed to working to achieve the visionary noise goals of Flightpath 2050 and CLEEN.

3.6 Assumptions concerning 'Imminent' Aircraft (Generation 1 Aircraft)

Aircraft incorporating 'Imminent' Generation 1 technology with significant fuel burn and noise benefits are already entering service or are currently offered for sale to the market (including all-new aircraft as well as re-engined aircraft). These are aircraft whose noise characteristics are well-defined. Their impact on noise emissions from UK aviation over the next two to three decades will be substantial.

We consider four distinct categories of 'Imminent' or 'Generation 1' aircraft, namely Regional Jets, Single-Aisle aircraft, Twin-Aisle aircraft and Very-Large Aircraft. Within these categories, we do not distinguish between Generation 1 aircraft produced by different manufacturers, but we do sometimes distinguish between light, medium and heavy weight versions[19]:

- Regional Jets (RJ)
    - In the small RJ sub-division of this category, there is no clear evidence when a new generation of aircraft will be developed; a later date of 2025 has therefore been assumed for the introduction of Generation 1 aircraft, though it should be noted that for regional and large airports the UK aviation noise output depends little on small aircraft in this category.
    - In the large RJ sub-division of this category, the Bombardier 'C' series is scheduled to enter service in 2014 and the Mitsubishi MRJ in 2015, whilst Embraer are currently evaluating options to re-engine the aircraft due to enter service in 2018.
- Single-Aisle (SA)
    - We divide this category into small, medium and large family members (e.g. A318/9, A320 and A321)[20]. The Airbus A320neo family will enter service in 2015 and the Boeing 737 MAX family will enter service in 2017.
- Twin-Aisle (TA)
    - In the small TA sub-division of this category, the Boeing 787 entered service in 2011
    - In the medium TA sub-division of this category, the A350 XWB-800/900 will enter service in 2014.
    - In the large TA sub-division of this category, the A350 XWB-1000 will enter service in 2017, and Boeing are currently evaluating a replacement for the B777 to enter service at the end of the decade

[19] The Sustainable Aviation CO2 Road-Map does not consider these sub-divisions, but they are more critical for noise

[20] Aircraft noise levels within an aircraft family vary more rapidly than the certification limits, such that smaller members of the family demonstrate greater margins to Chapter 3 than larger members of the family. In our modelling we have included information on the breakdown of air traffic movements by family member.

- Very-Large Aircraft (VLA)
    - We do not sub-divide this category, since the noise levels of the Generation 1 aircraft (A380 and B747-8) are broadly similar and the breakdown of future sales into different sizes is less clear. The Airbus A380 entered service in 2007 and the Boeing 747-8 Intercontinental entered service in 2012.

A number of these 'Imminent' aircraft have already been certificated. Table 3 and Figure 23 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 Chapter 3 as recorded on the European Aviation Safety Agency, (EASA), database to characterise their noise improvement.

Current Aircraft	Bypass Ratio	Arrival Noise	Departure Noise[21]	'Imminent' 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 3: Noise of Current and 'Imminent' aircraft relative to Chapter 3

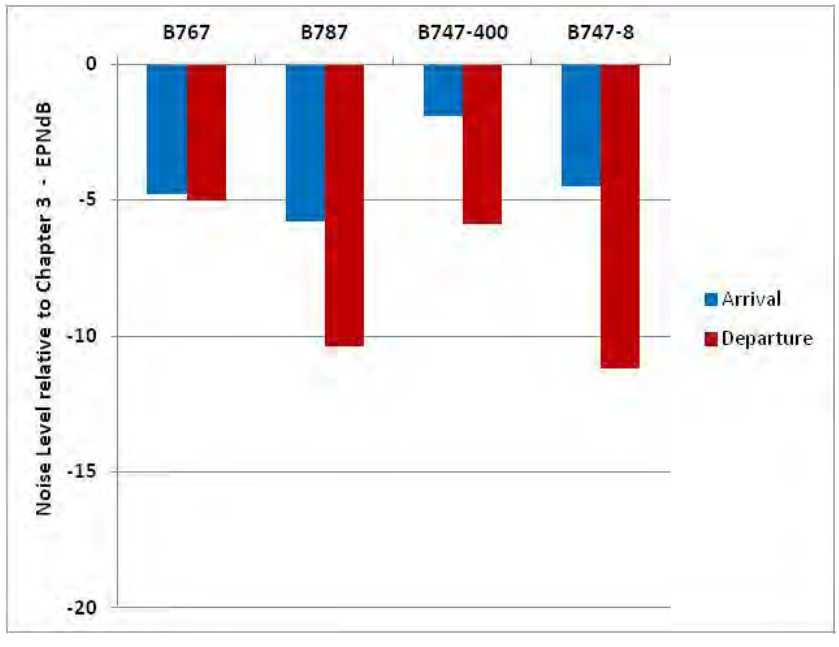


Figure 23: Noise of Current and 'Imminent' aircraft relative to Chapter 3

We apply these improvements in noise across all aircraft categories when predicting the noise of 'Imminent' aircraft that have not yet been certificated and hence whose noise is not yet known for certain. These predictions of noise levels are largely consistent with proprietary information available to manufacturers and to the International Civil Aviation Organisation's Committee for Aviation Environmental Protection.

[21] Average of Lateral and Flyover margins

3.7 Assumptions concerning 'Future' Aircraft (Generation 2 Aircraft)

The technology and knowledge in both airframe and engine design to achieve these noise goals is yet to be acquired, so manufacturers are engaged in extensive noise research programmes with financial support from government. In the UK, industry and government have funded extensive collaborative noise research programmes exploiting the capabilities of universities, research establishments and industry; the Technology Strategy Board has funded several cost-sharing research projects into aircraft noise, and recently an Aerodynamics Centre[22] was announced to support the development of new technologies and more environmentally friendly aircraft. Progress in achieving the Flightpath 2050 noise goals will largely depend on maintaining and enhancing funding support for research and development in Europe and in the UK.

Our assessment of the noise reduction potential of the 'Future' Generation 2 aircraft in each of the four categories is derived with reference to the corresponding Generation 1 aircraft, and is driven by three factors:

- the entry into service (EIS) date of the Generation 2 aircraft type relative to its Generation 1 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, etc.

Our assumed EIS dates for Generation 2 aircraft are as follows:

- **Regional Jets**
    - An EIS of 2050 is chosen for the small aircraft subdivision
    - An EIS of 2035 is chosen for the large aircraft subdivision

[22] http://news.bis.gov.uk/Press-Releases/Plan-launched-to-keep-UK-aerospace-flying-high-67cc0.aspx

- **Single-Aisle**
    - An EIS of 2025 is chosen to reflect a balance between several competing factors. Although 2025 will be only some 10 years after the introduction of the Generation 1 aircraft in this category, the Generation 1 aircraft are re-engined versions of existing aircraft and it is expected that technological developments will result in the introduction by 2025 of an all new aircraft type.
- **Twin-Aisle**
    - We assume a gap of approximately 20-25 years between Generation 1 aircraft and their successors in this category, leading to an approximate EIS of 2035 for the small aircraft subdivision
    - We assume an EIS of 2040 for the medium aircraft subdivision.
    - We also assume an EIS of 2040 for the large aircraft subdivision
- **Very-Large**
    - We assume a gap of approximately 30 years between Generation 1 aircraft and their successors, leading to an approximate EIS of 2040.

These dates correspond to the EIS dates of the SA CO_2 Road-Map[23] 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. A value of 0.1dB reduction in noise per annum 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.

We also consider significant technologies or configurational changes that could result in a step-change in aircraft noise. These include, for example, aircraft configurations that shield the engines significantly reducing the noise heard on the ground, but also aircraft powered by open-rotors or large turboprops that are expected to be more fuel efficient but noisier than equivalent turbofans. We consider two scenarios:

- The 'ultra-low-noise' scenario assumes aircraft configurations that shields the engines in all aircraft categories (e.g. blended-wing-body configuration for twin-aisle and very-large aircraft, and engine shielding by fuselage and tail-plane for single-aisle and regional jets, etc.)
- The 'ultra-low-CO_2' scenario assumes the same blended-wing-body configuration for twin-aisle and very-large aircraft, but open-rotor or large-turboprop powerplants for the single-

[23] http://www.sustainableaviation.co.uk/wp-content/uploads/SA-CO2-Road-Map-full-report-280212.pdf

aisle and regional-jet categories. The 'Future' aircraft in these latter two categories are assumed to show no noise improvement over the 'Imminent' aircraft.

Table 4 summarises these assumptions.

	Regional Jet	Single Aisle	Twin Aisle	Very Large
Baseline Forecast	-0.1dB	-0.1dB	-0.1dB	-0.1dB
'Ultra-Low-Noise' Forecast	-0.3dB	-0.3dB	-0.3dB	-0.3dB
'Ultra-Low-CO_2' Forecast	0dB	0dB	-0.3dB	-0.3dB

Table 4: Assumed annual rate of noise reduction for 'Future' (Generation 2) aircraft[24]

In February 2013, ICAO's Committee for Aviation Environmental protection (CAEP) agreed a new noise standard of 7EPNdB below Chapter 4 (cumulative over the three certification conditions), applicable to 'Future' aircraft entering service after the end of 2017 (2020 for lower-weight aircraft). Chapter 4 was applicable from the start of 2006, so for large aircraft the new noise standard represents an average reduction of almost 0.2dB per condition per year, almost double the rate of improvement in our baseline assumption for 'Future' aircraft. The more aggressive rate of improvement in the new noise standard cannot be read across directly to the rate of improvement in noise levels for our 'Future' aircraft, but it does indicate that our baseline scenario might in fact over predict the future noise output and that UK aviation might be able to accommodate more significant growth in air transport movements while reducing UK aviation's noise output.

Also in February 2013, independent experts reported to CAEP on their estimates of the noise goals for new aircraft entering service in 2030. They considered technology scenarios broadly similar to the baseline, the ultra-low carbon and the ultra-low-noise scenarios, and proposed noise goals broadly consistent with our assumptions for 'Future' aircraft.

3.8 Aviation Growth

The SA CO_2 Road-Map used forecasts of growth in revenue-passenger-kilometres (RPKs) provided by the UK's Department for Transport (DfT) to estimate the growth in aviation[25]. The RPK growth captures changes in the number of passengers and in the average distance flown, both important for estimating CO_2 emissions. For airport noise predictions, however, the growth in air traffic movements (ATMs) is more relevant. Over the 40 year period from 2010 to 2050, DfT forecasts ATMs to grow annually by varying amounts between 0.8% and 2%, resulting in the overall growth by a factor of about 1.9 by 2050. This growth rate is less than that assumed in some other global assessments (e.g. the growth in passenger traffic of 4.8% per year through 2036 in ICAO's Environmental Report of 2010).

[24] This assumed rate of noise reduction for Generation 2 aircraft is the assumed annual noise reduction at arrival and departure relative to the corresponding Generation 1 aircraft , such that on both departures and arrival Generation 2 aircraft are quieter than Generation 1 aircraft by an amount given by the difference in the years of their EIS multiplied by these factors

[25] https://www.gov.uk/government/publications/uk-aviation-forecasts-2013 page 82

3.9 Airline Fleet Transition

In the previous section, we set out our assumptions concerning the entry into service timescales of 'Imminent' (Generation 1) and 'Future' (Generation 2) aircraft types. In this section, we address the issue of fleet-turnover (the rate at which new aircraft types replace older aircraft in service). The transition from the current to 'Imminent' aircraft is modelled to start at the 'Imminent' Aircraft Transition Start Date, develop linearly and be complete by the Transition End Date in Table 3. Similarly transition from 'Imminent' to 'Future' aircraft is modelled to start at the 'Future' Aircraft Transition Start Date, develop linearly and be complete by the Transition End Date in Table 5[26]. This transition is illustrated in Figure 24 for a typical airport fleet mix, assuming ATMs grow by a factor of almost 2 over the period 2010 to 2050 in line with DfT predictions.

	'Imminent' Aircraft		'Future' Aircraft	
	Start	End	Start	End
Very Large Aircraft	2007	2027	2040	2060
Large Twin Aisle	2017	2040	2040	2060
Medium Twin Aisle	2014	2040	2040	2060
Small Twin Aisle	2011	2036	2035	2055
Single Aisle	2015	2045	2025	2050
Large Regional Jet	2015	2045	2040	2060
Small Regional Jet	2025	2045	2050	2070

Table 5: Transition dates for 'Imminent' and 'Future' Aircraft

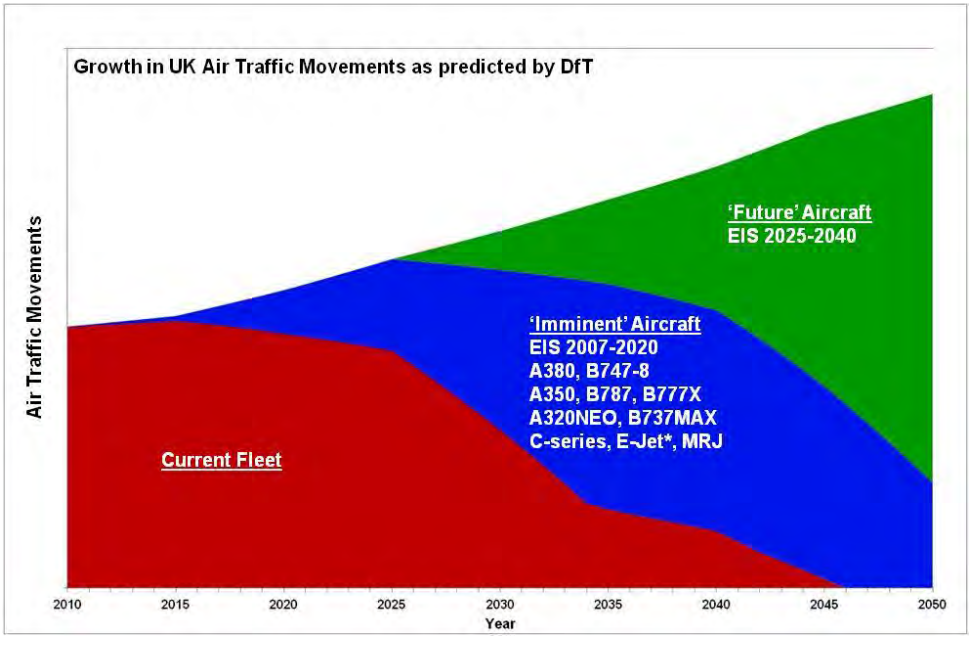


Figure 24: Typical fleet transition from current aircraft to 'Imminent' and 'Future' aircraft

[26] These transition rates are the same as those assumed in the CO2 Road-Map, except where additional sub-categories have been introduced.

3.10 Calculation of UK Aviation Noise Output

The noise levels of 'Imminent' and 'Future' aircraft and the fleet transition rates from current to 'Imminent' and 'Future' 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, although 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; the noise levels of 'Imminent' and 'Future' aircraft are assumed to be proportional to the equivalent arrival and departure levels described in previous sections. The relative importance of arrival and departure noise has been modelled by adding 9dB to the departure noise levels (to take account of the different microphone locations for the different certification conditions) in line with the correction in the Quota Count System at London Airports[27]. 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.

[27] "Review of the Quota Count (QC) System: Re-Analysis of the Difference between Arrivals and Departures". ERCD Report 0204, Environmental Research and Consultancy Department, Civil Aviation Authority.

3.11 Predicted changes in UK Aviation Noise Output

3.11.1 Baseline scenario

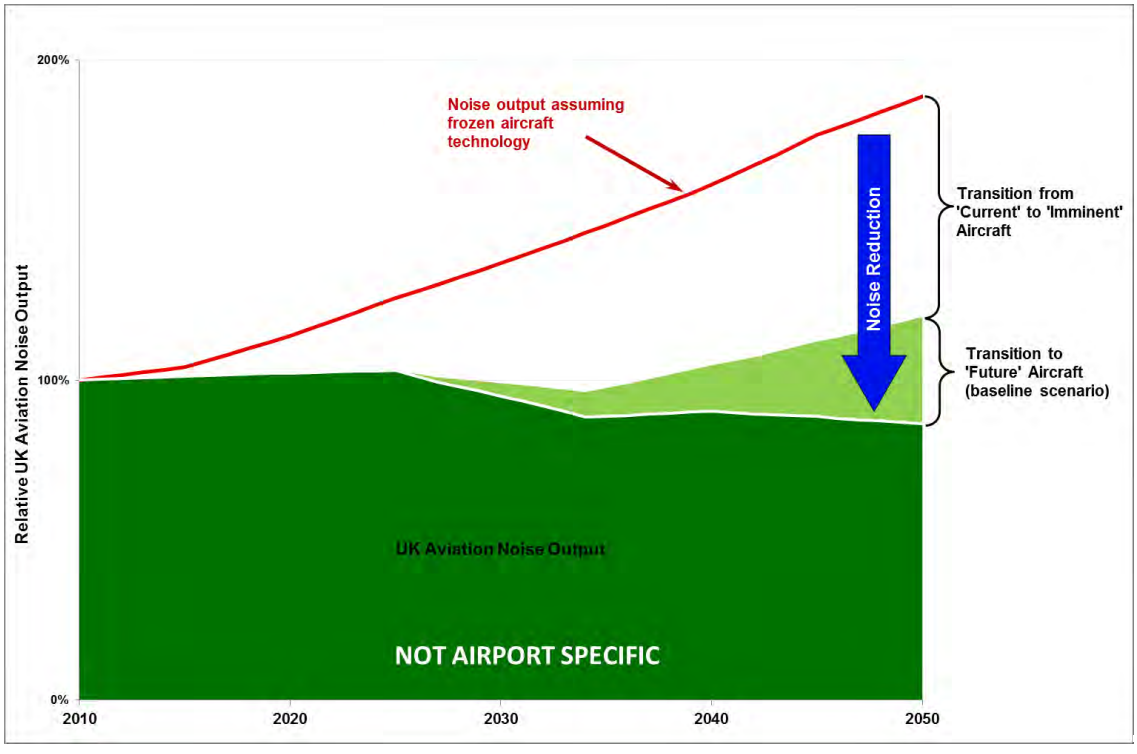


Figure 25: Variation in UK Aviation Noise Output - Impact of 'Imminent' and 'Future' aircraft

Figure 25 shows the predicted variation in UK aviation noise output. If the current fleet were to grow with no transition to 'Imminent' or 'Future' aircraft, the noise output would increase in line with the growth in ATMs by a factor of almost two over the period 2010 to 2050.

The transition from current to 'Imminent' aircraft, however, dramatically reduces the noise output; indeed, rather than increasing in line with the growth in traffic, the noise output reduces from its current value by the mid-2030s. Beyond then the impact of growth in aviation would outweigh the impact any residual retirement of current aircraft were it not for the transition to 'Future' aircraft that ensures noise output retains this reduction out to 2050.

Some previous assessments of the future noise climate have indicated that the population exposed to aircraft noise is expected to grow (e.g. ICAO's 2010 Environmental Report predicts an average annual growth rate of population exposed of between 0.7% and 1.6%), but this is due to the higher predicted growth in ATMs. With the current forecasts for growth of aviation in the UK, the predicted noise output reduces out to 2050.

3.11.2 'Ultra-Low-Noise' and 'Ultra-Low-CO_2' scenarios

In addition to the baseline scenario, which can be considered as representative of the historical underlying balance of design priorities between noise and fuel burn without radical changes in engine or aircraft configurations, we have also considered two other scenarios (the 'ultra-low noise' scenario and the 'ultra-low CO_2' scenario) in which significant technologies or configurational changes are considered

that could result in a step-change in aircraft noise. The 'ultra-low noise' scenario reflects aircraft configurations designed overwhelmingly for low noise, and includes aircraft configurations that shield the engines significantly reducing the noise heard on the ground. The 'ultra-low CO_2' scenario reflects aircraft configurations designed overwhelmingly for low fuel burn, and includes aircraft powered by open-rotors or large turboprops and blended-wing-body aircraft.

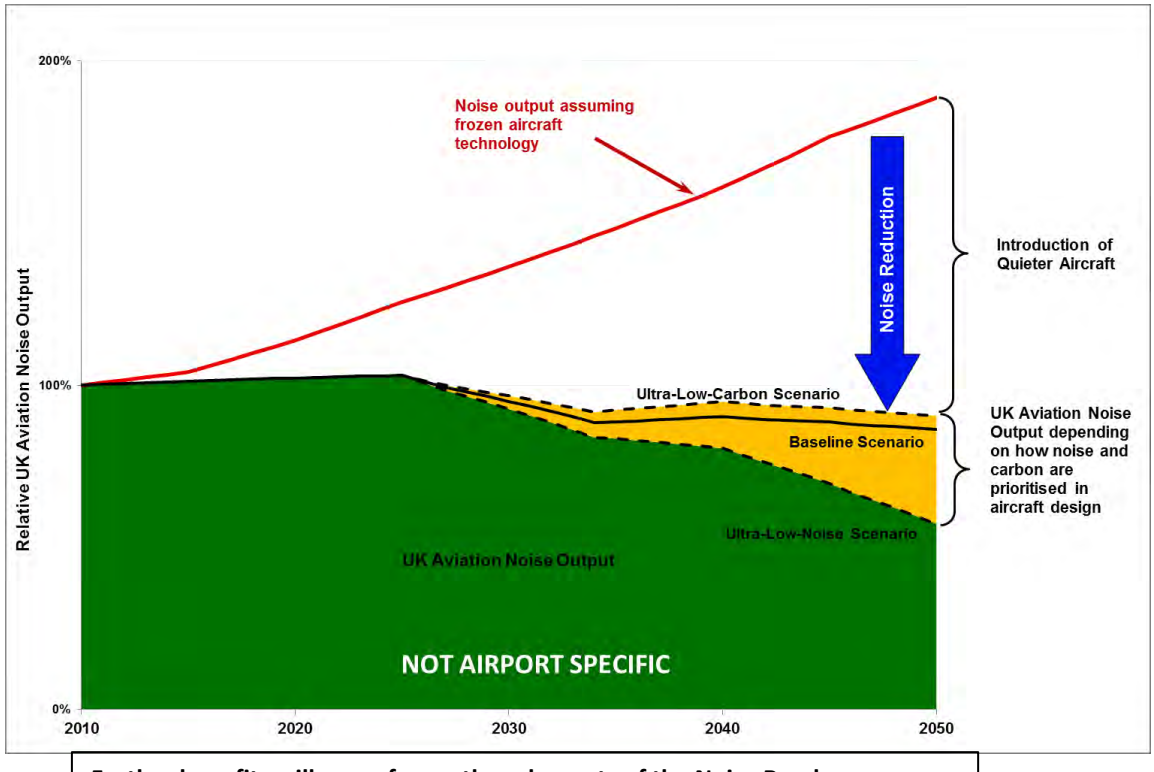
The 'ultra-low noise' scenario exhibits continuing noise output reductions out to 2050. The 'ultra-low CO_2' scenario, however, exhibits less reduction in noise output beyond the mid-2030s, when the introduction of blended-wing-body configurations for the twin-aisle and very-large aircraft categories is balanced by the introduction of large turboprops and open rotors for the regional jet and twin-aisle categories.

3.11.3 Scenarios for different transition rates

An assessment was also conducted of the sensitivity of the conclusions to the assumed transition rates to 'Imminent' aircraft, and to the EIS dates for 'Future' aircraft. If there are very significant delays to both the completion of transition to 'Imminent' aircraft and the EIS date for 'Future' aircraft noise output remains broadly constant out to 2050 rather than reducing.

3.11.4 Summary of Predicted Changes in UK Aviation Noise Output

The transition from current to 'Imminent' aircraft and its impact on UK aviation noise output is well understood; the transition to 'Future' aircraft, however, is less certain and results in uncertainty in the noise output out to 2050 as illustrated in Figure 26.



Further benefits will come from other elements of the Noise Roadmap

Figure 26: Forecast Changes in a UK Aviation Noise Output between 2010 and 2050

Actual noise performance will vary by airport, depending on the fleet mix, route structure, number of runways, 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 set out their own noise roadmaps based on the information provided by this Road-Map.

3.12 Risks and Barriers to delivering Technology Improvements

3.12.1 Aircraft noise levels of Generation 1 and Generation 2 aircraft.

The noise levels of 'Imminent' aircraft are well established and the required technology is well proven, but until the development programmes are completed and the aircraft is certificated there remains an element of uncertainty as to whether these levels might be achieved or might even be surpassed. Forecasts can be updated as more information becomes publically available on the noise of 'Imminent' aircraft.

In order to deliver the low noise levels of 'Future' aircraft, appropriate levels of government and industry investment are required to fund aerospace research, including the development of test facilities.

3.12.2 Environmental interdependencies

Environmental trade-offs exist between reducing noise and reducing fuel-burn and there remains uncertainty as to what will be the future balance of priorities. For example, Open-Rotor and large-propeller powered aircraft will be more fuel efficient but not as quiet as the equivalent turbofan powered aircraft. We have attempted to capture the impact of environmental interdependencies in the different scenarios considered[28].

3.12.3 Fleet transition rates

In addition, airlines might delay the introduction of 'Imminent' and 'Future' aircraft into their fleets, or manufacturers might encounter delays in the launch or certification of new aircraft types. We have attempted to capture the potential impact of such delays on noise levels around airports by conducting sensitivity studies.

3.12.4 Fleet growth rates

The SA CO_2 Road-Map used forecasts of aviation growth provided by the DfT. If aviation in the UK grows more rapidly than the DfT forecast, a greater level of individual aircraft noise reduction than assumed will be required to meet the noise output forecast in our Road-Map.

[28] Inter-dependencies between emissions of CO2, NOx & Noise from aviation, Sustainable Aviation Policy Discussion Paper, September 2010

4 Operational Improvement Opportunities

4.1 Key Messages

- Operational Improvements relate to how and where aircraft operate.
- Operational improvements give the opportunity to influence noise both close in to the airport and further away.
- There is scope to increase 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 decibels (SEL) by 2030 against a 2010 baseline.
- The exact noise improvement will vary for different communities depending on the current noise exposure and local scope for adopting new techniques.

4.2 Summary

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

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. 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 decibels (SEL) 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 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"[29].

A summary of operational noise mitigation opportunities is given in Table 6.

	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	☐ 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	☐ 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) ☐ London Airspace Management Programme ☐ Northern Terminal Control Area airspace improvements.	☐ SESAR ☐ London Airspace Management Programme ☐ Flexible use of airspace between civil aviation military and general aviation and airspace users. ☐ Route availability improvements, conditional routes through military air zones and procedural improvements.	
Ground Noise[30]	N/A	Siting of aircraft engine test facilities at airports	☐ Reduced engine taxi ☐ Use of Fixed Electrical Ground Power and Pre Conditioned Air

Table 6: Summary of noise mitigation opportunities

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

[30] for more information see industry departures code of practice: http://www.sustainableaviation.co.uk/wp-content/uploads/DCOPractice2012approvedhi-res.pdf

4.3 Introduction

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

Operational improvements give the opportunity to influence noise both close in to the airport and further away. Examples of operational measures that can have noise benefits closer to the airport, in the range 6 to 0 miles, 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 6 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. A plan view showing some of these operational techniques to reduce noise as we move forwards is presented in Figure 27 below.

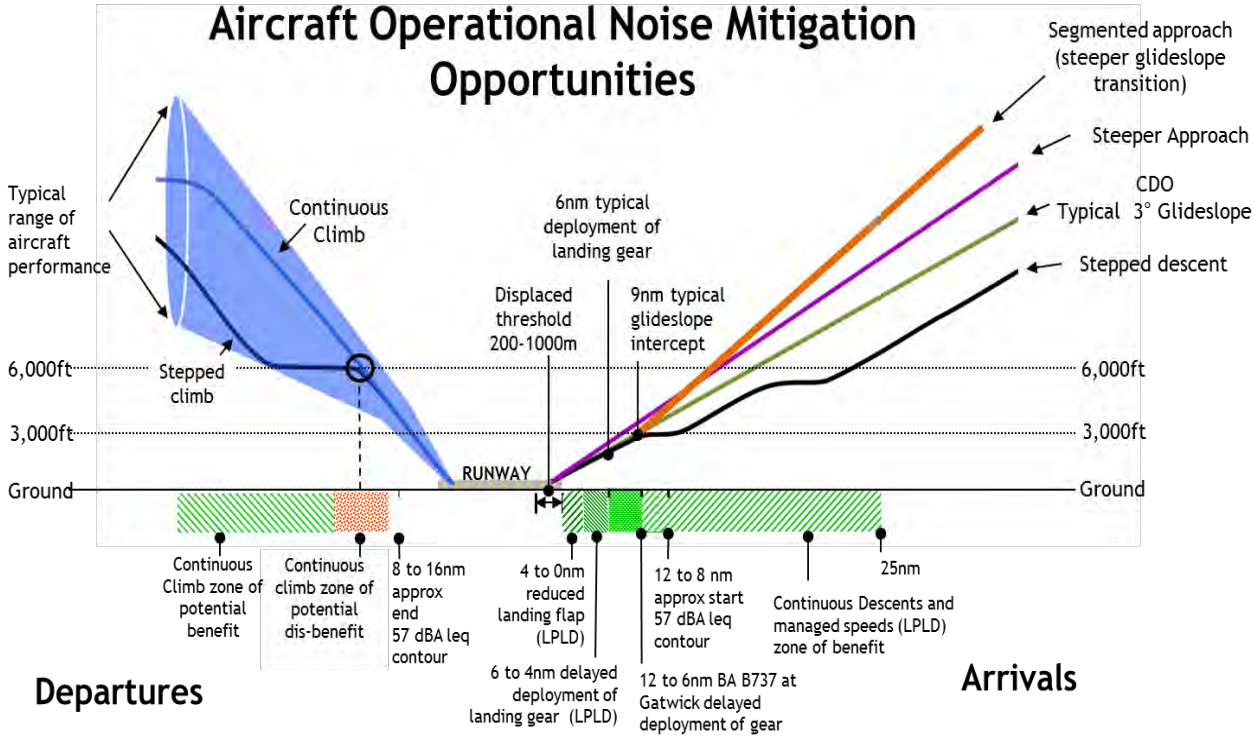


Figure 27: Schematic demonstrating location of noise benefits from different operational practices along a flight path.

The following sections of this chapter explore the opportunities in more detail.

4.4 Managing Noise from Arriving Aircraft

For arriving traffic, operational improvements are expected to offer noise reductions of between 1 to 5 decibels (SEL) by 2030 against a 2010 baseline. The following section describes examples of operational improvements to mitigate noise from arriving aircraft.

4.4.1 Continuous Descent Approaches (CDAs)

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[31][32] for the London Airports suggests CDAs from 7,000ft can offer between 1-5 dBA SEL 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 in Table 7. 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.

Year	Performance
2006	60% of all arrivals achieved CDA at 11 London FIR airports where NATS provides the ATC service.
2012	75% of all arrivals achieved CDA at 11 London FIR airports where NATS provides the ATC service
2012	72% of all arrivals achieved CDA at 15 UK airports where NATS provides the ATC service.
Definition of CDA for this study was 6,000ft – 1,800ft, with allowance for one level off of up to 2.5 nm. Level offs less than 0.5 nm were ignored and some airports adjusted for elevation and other criteria. Tool used was NATS Flight Profile Monitor which analyses radar data from all flights in UK controlled airspace.	

Source: NATS Flight Profile Monitor, 2012.[33]

Table 7: UK CDA achievement rates 2006 and 2012

4.4.2 Steeper Approaches

Slightly steeper approaches of up to 3.2 degrees versus a standard 3.0 degree approach may offer scope for noise reduction of up to 1dBA SEL. A study completed by British Airways and Airbus[34] proved the fly-

[31] CAA ERCD, BAA, CDA Briefing Paper, "Noise benefits associated with Continuous Descent Approach Procedures at London Heathrow".
[32] DTLR (1999). "Noise from arriving aircraft: Final Report of the ANMAC Technical Working Group," Departments for Transport Local Government and the Regions, December 1999
[33] Individual airport and airline performance within this average can vary significantly with some airports or airlines recording 85% achievement or more
[34] BA and Airbus, 2010, Arrivals Noise Study, using simulator runs and noise modelling of A320 aircraft.

ability of this approach angle for A320 aircraft although there remain operational, safety and infrastructure considerations to be overcome before this practice could be adopted for noise mitigation reasons in the UK.

British Airways, Heathrow Airport and Airbus are working together through Sustainable Aviation to investigate experience at other European airports before deciding on next steps in exploring potential adoption in the UK. It is likely that while some zones under the flight path may benefit from steeper approach angles, others may experience an increase in noise due to necessary adjustments to flap and landing gear deployment. On balance, however, it appears that steeper approaches may be able to offer important noise reductions at some airports. Further research is needed to validate these early findings and demonstrate future viability of steeper approaches for noise mitigation purposes.

Sustainable Aviation will continue to drive activity in this area directly through member airlines, manufacturers and NATS and also indirectly by maintaining links and learning from others internationally who are also conducting research into the potential for steeper approaches.

For example, ICAO's Committee on Aviation Environmental Protection tasked Working Group 2 with assessing the potential noise benefits of steeper approaches. The aim was to identify if a potential noise benefit exists; 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 8 below, reproduced from the CAEP working paper[35] 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[36] (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 8: Theoretical reduction in contour area as a function of final approach phase angle

It is important to recognise that Table 8 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 counter productive in

[35] , ICAO CAEP 8, WP40, 2010, Initial Assessment of the Potential Changes in Noise Exposure Associated with Steeper Approaches.

[36] Whilst approach angles of greater than 3.25 degrees are in operation at some airports, the operational feasibility of these increased angles in everyday use at all airports is yet to be established.

noise terms. Recent simulator trials have confirmed that 3.25 degree approaches can be consistently delivered at a range of aircraft weights and in a wide range of wind conditions without the need for early landing gear lowering. Further work is continuing to establish whether steeper descent angles can be flown while avoiding the unintended consequences mentioned above.

4.4.3 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 9.

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 9: Examples of UK Airport Displaced Thresholds

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[37] are presented in Table 10 for one aerodrome example; the changes in Leq contour area and population exposed will vary for different airports.

[37] 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).

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)[38]

Table 10

4.4.4 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[39].

4.4.5 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[40] study demonstrated that the noise benefits of reduced drag outweighed the extra noise generated by slightly faster speeds.

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 or 170 knots to 5 miles.

4.4.6 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

[38] changes in Leq areas may be different for different airports
[39] DfT, 1999, Noise from Arriving Aircraft, Final Report, 6.1.3.
[40] Airbus, Getting to grips with aircraft noise, 2003, http://www.captainpilot.com/files/AIRBUS/AircraftNoise.pdf

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. With regard to noise, it should be noted that with reduced flap the aircraft approach speed will be slightly higher than normal which will require more of the runway length to be used, and occasionally more 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.

One example of the use of reduced landing flap to reduce noise is Cathay Pacific's early morning arrival (before 6am) using 747-400s at Heathrow. The airline's standard operating procedures involve the use of 30 degrees of flap for landing. This resulted in a larger noise footprint for Cathay aircraft than for other airlines operating similar aircraft. Following review of the noise data and operational procedures between Heathrow Airport, Cathay Pacific and the CAA, Cathay Pacific have updated their operating procedures to use a lower flap setting for their early morning arrivals at Heathrow, reducing the size of the noise footprint.

4.4.7 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[41].

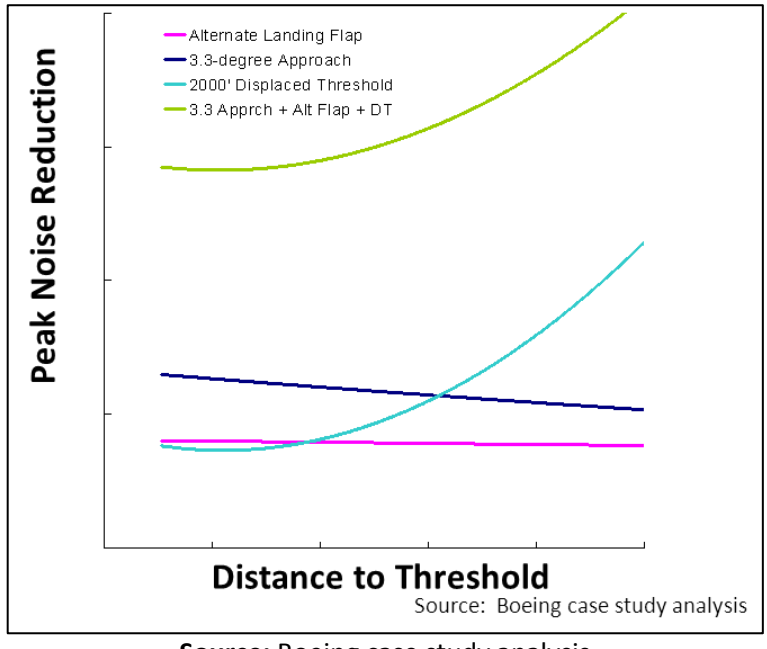
In another example, the British Airways Boeing 737 fleet at Gatwick was modified to enable the aircraft to be flown with a lower flap setting without the landing gear down. This enabled the gear to be deployed at 6 miles from touchdown instead of the previous 12 miles, providing a six mile zone of benefit from reduced airframe noise.

4.5 Benefits of combining several operational noise management techniques

Figure 28, reproduced courtesy of Boeing, highlights the individual and combined effect of some of the operational noise mitigation measures on one particular aircraft discussed above. It shows that 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.

[41] BA and Airbus, 2010, Arrivals Noise Study, using simulator runs and noise modelling of A320 aircraft.

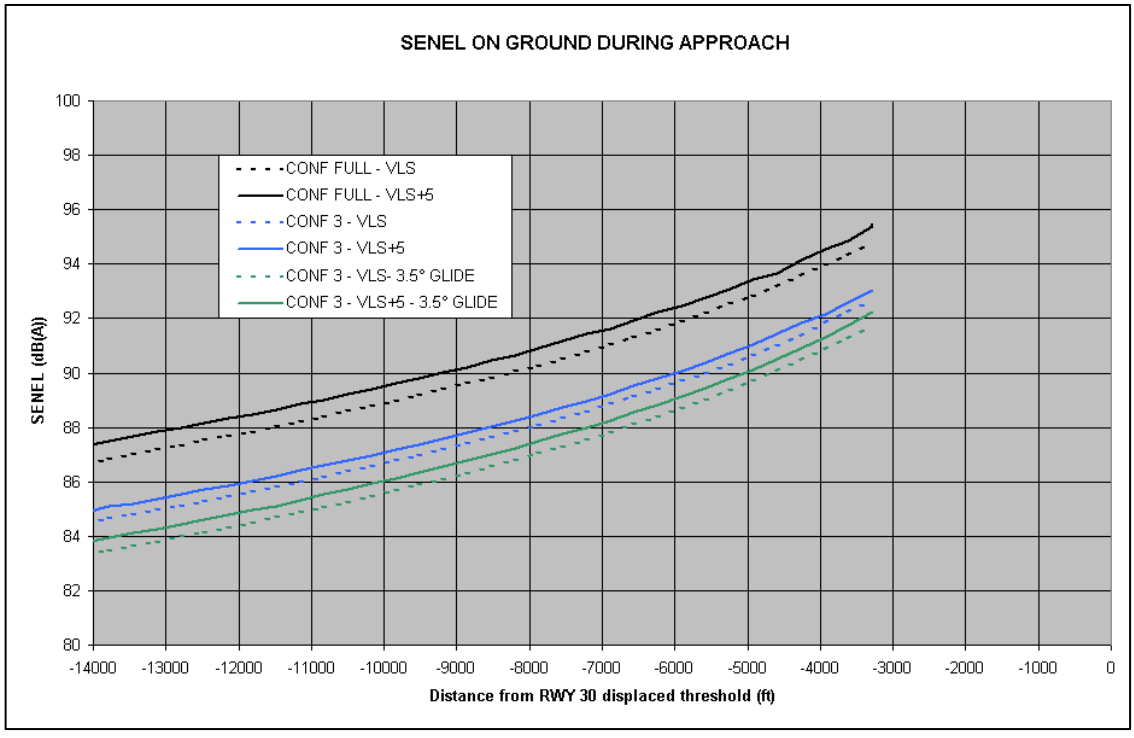
Furthermore, these noise benefits can be derived purely from operational improvements, offering benefits equivalent to those of a significant step change in technology which might take many years to realise. More research is needed to explore the practical steps required to apply some of these techniques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



Source: Boeing case study analysis

Figure 28: Combined effects of operational noise mitigation techniques

Figure 29 shows a similar study from Airbus and demonstrates the potential combined influence of approach speed, flaps/slats setting and glide angle on the approach noise. Again this demonstrates potential noise reduction of 3 to 4 dBA. However, it should be noted that there are dependencies between each of these individual noise mitigation techniques. Whilst it will normally be possible to combine several of these, this will not always be the case. Airport operators, airlines and Air Traffic Control agencies will be required to assess the optimum combination of these techniques on an airport by airport basis.



Source: Airbus, 2003.

Figure 29: Potential combined influence of approach speed, flap and slats setting and glide angle on approach noise.

4.6 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*'[42]. 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.

4.6.1 Continuous climb operations

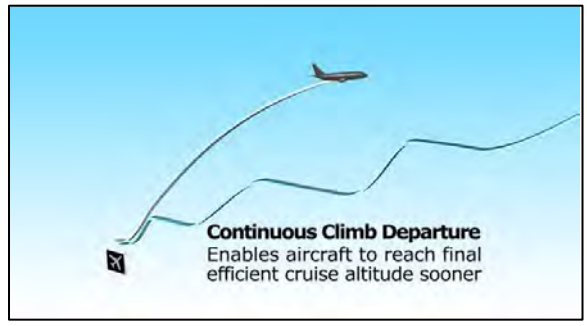
Continuous climb operations, (CCOs), where aircraft climb continuously to their cruise altitude, have always been and continue to be the default practice for airlines and air traffic controllers where airspace structures and traffic conditions allow. However, stepped climbs i.e. climbs with periods of 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.

[42] http://www.sustainableaviation.co.uk/wp-content/uploads/DCOPractice2012approvedhi-res.pdf

These concepts are depicted in figures 30 and 31.

Source: NATS, 2012.

Figure 30: Stepped Climb



Source: NATS, 2012.

Figure 31: Continuous Climb

Table 11 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 11: UK Continuous Climb achievement rates 2006 and 2012

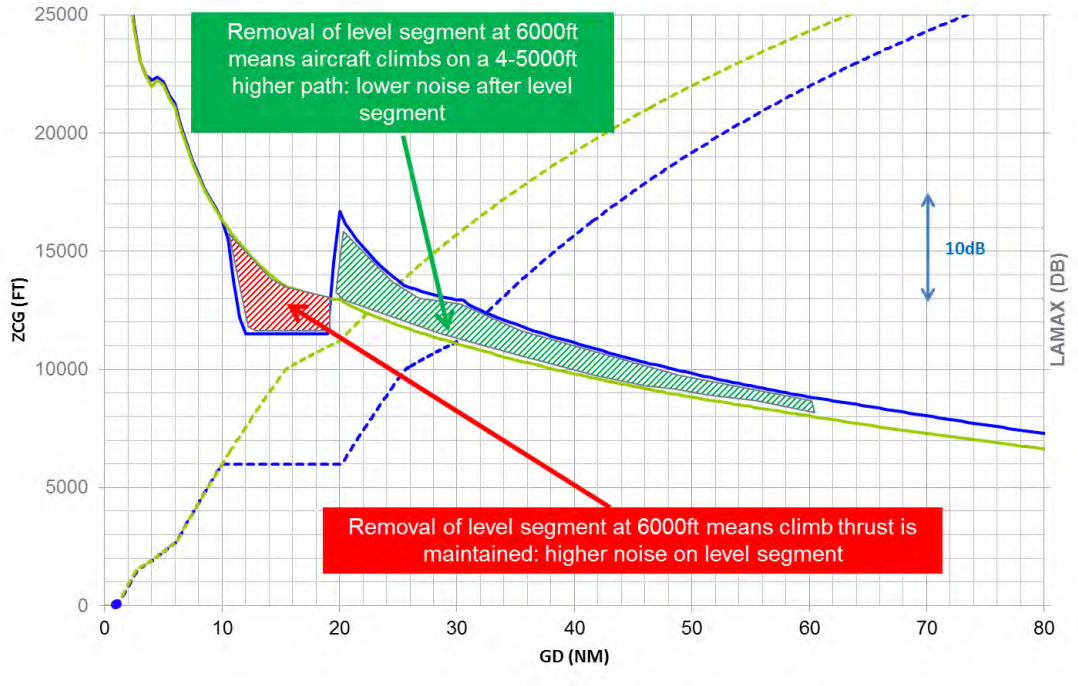
The fuel burn and noise penalty of stepped climbs is greatest at lower altitudes so eliminating level flight at low altitudes may have the multiple benefits of reducing fuel burn, emissions and noise. While the ideal outcome is to *remove* any level flight in the climb phase, fuel, emissions and noise 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. Figure 32 shows typical modelled

noise pattern of a continuous climb versus a stepped climb. This example shows a 10nm level segment in the climb although typical level offs are more usually between 3 to 5nm in length, while some can be longer. Nevertheless this example expresses clearly the concept of a potential zone of disbenefit followed by a longer zone of benefit. 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.

Take-off noise profile comparison A320 stepped climb with 10 NM level flight (blue dotted line) versus continuous climb (green dotted line).



Source: Airbus, 2012

Figure 32: Take off comparison: stepped climb with 10nm level flight versus continuous climb

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), and controller tools such as iFACTS are already enabling more CCOs in the UK. Further major airspace changes will enable greater implementation of CCOs in future.

4.6.2 Noise Abatement Departure Procedures

ICAO/CAEP commissioned a study[43] 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 in 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.

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 distant 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.

4.7 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.

Examples of predictable noise respite trials currently being explored in the UK include an early morning alternation of no-fly zones for pre-0600 arrivals[44], and varying the point at which aircraft join the runway extended centreline. In the departure phase, work is on-going to explore the feasibility of flying aircraft on the left or right hand side of a Noise Preferential Route and alternating the route daily or weekly.

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

[43] ICAO Circular 317 AT/136, 2008, Effects of PANS-OPS Noise Abatement Departure Procedures on Noise and Gaseous Emissions.
[44] http://www.heathrowairport.com/noise/noise-in-your-area/early-morning-trial

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. As a result, through engagement with local communities, Heathrow Airport, British Airways and NATS have agreed to trial a technique to alternate use of either side of the NPR: flying along one half of the NPR one day, and the other half the next. This would slightly increase the total number of people affected by noise (measured in terms of a noise exposure contour) but would provide more predictable periods of exposure to noise and reduce the impact on those under the centre of the NPR.

As with all noise mitigation, determining whether predictable respite is a suitable mitigation technique needs to be assessed on an airport by airport basis. Consideration of potential noise benefits needs to be weighed against potential dis-benefits on operational and environmental efficiency including fuel burn/CO_2 and NOx emissions.

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[45].

4.8 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.

[45] See Stansted NPR case study in appendix 7, annex F.

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.

4.9 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.

4.9.1 Noise Preferential Routes

There is currently some inconsistency between the definition and application of noise abatement procedures and established Noise Preferential Route (NPR) corridors. This inconsistency is apparent on some individual routes where the noise abatement procedures are inconsistent with the NPR (e.g. Gatwick westerly departures to Clacton and Dover[46]). Further issues 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[47] while aircraft performance characteristics and technologies have progressed.

SA recommends that policy regarding NPRs is updated to take into account the findings of the Future Airspace Strategy industry implementation group (FASIIG) and the SID Taskforce 2 with respect to updating the definitions for NPRs at the regulated airports.

[46] See also Stansted R-NAV Trial Case Study in appendix 7, annex F

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

4.10 Conclusions

There is significant scope to mitigate aircraft noise by adopting appropriate operational procedures. In most cases these improvements can be delivered more rapidly and cost effectively than the equivalent noise reductions derived from airframe and engine technology improvements.

The wider adoption of long-established techniques (such as CDAs, inset thresholds, low power low drag, etc.) along with new uptake of innovative procedures (such as steeper approaches and predictable noise respite) 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.

INDUSTRY COMMITMENT:
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.

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.

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.

A summary of operational improvements discussed in this chapter is given in Appendix 3.

5 Land Use Planning Opportunities

5.1 Key Messages

- Many elements of the ICAO Balanced Approach are already in place at UK Airports or within the UK Planning system
- Loss of national guidance on planning and noise needs to be addressed
    - Opportunity to re-provide guidance in national transport policy statements or 'best practice' guidelines to local authorities
- The industry will actively contribute to improving aircraft noise guidance in local planning policy in order to manage development in areas around airports to restrict the numbers of people affected by aircraft noise
- Opportunity to join up plans and policy covering noise around airports
    - Master Plans, Noise Action Plans, Local Plans, planning conditions and obligations
- Multi-stakeholder approach required with the aviation sector working within the UK planning system

5.2 Introduction

The previous sections of this document 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.

The contribution that can be made through effective Land Use Planning is to seek to protect the areas around airports that are affected by higher levels of aircraft noise from inappropriate noise sensitive development, particularly residential development.

ICAO's Balanced Approach for Noise identifies three categories for land use planning and management. These are:

- **Planning Instruments:** Comprehensive planning, noise zoning, 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 that assist in funding for mitigation and community initiatives

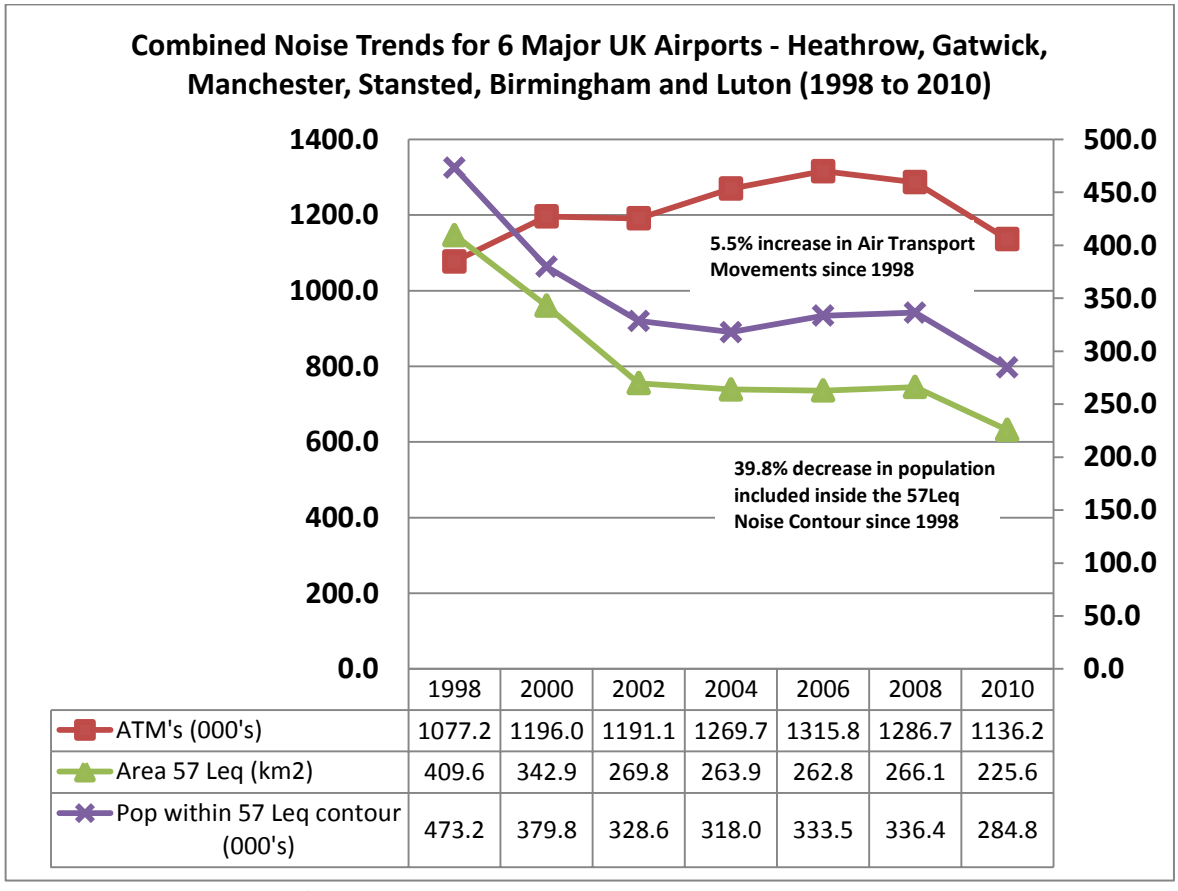
Many measures identified in the ICAO Balanced Approach are in place at UK airports and also through the UK Planning system. This chapter discusses issues relating to planning policy and

development approaches to noise-sensitive development around UK airports, and presents SA's view of how this should be improved.

5.3 Existing Measures and Activities

Significant progress has been made in recent years in reducing aircraft noise levels around the UK's major airports despite an increase in air transport movements.

Figure 33 shows noise trend data at six major UK airports: Heathrow, Gatwick, Manchester, Stansted, Birmingham and Luton, illustrating how combined noise trends have changed between 1998 and 2010. Whilst air transport movements at these six airports have increased by 59,000 over this time, the number of people included within the combined 57 LAeq (16hr) noise contour has dropped by 188,400, or almost 40%.



	1998	2000	2002	2004	2006	2008	2010
ATM's (000's)	1077.2	1196.0	1191.1	1269.7	1315.8	1286.7	1136.2
Area 57 Leq (km2)	409.6	342.9	269.8	263.9	262.8	266.1	225.6
Pop within 57 Leq contour (000's)	473.2	379.8	328.6	318.0	333.5	336.4	284.8

Source: Derived from DEFRA/DfT historic noise contour information and data from Manchester, Birmingham and Luton Airports

Figure 33

This clearly shows that over time the absolute level of noise generated by aircraft operations at these six airports has significantly reduced as a result of the introduction of newer, quieter aircraft and improved operational measures aimed at reducing noise impacts, despite the increase in overall

aircraft movements. While at some smaller airports where there has been a substantial growth in movements, noise contour areas may have increased in an overall UK context these population increases are relatively small.

At most airports, the noise contour areas and the population within them are considerably smaller than they were some ten years ago. For example, the 57 LAeq (16hr) contour at Heathrow was 163.7 sq km in 1998 compared to 108.3 sq km in 2010 and over the same period the population within the contour reduced from 341,000 to 229,000. Population reductions have also been secured within the higher noise contours, for example at Heathrow 15,500 people were estimated to live within the 69 LAeq contour, by 2010 this had reduced to 2,800.

Whilst the overall reductions in contour areas and population have been due mainly to improvements in aircraft engine technology (and the phase-out of ICAO Chapter 2 aircraft) there has also been the introduction of more stringent planning and operational controls on airports to manage the impact of aircraft noise on surrounding communities.

Overall community noise exposure at UK airports is determined by the growth in the number of aircraft movements and the aircraft fleet mix. It is clear that over recent years, noise contours have shrunk and in some areas have resulted in previously noisy areas being released for residential development.

5.4 Population Encroachment

In recent years, where noise contours have shrunk, land has become available for noise sensitive development that previously would not have been permitted. This creates a risk of population encroachment in noise sensitive areas around airports which acts to dilute the noise improvements that have been achieved by the industry.

Figure 34 shows research by the CAA which compared noise contours with both 1991 and 2001 census data for five UK airports. It shows that the numbers of people living in higher noise levels (63-69 LAeq noise contours) close to airports did not reduce between 1991 and 2001 (primarily due to Heathrow). Additionally, the population within the 2001 57-60 LAeq noise contours for the five airports using the 1991 Census data was 163,85, but when the 2001 Census data was applied, the population had increased to 178,719 or by 9%. This table is based on data for 1991 and 2001, and it is therefore recommended that a further analysis is undertaken comparing Census data for 2001 and 2011.

A full breakdown of this data is presented in Appendix 4.

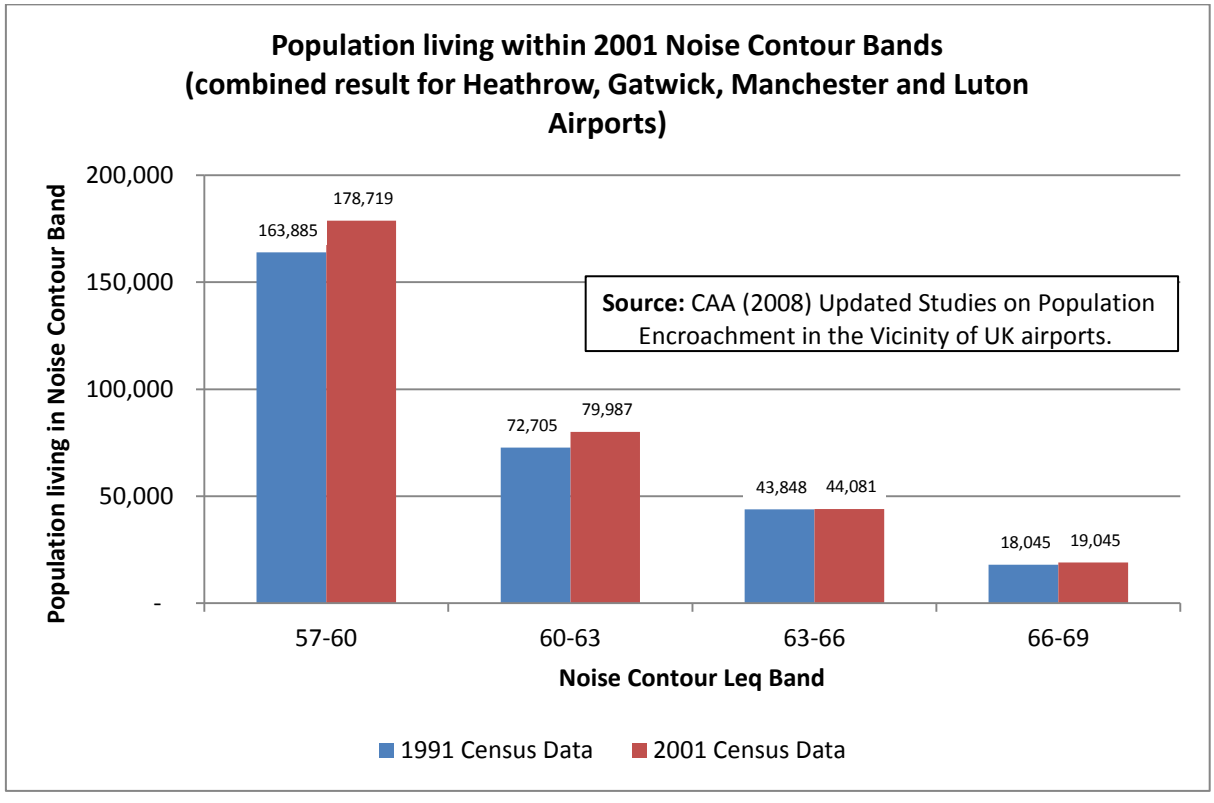


Figure 34

5.5 Planning Conditions and Planning Agreements

Most of the significant controls and operating restrictions are the result of planning consents and Town & Country Planning Act Section 106 Agreements for 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 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
- Ultimate Capacity limits on passenger and aircraft movement numbers
- Restrictions on aircraft engine testing and ground operations

- Building 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. Some UK airports are required to prepare Noise Action Plans under the EU Environmental Noise Directive (2002). The 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.

5.6 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. There are 3,790 eligible properties within the Sound Insulation Grant Scheme at Manchester, 7,600 at Birmingham and 41,000 at Heathrow. 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.

[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.

5.7 Other Measures

A number of other measures are in place at and around UK airport 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 Section 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 Planning Process and Policy

The purpose of the UK planning system is to balance economic development and environmental quality and to contribute to the overall achievement of sustainable development. The three dimensions of sustainable development – economic, social and environmental – are mutually dependent and the planning system plays a key role in seeking joint and simultaneous gains in all three areas.

Planning in the UK is plan-led, the overall approach set in national planning policy (Town and Country Planning Act 1990 and the National Planning Policy Framework 2012). Local planning authorities are responsible for preparing Local Plans that are the statutory starting point for decision-making on development. Planning law requires that applications for planning permission must be determined in accordance with the Development Plan unless there are material considerations that indicate otherwise.

Both national and local level planning policy influence decisions relating to airport development and noise sensitive development around airports, including:

- Environmental Impact Assessment Directive (97/11/EC)
- National Policy – 2003 Future of Air Transport White Paper
- Sustainable Framework for UK Aviation (2012)
- EU Environmental Noise Directive (2002/49/EC) – Noise Action Plans
- Town & Country Planning Act – including Section 106, Town & Country Planning (Scotland) Act 1997
- National Planning Policy Framework – Sustainable Development, Local Plans and Planning Conditions (2012)
- Local Plans – Site Allocations and Local Development Control Policy (currently based on PPG 24)

A more detailed commentary on the UK Planning Policy Framework can be found at Appendix 5. There is a considerable range of UK Planning and Transport Policy that relates to aviation and airport development and how issues of aircraft noise should be addressed. Reducing or consolidating this material would contribute to the overall simplification of the planning system and plan-making.

5.8.1 Local Plans

In preparing local plans, local planning authorities are required to have regard to policies and advice issued by the Secretary of State. This includes the 2003 Air Transport White Paper (now replaced by the Aviation Policy Framework) and other relevant planning policy and guidance, in particular the National Planning Policy Framework.

At the heart of the National Planning Policy Framework is a presumption in favour of sustainable development. For plan-making this means that local planning authorities should actively seek opportunities to meet the development needs of their area and that Local Plans should meet objectively assessed needs, with sufficient flexibility to react to rapid change (unless the impacts exceed the benefits or where specific national policies indicate that development should be restricted).

5.8.2 Land Use Planning Policy Requirements

Applications for planning permission must be determined in accordance with the approved development plan. Development plans should give developers and local communities some certainty about the areas where particular types of development will be acceptable and in respect of issues such as noise, identify areas where particular mitigation measures may be required. It is therefore important that airports contribute constructively to the preparation of Local Plans in the areas surrounding them.

These types of policies would usually be found within the section of the Local Plan that deals with development control matters. In some cases, development around airports, and the development of the airport itself are considered to be strategic issues and therefore may be included among the strategic objectives of a Local Plan.

For example, the North West Leicestershire Core Strategy (June 2012) says: 'Noise-sensitive development, particularly housing, will be resisted where it can be demonstrated that the noise levels associated with the airport [East Midlands] would be detrimental to the occupiers or users of such development.'

Similar policies are in place in Local Plans around most UK airports and their retention and updating is supported.

Area specific noise policies may be useful in certain circumstances, and in these cases the boundaries should be shown on a map that is contained within the Local Plan. Previous advice in PPG 24 suggested that it would be inappropriate to include detailed noise contours, as noise emissions (particularly in the case of aircraft noise), can change over time. In considering development proposals against the Noise Exposure Categories in PPG 24, local authorities traditionally used historic LAeq contours (day and night)' where contours were shrinking, this had

the effect of opening up areas for noise-sensitive development. This has been particularly evident in some areas around Heathrow.

Local plans have a time horizon of some 20 years and to provide a level of certainty to residents and airport operators, forecast noise contours should be prepared and where possible included as a map within the Local Plan. The forecast noise contours would be prepared using accepted methods, consistent with national forecasts, and agreed between the individual airport operator and the surrounding local authorities.

5.8.3 Land Use Planning Conditions

When imposing planning conditions on development, local planning authorities are required to only make conditions that are; necessary, relevant to planning; relevant to the development to be permitted; enforceable; precise; and reasonable. Previous planning guidance included model conditions to mitigate the effect of noise on new noise sensitive development. These conditions were:

'Construction work shall not begin until a scheme for protecting the proposed [noise-sensitive development] from noise from the […] has been submitted to and approved by the local planning authority; all works which form part of the scheme shall be completed before [any part of] the [noise sensitive development] is occupied.'

Local planning authorities should give applicants guidance on the maximum noise levels to be permitted within or around the noise-sensitive development so as to provide precise guidelines for the scheme to be submitted.

'The building envelope shall be constructed so as to provide sound attenuation against external noise not less than [x] dB(A) with windows shut and other means of ventilation provided.'

Lists of model conditions can be of benefit in improving the consistency of decision-making across different local planning authorities and the speed that planning applications are processed. They can however encourage the use of conditions as a matter of routine without a careful consideration of the particular issues associated with the case. Some suggested model planning conditions are included in Appendix 6 and could be incorporated in industry 'best-practice' guidelines.

5.8.4 Planning conditions on airport capacity developments

In determining planning applications, local planning authorities can impose operating restrictions on airport capacity developments. These restrictions can include:

- Limits on the area of a particular noise contour
- Aircraft movement limits
- Night noise restrictions e.g. movement and QC caps
- Operational restrictions

- Mitigation and compensation measures such as Sound Insulation Grant Schemes or Community Funds

These measures can be included in the planning conditions for the development or in agreements made under Section 106 of the Town and Country Planning Act. A number of major UK airports have such agreements in place.

5.9 Conclusions and required measures

- It is important to ensure that the land use planning system prevents the encroachment of noise sensitive development, in particular residential dwellings around UK airports. There have been significant reductions in populations in the areas around airports affected by aircraft noise and it is important to maintain that trend in the future.
- At some airports, Heathrow in particular, some population encroachment has occurred. This has resulted in a greater number of people affected by noise from aircraft operations. It is estimated that at Heathrow, population encroachment into the 57-60 LAeq contour between 1991 and 2001 has increased by some 15%.
- The publication of the National Planning Policy Framework in 2012 provides a clear and much simplified statement on how the planning system is expected to deliver sustainable development, and sets out the requirements for Local Plans and for decision-making on applications for planning permission. There is now a need for step change in land use planning controls. In simplifying planning guidance, previous advice to local authorities on planning and noise (PPG24) has been lost. A consistent national approach to planning and noise is essential in making policy and taking development decisions. This guidance could be provided within a national statement on aviation policy or in a form of industry 'best-practice'.
- 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.

INDUSTRY COMMITMENT:
The industry will actively contribute to improving aircraft noise guidance to 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

Table 13 gives a breakdown of actions the UK aviation industry sees as necessary for a successful resolution to land use planning controls.

Action	Who	When	Outcome
National Policy Guidance in National Aviation Policy or 'Best-Practice' Industry guidelines	DfT / DCLG / SA / AOA	2013	Retains the Noise Exposure Categories and the approach to planning policy and development management set in PPG24
Amend National Planning Policy Framework to provide a cross-reference to National Aviation Policy	DCLG	2013 - 2014	Provides a clear link between the two policy documents
Establish Noise Limits for Noise-Sensitive Development and Prepare Guidance	DEFRA / DCLG	2013	Retains a consistent national approach to noise-sensitive development around UK airports. To be included in National Aviation Policy or Industry 'best-practice'
Prepare Forecast Noise Contours	Airports / CAA	In line with individual airport's Masterplan	To provide details of the future noise climate for local planning policy
Review and update the analysis of population encroachment at major airports using 2011 Census data	CAA / DfT / SA	2014-15	To establish an evidence base on population encroachment within airport noise contours
Include Noise-Sensitive Development Control Policies in Local Plans	Local Planning Authorities / Airports	In line with the requirements in the National Planning Policy Framework	Establish future planning control on noise-sensitive development
Review Noise Action Plans	Airports / DEFRA	To cover the period 2013 - 2018	Set out a locally agreed approach to noise control and management
Review and update Airport Master Plans	Airports	Following publication of national aviation policy, and to be reviewed at 5 year intervals	To provide the evidence base for the development of local planning policy

Table 13: SA Proposed Land Use Planning Stakeholder Action Plan

6 Noise Communication and Community Engagement Opportunities

6.1 Key Messages

The SA Noise Roadmap introduces a new area to the ICAO 'Balanced Approach' which we believe is crucial in seeking to address the number of people affected by aircraft noise.

Over recent years the industry has put significant effort into improving noise abatement techniques, particularly through the technological development of aircraft and operational improvements. However, perceptions of noise by local communities have not always improved in line with these developments. .

The impact of aircraft noise differs between airports and communities so engagement must be tailored to the community; a one-size-fits-all approach is not appropriate. Past communication has often been perceived by local stakeholders and Local Authorities as a one-way flow, particularly on the issue of airport development.

. This section addresses these points in more detail and makes four key recommendations:

- airport operators commit to review their current engagement strategies based on the best practices presented in this Roadmap;
- regular stakeholder sessions are required to ensure that the appropriate representatives are at the table , with clear terms of reference
- airlines, Air Navigation Service Providers (ANSPs) and manufacturers should seek to explore how engagement can be improved, and how best practice can be shared between stakeholders in the future;
- the aviation industry commits to work with Government and other stakeholders to identify and resolve research gaps in:
    - how the variables in the 'Noise Challenge' diagram are weighted; and consult on whether a more accurate model can be developed to predict the number of people annoyed by aircraft noise under various 'what if' scenarios,
    - our understanding of individual reactions to aircraft noise,
    - noise acceptability vs. noise annoyance and
    - a basis for agreeable noise metrics.

6.2 Introduction

The UK's high population density, combined with the tendency for airports to be located near population centres, has resulted in noise impacts continuing to be an important issue for many local residents across the country. The reductions in aircraft noise achieved by the industry do not always translate to reduced levels of annoyance, given the very subjective nature of individual perception of noise. [49] Given the latest 2013 UK Aviation Forecasts from the Department for Transport[50] showing an expected increase in traffic, mitigating noise impact on the wider population will continue to be a primary focus for the aviation industry.

Successful community engagement is critical in addressing noise impacts effectively. 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 suit specific circumstances and issues. This work was last reviewed in detail when major UK airports were asked to develop noise action plans covering a five year period from 2010 to 2015[51]. Currently the success or otherwise of noise communication and community engagement strategies varies from airport to airport. Some are seen by communities and individuals as good, others acceptable and in some cases a 'trust deficit' has arisen where there is not always confidence in the data and information being provided.

Taking this into account, airports, with support from the wider aviation industry are now looking to ensure that appropriate engagement strategies are in place, seeking to improve practices where possible. A one size fits all approach to engagement will not work; instead, site specific solutions are required, sharing best practice successes where applicable.

This section of the Road-Map will review existing community engagement methods along with the barriers and opportunities for improvement. We propose a benchmarked level of community engagement against which major UK airports will review their current strategies, and offer recommendations for improvements.

6.3 Community Engagement and Government Aviation Policy

Following the publication of its Aviation Policy Framework (APF), the Government is now looking to strike a fairer balance between the negative impacts of noise and the economic benefits of aviation.[52] SA believes this approach offers potential for an improved debate on issues of aircraft noise and expects that it will result in more reasoned and evidenced outcomes.

One of the Government's key objectives is to look at '*encouraging the aviation industry and local stakeholders to strengthen and streamline the way in which the two parties work together*'. SA hopes this can be progressed by reflecting on how the current best practice methods of engagement

[49] ICAO, 2010. International Civil Aviation Organisation Environmental Report 2010.
[50] https://www.gov.uk/government/publications/uk-aviation-forecasts-2013
[51] 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
[52] DfT Aviation Policy Framework: https://www.gov.uk/government/publications/aviation-policy-framework

presented in this Road-Map can provide a foundation from which to build better engagement practices in the future.

Following SA's depiction of the 'Noise Challenge' diagram illustrating the range of variables that contribute to an individual becoming annoyed by aircraft noise, we recommend that further independent research is commissioned into community perceptions. It is imperative that any commissioned research is funded across industry parties and all stakeholder groups, to avoid any accusation of bias.

INDUSTRY COMMITMENT:
To work with Government and other stakeholders to identify and resolve research gaps in:

- **how the variables in the 'Noise Challenge' diagram are weighted and consult on whether a more accurate model can be developed to predict the number of people annoyed by aircraft noise under various 'what if' scenarios,**
- **understanding of individual reactions to aircraft noise,**
- **noise acceptability vs. noise annoyance and**
- **a basis for agreeable noise metrics.**

It is also important that any future policy decision making, whether it be through the Airports Commission or another decision making process, ensures that outcomes are based upon a well-informed evidence base from all stakeholders.[53] It is also hoped that the evidence and studies presented in this paper will also count appreciably towards these processes.

6.4 Current Noise Communication and Community Engagement Mechanisms

Over recent years 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. The Government has indicated that responses to the 2011 Scoping Document show there are many examples of good practices at airports across the UK, with the airport operator and the local community working closely together. [54]

The aim is to ensure that UK airports have reviewed their approach to community engagement against the best practice mechanisms detailed in this Road-Map. The Road-Map will then go on to use the best practice highlighted to develop a benchmarked level of engagement across major UK airports.

6.4.1 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 and media such as annual reports, targeted briefings, news bulletins and updates, providing direct access to information on what actions airport operators are taking.

[53] http://pressreleases.dft.gov.uk/Press-Releases/Airports-Commission-membership-68298.aspx

[54] http://assets.dft.gov.uk/consultations/dft-2012-35/draft-aviation-policy-framework.pdf

The introduction of online flight tracking has been a significant step forward in terms of information provision for local communities, enabling people to map the movement of aircraft over their homes at particular times of the day[55]. London Heathrow, London Gatwick and London Stansted all employ some variation of this system which is accessible through their main airport website.[56] Some airports also provide access to noise monitoring and track keeping information, allowing local residents to monitor individual aircraft movements. Feedback from local residents on these systems has been extremely positive.

Appendix 7, Annex A and Annex B contain case studies from Heathrow Airport and Gatwick Airport respectively, outlining their current information reporting mechanisms and channels.

The Civil Aviation Act 2012 introduced provisions granting environmental and consumer publication duties on the CAA in respect to all UK airports. Under these new duties the CAA will have a role in promoting better public information about the environmental effects of aviation, and in producing guidance for the industry with a view to reducing, controlling or mitigating the environmental impacts of aviation. SA agrees that providing better public information on the environment is a positive step, and that the CAA could play an important role in pulling together credible, reliable and comparable data, which can be agreed upon by all parties. However, it is important that these powers are only used where there is a clear demonstrated need, to avoid duplication of information already published elsewhere or loss of site specific information reporting on aircraft noise. SA welcomes the consultation process on the exercising of these new functions.

6.4.2 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.[57]

ACCs and similar groups can play an important role in the chain of engagement between airport and community. ACCs are generally comprised of Local Authority members, local groups of interest and industry users. They meet at least three times a year to discuss significant issues and activities taking place at the airport.[58] They will have some form of constitution with terms of reference.

A consultative committee aims to provide:

- an opportunity for information exchange between 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

[55] The data released through Webtack is delayed by between 24 – 48 hours for security purposes
[56] London Heathrow: http://webtrak.bksv.com/lhr; London Gatwick: http://webtrak.bksv.com/lgw; London Stansted: http://webtrak.bksv.com/stn
[57] http://www.legislation.gov.uk/ukpga/1982/16/section/35?timeline=true
[58] Committees are able to meet less than three times a year if this deemed sufficient

amicably. However, people interested in and affected by an aerodrome operation may have mutually inconsistent viewpoints and it is not to be expected that all matters of concern will be able to be resolved through discussion;

- greater understanding about aerodrome operations more widely, through dissemination of relevant information by committee members; and
- improved understanding by the aerodrome operator of the nature of its impacts on local communities and businesses.

Appendix 7, Annex C (Gatcom Consultative Committee) and Annex D (London City Airport Consultative Committee) provide examples of terms of reference. The following case study also provides an example of the view of the committee from the Heathrow Airport Consultative Committee Advisor.

Case Study: Heathrow Airport Consultative Committee

View from Committee Advisor:

Membership of HACC covers a wide range of stakeholder representatives. From the noise and planning point of view it is particularly well peopled by Local Authority councillors and by representatives of anti-noise groups, such as HACAN and LANC. Commercial interests are represented by IATA, BATA and the London Chamber of Commerce, amongst others. Travellers are represented by ABTA, GTMC and independent, regular, travellers through the airport. This cross section means that there are often clashes of interest, but it does mean that HACC is a good body for the exchange of information and for all parties to become aware of the concerns of others. Outside the meetings, HACC does not have a direct role in engaging with the wider community, but it does oversee the work done by the airport in this respect. HACC is sufficiently well funded by Heathrow Ltd to carry out its role.

SA welcomes the Government's commitment to Airport Consultative Committees playing a more effective role in the current engagement process. They are an invaluable forum for bringing together inputs from a wide range of stakeholders. However, where they exist, there are mixed views among stakeholders about how effective they are currently; issues such as weak proportionate representation, funding and clarity of achieved outcomes and results need to be addressed.

In addition, there is a need for clear transparency of the committees' work, and also for greater awareness of the committees themselves at a local level. Despite many local communities having representation on ACCs through their Local Authority, many residents are unaware of what they do – or even that they exist. SA views this as a key concern that must be addressed by committees in the future.

6.4.3 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.

More recently Noise Action Plans (NAPs) have become a primary vehicle for engagement for airports included in the requirement to produce one.[59] These plans are still evolving but provide a clear basis for engagement on noise issues. However, there continue to be varied views among stakeholders as to how well various outreach programmes currently work, and they require a high level of transparency and trust to be truly effective.

Appendix 7, Annex E (Manchester Airport) Annex F (Stansted Airport) Annex G (Birmingham Airport) all provide good examples of local engagement and outreach programmes currently in force.

6.4.4 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 5 years. The use of an airport operator's master plan by their relevant Local Planning Authority as a material planning consideration is at the discretion of each Authority.

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

Furthermore, AMPs are seen as a move towards a more open and transparent community engagement process allowing for greater certainty about airport development over significant periods of time.

Many airports developing their Master Plans have carried out extensive consultations with their local communities on their vision for the airport during set periods. Those local stakeholders who were aware of the consultation would be encouraged to find out more and participate in more detail. Engagement mechanisms have included public exhibitions, dedicated websites and focused workshops.

Gatwick has recently carried out this type of exercise on its vision for growth to 2020 and how the impacts of that growth could be best mitigated. Ten days of public exhibitions were held in each of the major population centres close to the airport where more than 1800 people stopped to discuss the proposals. In addition, 6000 unique visitors took the time to review Gatwick's proposals on-line. SA views such events as particularly helpful in improving understanding of local residents' views and requirements.

6.4.5 Aircraft Noise Management Advisory Committee

The Aircraft Noise Management Advisory Committee (ANMAC) advises 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 will be available for Ministers and the

[59] Under European Environmental Noise Directive 2002/49 (END)
http://ec.europa.eu/environment/noise/directive.htm

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. The aircraft and aero-engine manufacturers are not explicitly represented, although ADS was able to provide the link, where necessary.

The ANMAC has carried out a great deal of work to identify issues related to aircraft noise, including an authoritative study on arrivals noise in the late 1990s, development of the night restrictions QC scheme, and departure noise monitoring. Its current work plan includes analyses of night noise restrictions, noise envelopes, planning policy (though not strictly part of the ANMAC remit), health effects of noise, and reviews of ICAO noise standards and new noise abatement procedures for aircraft operations.

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.

While the ANMAC does not have a direct community engagement remit, it has a consultative role with industry stakeholders on noise issues at Heathrow, Gatwick and Stansted. Given that the ANMAC outputs can have implications for local communities, aircraft and airport operators, etc. and in order to establish greater transparency in its procedures, SA welcomes the recent decision by ANMAC to make the minutes of their meetings publically available.

6.5 Identified Barriers to Community Engagement

Despite the number of positive community engagement mechanisms previously identified, there are still distinct barriers to engagement which will require further research.

6.5.1 Disjoint in interpretation of impacts

The highest volume of complaints about aircraft noise does not always come from the areas subject to the greatest noise impact. This may be due to differing interpretations of the social, environmental and economic impacts of aviation by each resident and community. 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 living under a flight path.

This complicates engagement and representation on groups such as ACCs. It is up to the airport in question to try to find the right balance of engagement geographically; this may for example look to focus on areas with higher rates of complaint for aircraft noise.

6.5.2 Trust deficit between stakeholders

A breakdown in trust, or trust deficit, between the aviation industry and their stakeholders, particularly local communities is usually the result of one or a combination of the following factors:

- lack of trust in the noise metric or data produced by the industry, based on individual or community views that the data does not reflect their experience
- lack of confidence that an individual's or community concern is being properly considered by the industry
- concern that previous commitments made by the industry have not been honoured

Where relationships have broken down, it is usually as a result of lack of trust. Effective engagement is fundamentally dependent upon local communities believing that information is credible and the engagement process is effective and inclusive; this requires hard work by all parties.

It is worth acknowledging that past difficulties generally stemmed from uncertainties around an airport's potential for future growth. Although there is now greater transparency and trust being developed between stakeholders, this is an area that needs further work.

SA calls on all UK aviation companies to review their current community engagement methods and work with their stakeholders to resolve any trust deficit issues where they exist.

6.5.3 Gaps in channels for communication

There are acknowledged gaps in the channels for local communities to express their views. This may be because people are unaware of what channels are available, or because there is no adequate channel.

Gaps can manifest themselves in various ways. Primarily, local communities can often find it difficult to find out who to contact about their concerns, and what the appropriate forums are for working towards potential solutions. Direct engagement and representation with the airport can often leave both people even more frustrated. An airport must consider the view of its ACC in developing any possible resolution to the issues they may be facing.

Many local communities are unaware of their ACC, its role, or who represents them on it. This situation must change if community concerns are to be appropriately reflected. As ACCs are independent, the onus must be on them to reach out to the communities they represent.

6.5.4 Technical nature of the topic

The technical and complex nature of aircraft noise can lead to a lack of understanding creating tension between stakeholders. SA recognises that there is a need for the industry to simplify the technical issues in order to make discussion more accessible to a wider audience. It is hoped that this Road-Map will help add some clarity in this arena and be used as the basis for more informed decision making.

6.5.5 Interpretation of Government policy

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.

6.6 Opportunities for Improvement

Direct engagement with local residents and local groups needs to be widened beyond the airport operator alone. The wider industry including airlines, manufactures and other stakeholders needs to be more actively involved, to help develop a greater sense of trust in the engagement process.

There is potential for the industry to take a more pro-active approach to community engagement that is trusted by local residents, groups and wider stakeholders alike through:

- 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;
- a targeted outreach programme so that the airport operator is effectively reaching those concerned about aircraft noise issues from the airport;
- ensuring that there is increased governance 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.

There is a clear need to ensure that the social, economic and environmental impacts of aviation are discussed in the round, so that a proper check and balance is in place to examine positives alongside negatives, and to remove emotion as far as possible. . This could also be achieved by ensuring that groups such as ACCs are mandated to discuss such issues in a balanced and fair manner.

6.7 Key learning's 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 efficient 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.

Sustainable Aviation: Benchmark for Constructive Engagement

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

   1.1. maintaining a range of information resources through communication channels that are appropriate for the community;

   1.2. ensuring that communications channels are easily accessible to the local community;

   1.3. operating an open and transparent engagement process with the local community;

   1.4. ensuring that local community concerns are reflected as far as possible in an airport's noise strategy or communication efforts; and

   1.5. ensuring all public consultations are targeted at the relevant stakeholder, are open and transparent, with the final outcomes published through recognised channels.

2. Plan – where an airport operator has identified gaps in its engagement techniques against those best practices presented in this Road-Map, and has deemed it relevant that this technique should be employed; the operator should plan to do so in a suitable timeframe. This may include consulting with relevant stakeholders on whether or not this would add further value.

3. Air Navigation Service Providers, Airlines and Manufacturers to review their role in supporting airport operators in community engagement activities.

SA will work with stakeholders to ensure that over the period of the Road-Map he following will be achieved:

- more positive open forums of discussion established between all stakeholders;
- greater participation across local residents and stakeholders;
- ACCs are directly engaging with their stakeholders and dealing effectively with concerns;
- improved accessibility and information provision for local residents; and
- best practice for community engagement is shared and applied.

It is hoped that the above would be accomplished through:

- ensuring that debates are underpinned by a solid evidence base and trust between stakeholders;
- balanced discussion, ensuring that noise and wider environmental issues are discussed in the round along with social and economic impacts;

- robust projections that local residents can trust and therefore better inform the debate on issues such as increasing capacity.

INDUSTRY COMMITMENTS:

- **promote open and transparent engagement with communities affected by noise, to better understand their concerns and priorities and to establish trust in the engagement process.**
- **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 mechanisms from the Road-Map to local stakeholders through channels such as consultative committees to help airport operators better evaluate their engagement techniques.**

6.8 SA Requests to Government

SA requests the Government sanctions and leads further independent research on:

- community perception of aircraft noise, in particular the issue of noise annoyance vs. noise acceptability.
- 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.

7 Operating Restrictions

7.1 Key Messages

- In line with the ICAO balanced approach, SA considers operational restrictions to be a measure of last resort
- The aviation industry supports the ICAO view that any proposed operating restrictions should not be applicable to aircraft that meet at least the requirements of ICAO Annex 16, vol 1, Chapter 4.
- 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

7.2 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 Balanced Approach which focus on quieter aircraft, quieter operating procedures and land use planning and mitigation.

Within the EU there is clear guidance provided by "Directive 2002/30 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports". An underlying principle of the Directive is that operating restrictions should be considered on a case by case basis. This Directive is currently (Spring 2013) under revision; SA will continue to support the concept of a consistent and structured approach to the potential introduction of operating restrictions.

The current Directive defines an operating restriction as:

- *a noise related action that limits the access to or reduces the optimal capacity use 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, affecting the operation of civil aircraft according to time period*

The Directive also sets out a clear process for implementing operating restrictions and establishes a number of important principles, for example:

- *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.*
- *Measures or a combination of measures taken under this Directive shall not be more restrictive than necessary in order to achieve the environmental objective established for a specific airport. They shall be non-discriminatory on grounds of nationality or identity of air carrier or aircraft manufacturer.*
- *Performance-based 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 Convention on International Civil Aviation, third edition (July 1993).*
- *Operators should be given a reasonable period of advance notice when new operating restrictions are to be introduced*

The Directive also provides for the introduction of restrictions designed to encourage the withdrawal of marginally compliant Chapter 3 aircraft (currently defined as aircraft within 5 EPNdB cumulative of the Chapter limits) providing that all other available measures have been assessed. Where operating restrictions are applied SA will continue to work with the policy makers and regulators to ensure they remain effective.

7.3 Operating Restrictions Currently in place

Although the withdrawal of marginally compliant aircraft has not been implemented at a UK airport to date, a range of other operating restrictions have been implemented. The list below provides a summary of the type of restrictions in place at many Airports:

- Night Movement Limits
- Night Noise Quota Limits
- Annual noise contour area limits
- Annual Movement limits
- Runway use restrictions
- Aircraft type scheduling/operating restrictions
- Ground movement/stand activity/engine testing restrictions

Many airports apply operating restrictions as part of their day to day management of noise. 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 the size and shape of noise contours, or compound delays which result in operations occurring at more sensitive times. Flexibility is therefore important, for example to enable recovery from periods of disruption or to avoid the build-up of delays. Examples include runway alternation at Heathrow, and night restrictions at Gatwick, Heathrow and Stansted.

7.4 Future Restrictions

SA acknowledges that operating restrictions can, under some circumstances, be an effective tool in managing aircraft noise; however, introducing them is generally a protracted process which can be frustrating from both an industry and community perspective. Often a more constructive and effective approach is to seek collaboration between interested stakeholders which can lead to quicker voluntary solutions. SA requests Government to ensure that a voluntary and collaborative approach has been exhausted before considering operating restrictions.

7.5 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 - giving something back to those annoyed by the noise.

The challenge for the aviation industry is to ensure that future growth can be delivered whilst still providing an acceptable level of 'pay back' to local communities for noise disturbance.

SA believes that the tools to achieve this could be improved. A 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. We call on the Government to lead this debate.

7.6 Summary

In summary SA believes that operating restrictions:

- can be an effective tool in aircraft noise management, under some circumstances
- should be used proportionately and in direct response to an established environmental objective
- should only be used after other measures have been pursued in line with ICAO's Balanced Approach,
- should be cost effective and help stimulate growth in a sustainable way
- should be considered and implemented in line with the appropriate EU Directive (currently EU2002/30); and
- should be introduced with reasonable lead times to give the industry time to adapt.

8 The Sustainable Aviation Noise Road-Map

8.1 Key Messages

- SA is committed to developing ways to limit and where possible reduce the number of people adversely affected by aircraft noise.
- SA's work shows that even with a near 2% growth per annum in aircraft movements, we can achieve a reduction in UK noise output through replacement of the current UK fleet with imminent and future aircraft.
- If noise alone drove aircraft and engine design, total UK aviation noise output could decrease by over 40%. The requirement for low fuel burn (for instance Open Rotors), means UK aviation noise impacts will only reduce significantly with the help of operational and land use planning improvements.
- Further noise reductions may be possible through improved operational techniques and land use planning.
- independent research is needed into the variations in individual perception and reaction to aircraft noise.
- 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.
- The aviation industry cannot tackle noise on its own; support and guidance are also required from Government and other stakeholders.

8.2 The Road Map

Figure 36 sets out how the aviation industry believes future growth, as currently forecast by the DfT, can be achieved while reducing UK aviation noise output through the introduction of new aircraft technology.

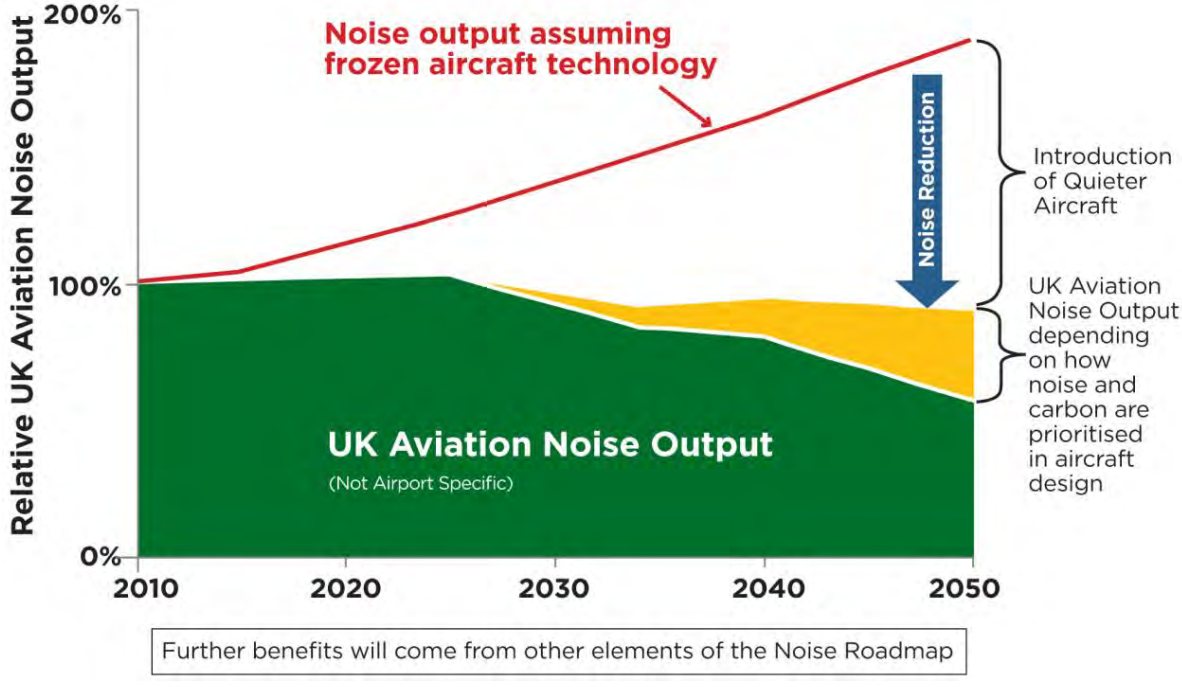


Figure 36: Sustainable Aviation Noise Road-Map

Total UK aviation noise output could be reduced by more than 40% if aircraft and engine designs were largely driven by the requirement for low noise. However, if aircraft and engine designs are dominated by a requirement for low fuel burn (for instance Open Rotors), UK aviation noise output would reduce by less than 10%.

In addition to new quieter aircraft, SA believes further reductions in UK aviation noise impacts are achievable from operational improvements and better land use planning. Figure 36 is not airport specific and cannot be read as the projection of noise output for particular airports. This will depend on the aircraft mix and rates of penetration of newer aircraft at individual airports; noise impacts will also be influenced by geographic factors including topography, population densities and prevailing weather conditions. SA commits to developing airport-specific Noise Road-Maps, in a manner best suited to the stakeholders at the airport in question.

8.3 Discussion

Based on the information presented in this document SA believes that future growth in UK aviation to 2050, as predicted by the 2013 DfT Aviation Forecasts, can be achieved while reducing UK aviation noise output by an average of 20%. The precise nature of this change will vary from airport to airport depending on the traffic mix, rate of introduction of newer aircraft types and other local factors.

How this change may be perceived by local communities will be influenced by a complex set of factors that determines whether or not someone becomes annoyed about aircraft noise. The aviation industry has a varying level of control or influence over these factors.

It is clear that further research into this topic is needed to improve our understanding of trigger factors that lead to people becoming negatively affected by aircraft noise. From this it would then be sensible for further work to be carried out to determine ways to avoid individuals reaching those trigger points. SA and the Aviation Industry are committed to working with others to help progress this work but suggests that the work must be carried out in an independent manner to ensure it produces trusted information for all stakeholders.

Technology can achieve substantial reductions in aircraft and engine noise. To enable this continued support in research and technology programmes will be required.

Operational procedures offer potential to reduce the noise intensity for both arriving and departing aircraft but the precise scale of this improvement will vary depending on where people live compared to the aircraft flight path. To enable these improvements a number of modifications to aircraft and airspace operating procedures will be required as well as some changes to airspace structures across the UK.

Land use planning around airports offers the potential to reduce the people exposed to significant levels of aircraft noise. For this to be achieved there are a number of improvements that are required to the current UK planning processes, perhaps the most important being the re-development of planning guidance to local authorities in regard to aircraft noise.

The issue of noise communication and community engagement between the aviation industry and local communities has a number of ways in which SA believe it can be improved. Whilst this alone will not reduce actual aircraft noise SA believes it will help in managing how people react to aircraft noise events.

Whilst SA acknowledges that operating restrictions may be seen as a preferred tool by Government and local community to manage aircraft noise events, it is the industry's view that they should only be used as a measure of last resort. Instead we call on stakeholders to work with the industry in a more proactive way to improve noise from aircraft operations.

In general SA believes that future success in reducing the number of people affected by aircraft noise requires a collaborative approach, working together to overcome problems. Additionally it is

critical to success that local circumstances around airports are properly accounted for in devising solutions to reduce noise, as perceived by those living near the airport.

Achieving this requires sustained commitment into research to assist both technology development to reduce source noise from aircraft and improved understanding of individuals' reactions to aircraft noise events.

Taking this all into account, it is imperative that all stakeholders see this Road-Map as a first step towards more effective aircraft noise management. Within this there is a critical need for site specific action plans to be developed for UK airport communities.

8.4 Industry Commitments

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

- 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 to achieve the visionary noise goals of Flightpath 2050 and CLEEN.
- The industry will increase the use of existing operational techniques that reduce noise where safe and feasible.
- The industry will collaborate to explore and develop new operational techniques that reduce noise where safe and feasible.
- 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 and to establish trust in the engagement process.
- 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 mechanisms from the Road-Map to local stakeholders through channels such as consultative committees to help airport operators better evaluate their engagement techniques.

- The industry will work with Government and other stakeholders to identify and resolve research gaps in:
    - how the variables in the 'Noise Challenge' diagram are weighted and consult on whether a more accurate model can be developed to predict the number of people annoyed by aircraft noise under various 'what if' scenarios,
    - understanding of individual reactions to aircraft noise,
    - noise acceptability vs. noise annoyance and
    - a basis for better noise metrics.

8.5 Industry Request for Support

8.5.1 Government

SA requests the following support from the UK Government

- support research and development in aerospace technology ensuring the right incentives are in place to enable uptake by the industry,
- work with the aviation industry to clarify relative environmental impacts between reducing noise and CO_2 emissions to enable future aeronautical design priorities.
- strengthen and support local authorities' ability to enforce land use planning controls around airports,
- implement improved airspace structures and operational procedures through the CAA,
- 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.
- 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

8.5.2 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 highlight areas for improvement

9 Implementing the Road-Map

The SA Noise Road-Map provides a template for assessing noise output and offers tools for how this can be managed. SA now calls on UK aviation companies to adopt this Road-Map, seeking to develop clear strategies for addressing aircraft noise. The next step is for individual airports and their stakeholders to interpret this Road-Map for local use, to ensure the full potential can be realised.

The aviation industry will use this Road-Map as a toolkit for developing plans for continued improvement in existing noise management practices, in order to enable sustainable growth. These plans will be on two separate scales:

- **Noise Road-Map Delivery Action Plan –** Developed by SA members to monitor and manage common industry actions.
- **SA Member Specific Action Plan –** Developed by individual airlines and airport sites with their relevant stakeholder groups to incorporate the principles defined in this Road-Map into existing noise strategies such as airport Noise Action Plans.

SA will obtain SA members' signatures to the commitments specified in this Road-Map; and monitor and report progress by SA members through the bi-annual SA Progress Report.

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ICAO		Annex 16
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SA	2012	CO_2 Road-Map
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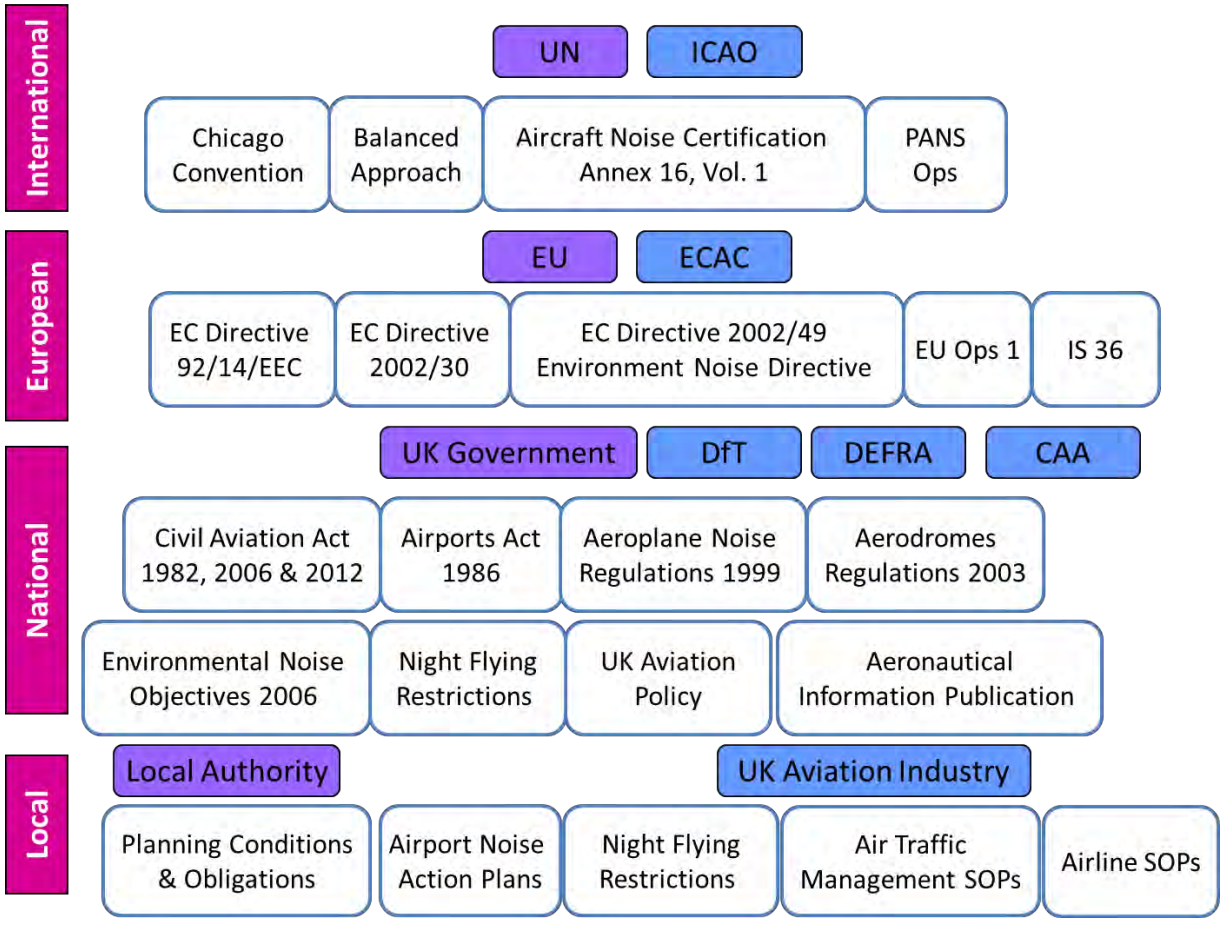
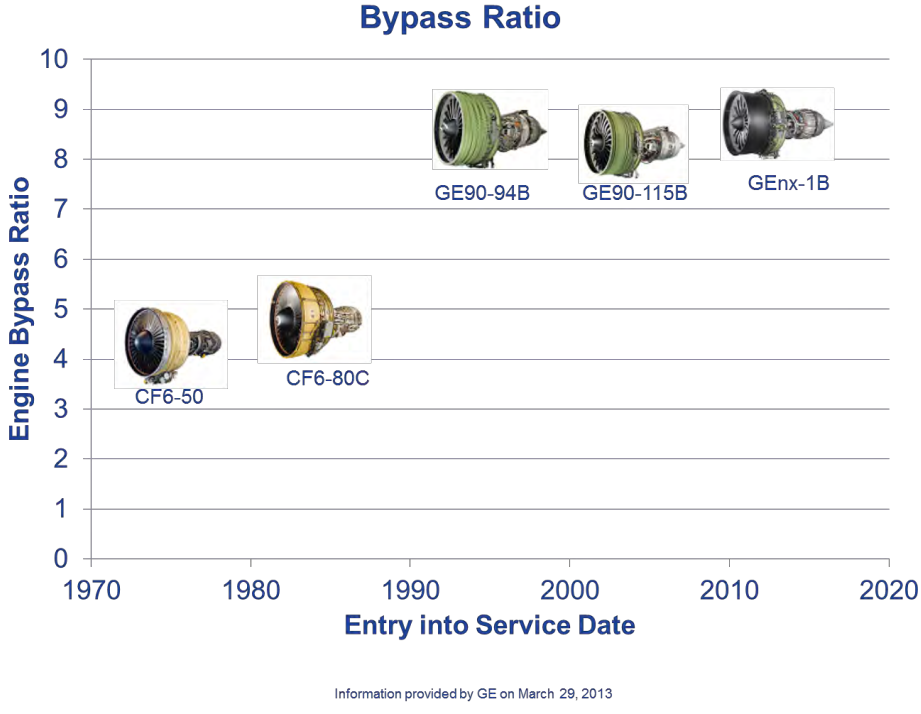
Appendices

Appendix 1: Diagram to show hierarchy of major regulation relating to aircraft noise



Appendix 2: GE Aviation Aircraft Engine Noise Improvements

The charts confirm a similar level of noise improvement in aero-engine design by General Electric Aviation to that shown by Rolls Royce in chapter 3, figure 12.



Information provided by GE on March 29, 2013

Appendix 3: Potential Noise Benefits from Operational Improvements

The following table is intended as a quick guide to potential operational noise mitigation techniques. The noise benefits and regions of effect are offered as rules of thumb only and should not replace case-by-case thorough analysis of potential noise effects of operational changes.

Operational noise mitigation measure	Potential noise benefit where known* (*Not cumulative or comparative as different metrics apply)	Approximate region of noise benefit below flight path
Arrivals		
Continuous Descent Approaches (CDA)	1-5 dBA SEL	25 nm to 9 nm from touchdown
Managed approach speeds (LPLD)	1-3 dBA SEL	20-12 nm from touchdown
Displaced threshold Example 1000m displacement	2-4% Reduction in area of 57 and 72 dBA Leq contours respectively	200m-1000m displacement of noise effect
Slightly steeper approaches – up to 3.2 degrees	0.5-1 dBA SEL	Approx. 25nm to touchdown
Steeper approaches – 3.25 to 4 degrees	1-2 dBA SEL Approx. 0.5 dB reduction per quarter degree increase in final approach angle	Approx. 25nm to touchdown
Delayed deployment of landing gear	Up to 2 dBA SEL	6-4 nm from touchdown
Reduced landing flap	Up to 1dBA SEL	4nm to touchdown
Departures		
Continuous climbs enabled where airspace and traffic conditions allow	2-8 dB (LAmax) zone of theoretical dis-benefit followed by 2-8 dBA (LAmax) zone of benefit	Approx. 10-20nm from take-off
NADP 1 or NADP 2	Up to 5dAB noise difference between the two techniques	Close-in benefit 0-11 nm from take-off. Distant benefit 5-15nm from take-off.

Appendix 4: Population around UK airports 1991 vs. 2001

Based on CAA data prepared for ICAO CAEP meeting (December 2008)

Airport	2001 Leq Contour	Population Using 1991 Census Data	Population Using 2001 Census Data	Population Change	% Change
Heathrow	66-69	15,627	17,238	1,611	10.31%
Gatwick	66-69	378	242	- 136	-35.98%
Manchester	66-69	1,604	1,350	- 254	-15.84%
Birmingham	66-69	430	215	- 215	-50.00%
Luton	66-69	6	-	- 6	-100.00%
COMBINED	**66-69**	**18,045**	**19,045**	**1,000**	**5.54%**

Airport	2001 Leq Contour	Population Using 1991 Census Data	Population Using 2001 Census Data	Population Change	% Change
Heathrow	63-66	35,166	36,738	1,572	4.47%
Gatwick	63-66	571	533	- 38	-6.65%
Manchester	63-66	4,868	4,149	- 719	-14.77%
Birmingham	63-66	3,196	2,621	- 575	-17.99%
Luton	63-66	47	40	- 7	-14.89%
COMBINED	**63-66**	**43,848**	**44,081**	**233**	**0.53%**

Airport	2001 Leq Contour	Population Using 1991 Census Data	Population Using 2001 Census Data	Population Change	% Change
Heathrow	60-63	47,856	53,463	5,607	11.72%
Gatwick	60-63	875	882	7	0.80%
Manchester	60-63	16,317	17,992	1,675	10.27%
Birmingham	60-63	6,686	6,922	236	3.53%
Luton	60-63	971	728	- 243	-25.03%
COMBINED	**60-63**	**72,705**	**79,987**	**7,282**	**10.02%**

Airport	2001 Leq Contour	Population Using 1991 Census Data	Population Using 2001 Census Data	Population Change	% Change
Heathrow	57-60	123,326	141,370	18,044	14.63%
Gatwick	57-60	3,399	3,716	317	9.33%
Manchester	57-60	21,466	19,213	- 2,253	-10.50%
Birmingham	57-60	14,645	13,065	- 1,580	-10.79%
Luton	57-60	1,049	1,355	306	29.17%
COMBINED	**57-60**	**163,885**	**178,719**	**14,834**	**9.05%**

SUMMARY

Airport	57-60 Leq	60-63 Leq	63-66 Leq	66-69 Leq
	Percentage Change in Population Numbers (2001 Census vs 1991 Census)			
Heathrow	14.63%	11.72%	4.47%	10.31%
Gatwick	9.33%	0.80%	-6.65%	-35.98%
Manchester	-10.50%	10.27%	-14.77%	-15.84%
Birmingham	-10.79%	3.53%	-17.99%	-50.00%
Luton	29.17%	-25.03%	-14.89%	-100.00%
COMBINED	9.05%	10.02%	0.53%	5.54%

Combined Airports	2001 Leq Contour	Population Using 1991 Census Data	Population Using 2001 Census Data	Population Change	% Change
Combined	57-60	163,885	178,719	14,834	9.05%
Combined	60-63	72,705	79,987	7,282	10.02%
Combined	63-66	43,848	44,081	233	0.53%
Combined	66-69	18,045	19,045	1,000	5.54%
Total	**57-60**	**298,483**	**321,832**	**23,349**	**7.82%**

Source: CAA (2008) Updated Studies on Population Encroachment in the Vicinity of UK airports.
Delivered to ICAO CAEP Working Group 2 - Operations, Task Group 1 - Land Use Planning Fifth Meeting, Montreal, 1-3 December 2008

Appendix 5: UK Planning Policy

The National Planning Policy Framework (2012)

A significant change was made to UK planning legislation through the publication of the National Planning Policy Framework in March 2012. It sets out the Government's planning polices for England and how these are expected to be applied. The National Planning Policy Framework also revoked a considerable amount of planning policy guidance that had been prepared over many years. It set out a principle that the Government's requirements for the UK planning system should be relevant, proportionate and necessary. It aims to provide a framework within which local people and their local councils can produce their own local and neighbourhood plans that reflect the needs and the priorities of their own communities. The National Planning Policy Framework must be taken into account in the preparation of local and neighbourhood plans, and is a material consideration in making planning decisions.

The National Planning Policy Framework recognises that Local Plans are key to the delivery of sustainable development. They should reflect local circumstances but should also be consistent with the principles and the policies within the National Planning Policy Framework. It is also clear that local planning authorities should seek opportunities to achieve each of the economic, social and environmental dimensions that make up sustainable development. Local Plans should:

- Plan positively for the development of infrastructure required in the area and meet the principles set in the National Planning Policy Framework
- Be drawn up over an appropriate time-scale (preferably 15 years), take account of longer-term requirements and be kept up to date
- Be based on co-operation with other local authorities, and public voluntary and private-sector organisations
- Indicate broad locations for development and land-use designations on a proposals map
- Allocate and identify development sites, but also identify areas where development would be inappropriate, for instance due to its environmental or historic significance

Local Plans are examined by an independent inspector who examines whether the Plan has been prepared in accordance with the National Planning Policy Framework and whether it is considered to be sound. The test of soundness includes that it has been positively prepared; justified; effective; and consistent with national policy.

The National Planning Policy Framework sets out the requirements for decision-making on planning applications. As planning law requires that planning applications must be determined in accordance with the development plan (Planning and Compulsory Purchase Act 2004). In considering applications for planning permission local authorities can consider whether unacceptable development can be made acceptable through the use of planning conditions or planning obligations (Section 106 Agreements or unilateral undertakings). These obligations need to be necessary to

make the development acceptable in planning terms; be directly related to the development and be fairly and reasonably related to the development. Planning conditions should only be imposed where they are necessary, relevant, enforceable, precise and reasonable.

The National Planning Policy Framework does not provide detailed guidance on the approach to be taken in relation to noise (in particular transportation noise). It does require that Local Plans should take account of the growth or ports and airports and the relevant national policy statement (The Sustainable Aviation Policy Framework). In respect of development and noise, The National Planning Policy Framework also requires that planning policies and planning decisions should aim to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development
- Mitigate and reduce to a minimum other adverse impacts on heath and quality of life arising from noise from new development, including through the use of conditions
- Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restriction put on them because of changes in nearby land uses since they were established
- Identify and protect area of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason

The 2012 National Planning Policy Framework has significantly reduced the quantity of planning policy and planning guidance and put on a greater emphasis on planning at a local and at a neighbourhood level. This has simplified the planning system and sets out planning as a collective enterprise. This has been generally welcomed although there have however been consequences with the revocation of detailed planning guidance relating to planning and noise sensitive development, including transportation noise. (Planning Policy Guidance Note 24)

The Future of Air Transport White Paper (2003)

The Air Transport White Paper set out a strategic framework for the development of UK airport capacity over a period of some 30 years. It identified a range of capacity development options and it was intended to inform and guide the consideration of planning applications for major airport capacity schemes. It provided a long-term national strategic framework against which the UK aviation industry and planning authorities could use to plan ahead and to give greater certainty to those living close to airports and their flight paths. The Air Transport White Paper also recognised that airport can have significant impacts on people living nearby and it included proposals to reduce, limit environmental impacts, including the effects of aircraft noise.

In relation to noise, the Air Transport White Paper required that local controls should operate and that noise impacts be limited and where possible, reduced over time. It also set out land-use planning and management measures around airports, including avoiding new housing development in areas exposed to high levels of noise. It also endorsed the ICAO Agreement on a balanced approach to the control of noise at airports (2001). In relation to land use planning this sought to

ensure that inappropriate development is discouraged or prohibited around major airports and suggested an update of Planning Policy Guidance Note 24 (Planning and Noise).

The Air Transport White Paper also set out a range of noise mitigation measures. These included an expectation that airport operators would:

- Offer households subject to high levels of noise (69 LAeq or more) assistance with the costs of relocating
- Offer acoustic insulation to residential properties and other noise sensitive buildings exposed to noise levels of 63 LAeq or more
- Address the impacts of major future developments through the introduction of property purchase schemes in areas subject to a high level of noise (>69 LAeq) or an increase of 3dB or more
- Prepare Noise Action Plans in line with the EU Directive 2002/49/EC
- Maintain a Masterplan detailing future development proposals including surface access developments, environmental controls and mitigation

The majority of UK airports have implemented the requirements of the 2003 Air Transport White Paper and the overall approach to noise control and mitigation are supported and in place. The Air Transport White Paper is recognised by Government now to be 'fundamentally out of date'. Although it is current national policy, it will be replaced by the UK Aviation Policy Framework in 2013. The overall approach to airport noise mitigation set out in 2003 White Paper should be retained, and developed where appropriate.

DfT Draft Aviation Policy Framework (2012)

The Draft Policy Framework aims to support the growth of the aviation sector which maintains a balance between the benefits of aviation and its costs, especially climate change and noise. It is expected that a final Aviation Policy Framework will be published in 2013. This will then replace the 2003 White Paper.

In relation to aircraft noise and land use planning the Draft Policy Framework recognises that noise continues to be a key concern for communities living around UK airports but that significant progress has been made in reducing the number of people affected by noise, particularly around Heathrow and Gatwick. The Draft Framework again recognised the ICAO Balanced Approach and that land use planning and management is one of four measures in the balanced approach to reduce populations affected by aircraft noise. It makes clear that local planning authorities have a responsibility to ensure that this element of the balanced approach is implemented in the context of their Local Plan policies.

The scoping document for Draft Policy Framework identified the concept of noise envelopes with the aim to limit the number of people affected by aircraft noise and to provide future certainty. No detailed proposals on noise envelopes are set in the Draft Policy, however restrictions on noise

contour areas at the UK's major airports are already in place. These include a planning condition on the T5 development at Heathrow that the 57 LAeq contour should not exceed 145 sq km from 2015 onwards. These agreements have been developed at a local level and to suit local circumstances.

Over 30 UK airports have prepared Masterplans since the 2003 White Paper, and the Draft Policy Framework recommends that they are retained and updated at least once every five years.

The Draft Policy Framework recognises that planning has a role to play in controlling the numbers of people affected by aircraft noise and a number of measures from the 2003 White Paper are retained. There is a need for a closer connection between the National Planning Policy Framework and the emerging aviation policy. The National Planning Policy Framework makes no reference to specific noise exposure levels used in planning policy and decisions on planning applications. There is an opportunity for Noise Exposure Categories to be retained and included as part of the national aviation policy.

Planning Policy Guidance – PPG24 Planning & Noise, Circular 1/2011 (Scotland)

Planning Policy Guidance Note 24 (PPG 24) gave local planning authorities guidance on how the UK planning process can reduce the effects of noise. PPG24 set out the issues that local planning authorities should take into account when considering planning applications for developments that could be affected by noise and developments that could generate noise. It also introduced noise exposure categories for residential development that recommended appropriate levels for noise exposure and advised on the use of planning conditions to minimise the impact of noise.

Existing planning policy, as set out in local authority's development plans generally follows the approach that is set out in PPG 24 – Planning and Noise. PPG 24 establishes noise exposure categories against which noise sensitive development can be considered. These are:

- NEC A - <57LAeq (daytime) and <48 LAeq (night) – Noise need not be a determining factor in granting planning permission
- NEC B – 57 – 66 LAeq (daytime) and 48 – 57 LAeq (night) – Noise should be taken into account when determining planning applications and where appropriate, conditions imposed to ensure an adequate level of protection against noise
- NEC C – 66 – 72LAeq (daytime) and 57 – 66 LAeq (night) – Planning permission should not normally be granted. Where it is considered that permission should be given, for example because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise
- NEC D - >72 LAeq (daytime and >66 LAeq (night) – Planning permission should normally be refused

PPG 24 includes guidance to local planning authorities on drafting planning policy and on drafting appropriate planning conditions. It provided a consistent approach to development control around UK airports.

PPG 24 was cancelled by the National Planning Policy Framework in March 2012 as part of the Government's process to simplify the UK planning system. Whilst it is recognised that planning policy had become so elaborate and complex, some elements of national planning policy were lost and not recreated in the National Planning Policy Framework. The replacement of this planning guidance would ensure a continued and consistent approach to local planning policy and development management around UK airports. This could be provided within a future National Aviation Policy Framework. An amended set of Noise Exposure Categories along with a proposed model Local Plan policy is included in Appendix 6.

Airport Masterplans

The 2003 Air Transport White Paper included an expectation that airport operators prepare long term Masterplans to show how the national policy can be applied at an individual airport level. To ensure that the Masterplans are kept up to date, operators were encouraged to review them every five years. Although Masterplans are not part of the statutory planning framework, they are widely used as part of an evidence base to feed into the development plans prepared by local planning authorities. The approach on Masterplans has been reiterated in the 2012 Draft Aviation Policy.

Airport Masterplans include forecasts of aviation growth, future capacity requirements and long-term land requirements. They also set out an airport's approach to how that growth can be managed over the period of the plan. Masterplans therefore include a range of environmental policy (including aircraft noise management) and measures and initiatives to encourage the increased use of public transport as a mode of airport access.

The airport's approach to noise management is usually included in the Masterplan setting out a range of noise control policies. A number of airports also include forecast noise contours within the Masterplan.

EU Environmental Noise Directive (2002/49/EC)

There are two main aims of the Environmental Noise Directive. These are to:

- Define a common approach to avoiding, preventing or reducing the harmful effects (including annoyance) of exposure to environmental noise. EU Member States are required to carry out noise mapping to determine the levels of exposure and the populations affected; provide information to the public; and adopt Action Plans that aim to prevent or reduce noise where the levels can have harmful effects on human health and maintain noise levels in quieter areas.
- Noise Action Plans should provide a basis for developing measures to reduce noise from major sources including road vehicles, trains, aircraft outdoor equipment, industry and mobile machinery.

The Environmental Noise (England) Regulations 2006 & the Environmental Noise (Scotland) Regulations 2006

These regulations put in place the requirements to meet the EU Environmental Noise Directive and establish the airport operator as the 'competent authority' for responsible for preparing noise maps (the Secretary of State for Transport is responsible for noise mapping at the three designated

London airports). Along with noise maps, the Regulations require the preparation of a Noise Action Plan and that the Action Plan should:

- Cover areas around the relevant airport that fall within the 55 dB(A) Lden contour or the 50 dB(A) Lnight contour
- Seek to include measures to manage noise levels and effects, and where necessary reducing noise levels
- Aim to protect quiet area against an increase in noise

An airport must produce a noise map if it handles more than 50,000 air transport movements a year or it is near an agglomeration (a population greater than 250,000 people) where aviation activity causes noise greater than 55 dB(A) Lden or 50 dB(A) Lnight. The major airports included in the first round of noise mapping I 2007 were; Birmingham, Blackpool, Bournemouth, Bristol, Leeds Bradford, Liverpool, London City, Gatwick, Heathrow, Luton, Stansted, Manchester, Newcastle, East Midlands, Southampton and Southend.

The Noise Action Plan process for agglomerations places a reliance on PPG 24 to deliver safeguards and protection against increasing populations affected by noise. The consistent national approach has been lost following the publication of the National Planning Policy Framework and the withdrawal of Planning Policy Guidance Notes.

The Noise Action Plan for individual airports could include land-use planning led restrictions and policies that could feed and be incorporated into the Local Plan for the area. Generally Noise Action Plans are not linked to an airport's Masterplan but there are benefits in ensuring a consistency of approach and timing and potentially the linking of the two processes.

Appendix 6: Draft Text for Model Noise Policy and Supporting Text

POLICY AN1 - AIRCRAFT NOISE

Applications for noise sensitive development or redevelopment on sites likely to be affected by aircraft noise will be determined in relation to the latest accepted prediction of existing and foreseeable ground measurement of aircraft noise. Applications for noise sensitive development will be determined in accordance with the following noise exposure categories:

- **NEC A <57 LAeq - Aircraft noise will not be a determining factor**
- **NEC B 57-66 LAeq - Aircraft noise will be taken into account in determining applications for planning permission, and where appropriate conditions will be imposed to ensure an adequate level of protection against noise**
- **NEC C 66-72 LAeq - Planning permission will not be granted except where the site lies within the confines of an existing substantially built-up area. Where residential development is exceptionally granted, conditions will be imposed to ensure an adequate level of protection against noise**
- **NEC D >72 - Residential or other noise-sensitive development will not be permitted**

Policy AN1 seeks to limit the effect of aircraft noise on sensitive developments such as housing, schools and hospitals, by restricting locations where such development may be sited. Previous planning guidance (PPG24) (now superseded) introduced the concept of Noise Exposure Categories (NEC's) in respect of residential development and encouraged their use in the control of noise-sensitive development. The four NEC's range from circumstances where noise need not be a determining factor, to those where noise levels are such that permission should be refused. The guidance also indicated that in exercising planning control, regard should be paid not only to existing noise contours, but also any increase that may reasonably be expected in the foreseeable future. The establishment of these categories resulted from extensive noise research and as a result remain valid when considering applications for planning permission in the vicinity of 'X' Airport.

For the purposes of Policy AN1, noise-sensitive development / redevelopment includes schools, hospitals and any other use the function or enjoyment of which could, in the opinion of the Council, be materially and adversely affected by noise.

The provisions of Policy AN1 will not apply to applications for planning permission relating to minor extensions to existing houses provided:

- Permission for the construction of the house itself was not granted subject to the provisions of this Policy; or
- The extension is not intended to form a separate unit of living accommodation

The latest accepted prediction of existing ground noise measurement of aircraft noise will be the noise contours provided by 'X' Airport and confirmed by the Council's Environmental Health Department. The foreseeable predictions of aircraft noise are contained in the 'X' Airport Master Plan, published in 20XX, and covers the period up to 20XX.

'X' = Airport Name

Appendix 7: Community Engagement Case Studies

Annex A: Case Study: Heathrow Airport

Heathrow Airport Limited (HAL) has over recent years taken further steps to take local community concerns into consideration through their engagement plan. The operator has now introduced a dedicated website for aircraft noise amongst other mechanisms of engagement (http://www.heathrowairport.com/noise) as a transparent way of communicating with its local residents.

The website allows local residents to read briefing documents on how aircraft noise is created, its effects and how it is measured. The site also contains a series of factsheets relating to aircraft noise from specific operations. These documents have been produced to simplify the somewhat complex nature of noise pollution in a form that is accessible to local residents. Furthermore, there is also an online facility for local resident to log complaints and enquiries.

A flight tracking system what allows people to see and track flights using the airport has also been incorporated into this site. This tool records the aircraft type, flight number, speed and altitude they are flying, providing local communities with further information and insight into noise impacts.

Furthermore, HAL employs a number of communication channels communicating directly with local residents:

- Online noise complaints submission system;
- Post/email/telephone channels;
- Social media including Twitter and Facebook;
- RSS news feed; and
- Community meetings.

Every two years HAL completes a stakeholder engagement exercise to benchmark the airports performance against other leading airports and assess where improvements could be made.

Annex B: Case Study: Gatwick Airport

Gatwick Airport has completely reviewed the way in which it informs and engages with local communities around noise. Gatwick has a dedicated website (www.gatwickairport.com/noise) outlining the way in which airport related noise arises, and providing means to record any particular concerns the community has. The site is maintained by a dedicated team that sits within the airport's broad corporate affairs and sustainability Department. Historically, noise information was dealt within the technically-orientated Airfield operations area. By bringing the experts together with the communications professionals, Gatwick have ensured that the information it provides is meaningful and relevant to concerned residents.

Website users are also able to see specifically where around the airport noise can be concentrated, so that in taking a decision to move home, they have a ready source of information to inform their decision. They can also use a flight tracking tool which shows the flight-path that each arrival and departure from Gatwick followed on arrival and departure and the noise impact that each individual flight has it passes by an element of Gatwick's noise monitor network. This is complemented by a tool, unique to UK airports, that allows users to see the altitudes that all aircraft are following. On-line information and engagement is complemented by a dedicated free-phone line and regular programme of 'town hall' meetings with local residents that the airport co-ordinates.

These channels are complemented by the Noise and Track Monitoring Advisory Group (NATMAG), a dedicated group of Local Authority representatives, which receives briefing on the latest data collected by the airports seven mobile monitoring stations, and also determines where the community believe those monitors should be located.

Annex C: Case Study: GATCOM

Gatwick Airport Consultative Committee (GATCOM) membership is comprised of a number of Local Authorities given the location of Gatwick Airport. For some the broad membership and representation ensures that good and well-rounded debates are able to take place. The Committee works to try to balance the both the benefits and dis-benefits of the airport.

Members including the following:

- Local Authorities (East Sussex County Council; Surrey County Council; West Sussex County Council; Crawley Borough Council; Mid Sussex District Council; Reigate and Banstead Borough Council; Horley Town Council; Kent County Council; Horsham District Council; Mole Valley District Council; Tandridge District Council; Charlwood Parish Council; Burstow Parish Council; Rusper Parish Council)
- Association of British Travel Agents (ABTA)
- British Air Transport Association
- Gatwick Diamond Business
- South London Business
- International Air Carriers Association
- London Chamber of Commerce and Industry
- Environment and Amenity Groups
- Trades Union Congress Southern and Eastern Regional Council
- Coat to Capital Local Economic Partnership
- Gatwick Airline Operators Committee
- Tourism South-East

The committee has developed clear terms of reference for the basis of its meeting which take place including:

1. To stimulate local interest in the airport.
2. To foster communication and build understanding between the airport and its users, local residents and the business community.
3. To consider and comment upon the impacts of the airport's administration, operation and development in relation to:
    - The environment
    - Surface access issues associated with the airport
    - Employment
    - The local, regional and national economy
    - The circumstances of local communities and their residents.
4. To work with the airport in the preparation of a sustainable development strategy to accommodate the future growth of the airport and to promote that strategy across all airport communities.

Full Terms of Reference are available at http://www.ukaccs.info/gatwick/constitution.htm
However, it is thought that more could be done to establish the committees responsibly amongst local communities as a forum for any issues they may have in relation to the airport.

Annex D: Case Study: London City Airport Consultative Committee

London City Airport Consultative Committee has been highlighted as a consultative committee which is particularly effective in ensuring balanced outcomes are reached through proportionate representation. The Committee meets quarterly and members of the Committee include: Local Authorities and Public Bodies, Airport Operator and airport users, local community residents and numerous observers ensuring a well-rounded representation of views.

Terms of Reference

- To monitor the environmental impact of all aspects of the operation of the Airport and to advise on operating procedures resulting from such monitoring with a view to minimising noise or other pollution from whatever source;
- To monitor the implementation of the provisions of this Agreement and advise from time to time on the need for any revision thereof;
- To agree with the Airport formal procedures for recording complaints about aircraft noise and other adverse effects of the Airport. Such procedures should provide for complaints to be made to the Airport by telephone or in writing, for the complainant to provide his/her name, address and telephone number and information in sufficient detail to enable any necessary investigation of the complaint to be carried out. The Airport shall take such steps as it may agree with the Committee to ensure that the complaints procedure is fully and widely publicised. The Airport shall keep a record of all such complaints which shall should be made available to the Committee;
- To consider any matter that the Airport might raise with the Committee as well as issues arising directly or indirectly from the operation of the Airport; and
- Generally to keep all interested parties adequately informed of matters affecting them and to provide an opportunity for reconciling any differences of view that may arise and for resolving difficulties through agreed voluntary action.

Again despite its range of representation and comprehensive terms of reference, it is thought that more could be done to establish the ACCs presence in the local community.

Annex E: Case Study: Manchester Airport

Manchester Airport Group (MAG) has developed a significant work stream on community relations over the past 12 years with a high degree of success. This had been adopted to see through the introduction of a second runway, investment in car parking adjacent to the site and considerable night works with major community disruption. Through this MAG has developed a diverse range of engagement tools with a wide number of stakeholders, and external parties affected to create atmosphere openness and inclusion that ensures community views are taken into account

The work plan has included:

- Establishing a regular and published outreach programme in 2000 with regular meetings in high impact communities surround the airport and a travelling road show;
- Postcard correspondence to local residents as an alert system;
- A page on the web site with bulletin data;
- a range of data sheets available as printed copy, web copy and as film clips showing behind the scenes and with interviews from pilots, runway staff and ATC;
- Quarterly e newsletter also available on line which has a distribution within 10 miles of the airport;
- Annual reporting with a wide circulation to local residents and on line copy;
- Annual impact studies with key stakeholders to inform action plans (overall rating and results are published on Manchester Airport's website);
- An excellent collaborative relationship with the Consultative Committee where the participants are engaged in changes and offered regular training alongside meetings;
- Regular parish council meetings with over 120 elected representatives meeting twice per year;
- A diverse CSR strategy that is embedded in the local community delivering directly relevant programmes that benefit local people; and
- A Community Trust Fund funded by the airport and environmental fines benefiting those affected by aircraft noise.

MAG is continually striving to update and take account of new technology and engagement methods which has resulted in successful outcomes during this period. During this time complaints have significantly reduced to less than 1000 per year and the community impact rating score has also improved.

Annex F: Case Study: Stansted Airport

Over recent years the airport has continued to work with the airlines and also the local communities around the airport to both investigate and demonstrate the benefits of P-RNAV routings. In 2008, the Malaysian low-cost long-haul operator, Air Asia X, began flying from Stansted to Kuala Lumpur using A340-300 aircraft. These airframes were significantly larger and generally nosier than the A319 and B737-800 aircraft that are operated by easyJet and Ryanair respectively and the departures predominantly followed the 22 Clacton NPR. This route took the aircraft close to two villages, Hatfield Heath and Hatfield Broad Oak. Due to time zone differences between the UK and Malaysia, the aircraft were scheduled to depart from Stansted between 2300 and 0000hrs local time.

This change to the noise patterns experienced by the local residents under the departure route led to a significant increase in complaints to the airport and resulted in a meeting being arranged in Hatfield Heath in September 2009 which involved the local MP. In this meeting, the airport working with community representatives through the noise and track keeping working group, proposed a series of steps they would take to try and find ways of reducing the noise nuisance for the affected communities. One of these steps was to set up a P-RNAV trial on the Clacton-22 NPR to see if aircraft could be directed between (rather than over) the two villages.

Figure 1: P-NAV trial on the Clacton 22 NPR. Circles indicate the new waypoints, the mauve swathe the extent of the existing NPR.

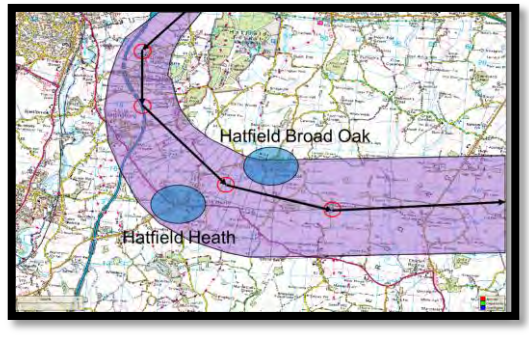
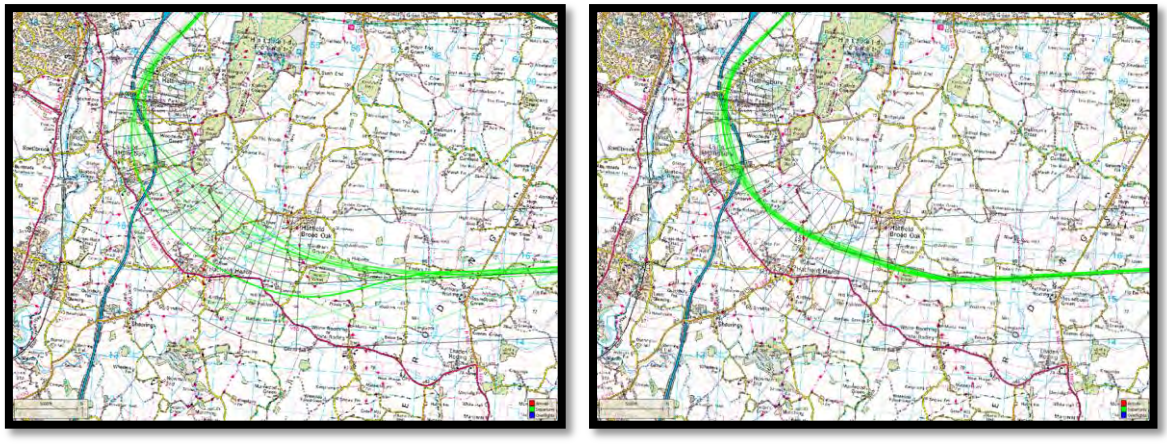


Figure 2 (Left): Track of Air Asia X flights before the P-RNAV trial (December 2009).

Figure 3 (Right): Track of Air Asia X flights following the introduction of P-RNAV waypoints (July 2010)



In November 2011, the CAA agreed to explore the possibility of a formal trial based on a Radius-to-Fix (R-T-F) design on the Clacton-22 and Dover-04 NPRs. At the time of writing, a number of flight safety assessments are being undertaken on flight simulators. If these are successful, it is hoped a formal trial will start in the autumn of 2012 with a view to having the new information published in the UK AIP (Aeronautical Information Publication). This case highlights the importance of engaging not only airline partners, air traffic control providers and local communities in a collaborative dialogue but also the CAA.

Annex G: Birmingham Airport - Community Engagement Case Study

For Birmingham Airport noise continues to be the greatest environmental concern for nearby communities. Despite the airports relative noise impact, it has developed a strong community engagement programme and has built good relationships with its local communities.

Community complaints are not only logged and investigated, the resulting information is actively analysed. Detailed complaint analysis allows the Birmingham Airport to identify trends, better understand community concerns and thereby develop practical measures that where possible, mitigate noise and reduce concerns.

Analysis of the complaints shows an increase in complaints during 2003, the year the 'Future of Air Transport' White Paper was published, recommending a second runway at Birmingham. Complaints peaked again in 2005, when Birmingham's Draft Master Plan was published, which included plans for a second runway. In response a number of proactive schemes have been implemented to strengthen the relationship with the local community and there has been a resulting reduction in complaints during 2009 which is at least in part, to some of these measures, including our Community Outreach programme and Community Impact Alert System.

Some of the key features of this proactive approach to community relations include:

• Always taking care to ensure that all communications are clear, professional, open and transparent.

• The development of a positive working relationship with the Airport Consultative Committee, and the Environmental Monitoring Working Group.

• The education of key members of local communities so that they gain a thorough understanding of our policies, procedures and our Aircraft Noise and Operations Monitoring System (ANOMS) enabling them to communicate this information to their local communities on our behalf.

• The implementation of a Community Alert System, which provides key community contacts with details of any planned unusual activity which may affect their area. Those notified are then able to spread the message in their community. This promotes trust in the Airport's commitment to providing an open, transparent and informative service. Notifications are sent by SMS, email, by telephone or in writing, as appropriate to the situation and available timescale.

• A scheduled Community Outreach programme, where representatives from the Environment and Community teams run drop-in sessions in local communities to answer any questions and concerns residents may have

• The creation of a file for Google Earth which shows key environmental information such as typical flight tracks, the boundary of our sound insulation scheme, or the location of engine ground running activity. This allows individuals to gain a better understanding of how Airport activities could impact on their specific area. It is particularly useful for people looking to relocate close to the Airport.

• Conducting a number of noise studies using our portable noise monitor. Birmingham Airport will respond to requests for noise studies and after collecting data a full noise report is generated and its finding presented to the community.

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