Civil Aviation Authority
Environmental Research and Consultancy Department

Noise Analysis: Stansted

Revision D issued: 25 September 2013

Revision C issued: 24 September 2013

Revision B issued: 30 August 2013

Revision A issued: 18 July 2013

Original issued: 21 June 2013

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Summary

This document presents the methodology, results and analysis relating to aircraft noise exposure contours calculated for the proposed enlarged Stansted airport site. The analysis was undertaken of the proposed five-runway airport operating at approximately 1.2 million aircraft movements per annum to support 180 million Hub passengers per annum giving a total of 208 passengers per annum in 2050.

It was found that 37,800 people would be exposed to noise levels of >55 dB L_{den}, 8,000 to >50 dB L_{night} and 12,000 to >57 dB $L_{Aeq,16h}$.

Account has been taken of the Davies Commission's sift criteria detailed in Guidance Document 02. A glossary of technical terms is provided in Appendix A.

ERCD has undertaken this objective analysis work and provided completely impartial advice to accurately inform the Airports Commission. The work should not be interpreted as support for a particular proposal.

Policy context

Noise metrics

The L_{den} metric is the European Union (EU) policy indicator, whereby people exposed to 55 dB or more are considered to be affected by noise. It is one of the two principal noise metrics assessed under the Environmental Noise Directive, the other being the L_{night} metric. This is usually reported down to a level of 50 dB.

The Aviation Policy Framework (APF) states that the Government 'will continue to treat the 57dB $L_{Aeq,16h}$ noise contour as the average level of daytime aircraft noise marking the approximate onset of significant community annoyance'. It also recognises that 'this does not mean that all people within this contour will experience significant adverse effects from aircraft noise', 'nor does it mean that no-one outside of this contour will consider themselves annoyed by aircraft noise'.

The analysis below considers the results of the noise calculations principally in terms of 55 dB L_{den}, 50 dB L_{night} and 57 dB $L_{Aeq,16h}$.

Policy objectives

Consideration has been given to the Government's noise policy objectives. The APF states the Government's aim 'to limit and where possible reduce the number of people in the UK significantly affected by aircraft noise'.

The Noise Policy Statement for England (NPSE) also presents the Government's vision to 'promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development'.

The NPSE forms a basis for the National Planning Policy Framework (NPPF) which sets out the following aims of planning policies and decisions relating to noise:

- 'avoid noise from (the new development) 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 health 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 restrictions put on them because of changes in nearby land uses since they were established; and
- identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.'

Noise modelling

The noise assessment is based on noise contours which were calculated with the UK Civil Aircraft Noise Contour model ANCON (version 2.3). The ANCON model is developed and maintained by ERCD on behalf of the DfT and is also used for the production of annual and forecast contours for Heathrow, Gatwick and Stansted airports, and a number of regional airports in the UK.

ANCON is fully compliant with the latest European guidance on noise modelling, ECAC.CEAC Doc 29 (3rd edition), published in December 2005[1]. This guidance document represents internationally agreed best practice as implemented in modern aircraft noise models.

Information on runway and route geometry was provided by Atkins in a CAD format. This geometry reflected the proposed enlarged airport masterplan and was transposed directly into the ANCON model.

Atkins provided average and busy day movement numbers by hour of the day, runway and route (which embodied the runway modal splits for each metric), and proportions of aircraft movements by ICAO Airport Reference Code (ARC). Additionally, the DfT unconstrained 2050 forecast was also received via Atkins. The fleet mix used for the modelling was calculated by allocating an ARC to each aircraft type in the DfT forecast, establishing the DfT fleet mix for each ARC, and applying these ARC-specific fleet mixes to the proportions of aircraft movements by ARC provided by Atkins. The 24-hour average day movements (total of 3,167 movements) by aircraft type are presented in Appendix B. Of these, 303 were allocated to the night period.

Imminent and future next generation aircraft types were allocated to movements according to the DfT forecast within the process described above. Estimated noise performance for these aircraft types was developed based on available manufacturer's data and current industry knowledge. The process and rationale used for this is summarised in Appendix C.

Existing aircraft were modelled using the ANCON noise database for operations at Heathrow Airport. This database is reviewed and updated annually and reflects the operational noise performance of each aircraft type at Heathrow.

Noise exposure contours were submitted as CAD files to Atkins.

Results, airport impacts

The noise exposure contours listed below were calculated:

- L_{den} metric calculated for the annual average daily movements forecast for the year 2050 over the 24-hour period. Contours from 55 to 75 dB were plotted in 5 dB steps.

[1] European Civil Aviation Conference. Report on Standard Method of Computing Noise Contours around Civil Airports ECAC.CEAC Doc 29, 3rd edition, Volumes 1 & 2, December 2005

- L_{night} metric calculated for the annual average daily movements forecast for the year 2050 over the night period between 23:00 and 07:00. Contours from 50 to 70 dB were plotted in 5 dB steps.
- $L_{Aeq,16h}$ metric was calculated for the busy summer day movements forecast for the year 2050 over the 16-hour daytime period between 07:00 and 23;00. Contours from 54 to 72 dB were plotted in 3 dB steps.

These contours are presented in **Figures 1 – 3**, which were prepared by Atkins. The areas of the contours were calculated, along with estimates of the population and number of households exposed, based on CACI 2012 population data for the UK. These results are presented in **Tables 1 – 3**. Population and household data has not been adjusted to reflect any future changes, however, the population and number of households within the proposed enlarged airport site boundary have been removed from these estimates.

Table 1: Noise exposure contour information, L_{den}

Contour, dB	Area, km^2	Population	Households
>55	306.5	37,800	16,200
>60	135.2	9,200	3,900
>65	46.9	3,800	1,700
>70	15.1	100	<50
>75	5.6	<50	<50

Table 2: Noise exposure contour information, L_{night}

Contour, dB	Area, km^2	Population	Households
>50	117.2	8,000	3,300
>55	51.2	3,800	1,700
>60	17.4	<50	<50
>65	5.6	<50	<50
>70	2.2	<50	<50

Table 3: Noise exposure contour information, $L_{Aeq,16h}$

Contour, dB	Area, km^2	Population	Households
>54	292.5	32,600	13,900
>57	169.9	12,000	5,100
>60	88.3	7,600	3,300
>63	43.8	1,500	700
>66	22.7	100	<50
>69	12	100	<50
>72	6.7	<50	<50

L_{den}

Due to the site of the proposed enlarged airport, the L_{den} contours generally fall in sparsely populated areas. The 55 dB contour encloses Sawbridgeworth and also encroaches on the east of Bishop's Stortford, the north of Harlow and the east of Great Dunmow. Takeley is located close to the proposed enlarged site boundary and lies almost entirely within the 65 dB contour. A number of other small towns also lie within the contours.

L_{night}

The night time operations are limited to the centre two runways, which reduces the extent of the noise contours in the directions perpendicular to the runway centrelines. The use of the centre runways means that, compared to current airport operations, the night time movements and resulting noise contours are shifted to the north east. As a result, Bishop's Stortford, Sawbridgeworth, Harlow, Thaxted and Great Dunmow all lie outside the 50 dB L_{night} contour. Due to its proximity to the site, Takeley lies within the 55 dB L_{night} contour. The populations exposed to night noise are smaller than those within the L_{den} contours.

$L_{Aeq,16h}$

The area enclosed by the 57 dB $L_{Aeq,16h}$ noise contour is slightly more than half of that enclosed by the 55 dB L_{den} contour, and the population exposed is significantly lower as a result. The 57 dB $L_{Aeq,16h}$ contour has less encroachment into Bishop's Stortford, Sawbridgeworth and Great Dunmow than the 55 dB L_{den} contour. Harlow is located outside the 57 dB $L_{Aeq,16h}$ contour.

55 dB L_{den} ranking

The L_{den} metric was first used in the UK for mapping of airports in 2006. In total, 20 airports were mapped using the L_{den} metric. **Table 4** shows how the proposal would rank amongst those 20 airports, based on population exposed above 55 dB L_{den}, as a way of comparing it with airport noise exposure today.

The 2006 assessments do not include the technological improvements assumed in the assessment of the proposal in 2050 which would tend to reduce the contour areas. However, they also do not include any allowance for growth from 2006 traffic levels which would tend to increase the contour areas.

Table 4: Population ranking (on 55 dB L_{den} population) of proposal in 2050 against 2006 L_{den} noise mapping

Rank	Airport	Movements in 2006[2]	Population exposed to L_{den} level				
			>55	>60	>65	>70	>75
1	Heathrow	477,000	756,150	194,600	54,250	9,650	750
2	Manchester	230,000	92,950	30,650	3,950	700	50
3	Glasgow	110,000	56,750	11,650	400	<50	<50
4	Birmingham	119,000	48,400	15,300	2,200	<50	<50
5	**Stansted proposal**	**1,156,000**	**37,800**	**9,200**	**3,850**	**50**	**<50**
6	London City	79,000	19,100	3,650	<50	<50	<50
7	Aberdeen	117,000	13,750	2,700	100	<50	<50
8	Gatwick	263,000	12,500	3,300	600	150	<50
9	Edinburgh	127,000	11,750	2,900	450	<50	<50
10	Southampton	56,000	11,550	1,850	100	<50	<50
11	East Midlands	89,000	11,050	2,550	700	<50	<50
12	Stansted	207,000	9,750	1,950	300	<50	<50
13	Luton	116,000	8,600	2,100	100	<50	<50
14	Leeds Bradford	67,000	8,200	1,150	<50	<50	<50
15	Newcastle	82,000	6,000	1,550	<50	<50	<50
16	Bristol	85,000	5,400	1,050	50	<50	<50
17	Liverpool	91,000	5,200	2,000	100	<50	<50
18	Southend	39,000	4,250	300	50	<50	<50
19	Bournemouth	76,000	3,400	200	<50	<50	<50
20	Coventry	62,000	3,250	600	50	<50	<50
21	Blackpool	66,000	600	350	<50	<50	<50

This shows that the aviation noise impact of the proposal is between that of London City and Birmingham in 2006, based on the population exposed to 55 dB L_{den}.

The proposal would increase the population exposed to aviation noise near Stansted significantly (approaching four times) compared to the existing airport.

[2] Data from CAA UK Airport Statistics: 2006 – annual, except for *Stansted proposal* which is based on movement numbers provided by Atkins. Figures presented to the nearest 1,000 aircraft movements.

However, the location of the proposal is a sparsely populated area and so exposes relatively few people to aviation noise when taking into account its envisaged capacity. It therefore meets the first objective from the NPPF, ‘to avoid noise from (the new development) giving rise to significant adverse impacts on health and quality of life as a result of new development’.

Annoyance and sleep disturbance

In 2007, Miedema presented an overview of a number of exposure-response relationships that can be used for assessing the impact of environmental noise. These included relationships between L_{den} and annoyance, and between L_{night} and self-reported sleep disturbance.

Applying these relationships to the populations within the modelled contours for L_{den} and L_{night} (to the nearest decibel), the corresponding number of people who would be highly annoyed and highly sleep-disturbed under this proposal has been calculated. Using dose-response relationships like these is an effective way of weighting the impacts at different exposure levels in order to give a single value of the impact as a result of the noise exposure. These results are presented in **Table 5**.

Table 5: Annoyance and sleep disturbance

Population highly annoyed	Population highly sleep-disturbed
5,700	800

It should be emphasised that the annoyance and sleep-disturbance relationships represent long-term habituated responses. Were an airport to be developed at this location, responses would initially be expected to be higher than those estimated in Table 5 and to fall back towards those values over a number of years.

How the proposal may alter current and predicted patterns of aviation noise in the surrounding area

As this proposal envisages the expansion of an existing airport, aircraft noise is already experienced by local communities. However, the proposal would lead to an increase in the number of flights (approximately an order of magnitude) compared to current levels at Stansted airport. As a major hub airport, it would also be expected that there would be a greater proportion of larger, long-haul aircraft in the traffic mix. Therefore, people living in areas underneath the proposed flight paths would experience a significant change in their noise environment.

Possible changes to noise profiles at other airports as a result of the proposal

For the proposal to operate as intended, as an international hub, it is likely that there would be a need for current hub activity at Heathrow Airport to cease. This would result in highly populated areas to the west of London near Heathrow experiencing significant reductions in aircraft noise.

Additionally, there would be corresponding reductions in the numbers of operations passing over central London and other populated areas further out from the city centre. Such areas are not enclosed by Heathrow Airport's noise contours, but some may still be exposed to noise from aircraft using Heathrow, but at lower levels. As acknowledged in the APF, people living in these areas may consider themselves annoyed by aircraft noise.

Referring to Table 4, the proposal would cause an estimated 37,800 people to become significantly affected by aircraft noise (an increase of 28,050 compared to 2006 levels). However, in the extreme case of Heathrow closing, this could be offset by relieving some 756,000 people in West London of the aircraft noise they are currently significantly affected by (note the second round of noise mapping presents an estimate for 2011 of 766,100 people[3]). This would be in line with the Government's objective to limit and where possible reduce the number of people in the UK significantly affected by aircraft noise.

Measures to limit or reduce the number of people affected by noise

The ICAO Balanced Approach provides a framework of measures which could be used to limit or reduce the number of people affected by noise:

Reduction of noise at source

This is largely taken into account in the modelling of quieter next generation aircraft types. There is potential to use the likely prestige of a new UK hub airport to apply pressure on aircraft manufacturers and airlines to incentivise resolution of any specific noise issues associated with individual next generation aircraft types or variants.

[3] ERCD Report 1204, Strategic Noise Maps for Heathrow Airport 2011, Table A4.

Land use planning and management

There is significant risk that such a major infrastructure development would lead to major population growth in the vicinity. Intervention with the planning system would be needed in order to ensure that residential developments built to serve the airport are not located in areas most affected by noise. Criteria for the compatible development of such land should be established, and compliance achieved through enacting legislation, establishing guidance or through other appropriate means. Preference should be given to locating residential developments in zones that are side-line or away from departure and arrival routes as far as is possible. This would help to meet the Government policies which aim to minimise the population affected by aircraft noise.

For existing dwellings which would become exposed to significant levels of noise, noise mitigation could be provided, either part or fully funded, by the airport for these properties. Such mitigation would typically comprise the provision of acoustic glazing and ventilators, and acoustic loft treatment. In some cases, voluntary relocation support packages could be offered.

Noise abatement operational procedures

Noise abatement procedures are a comparatively low-cost means to enable noise from aircraft operations to be reduced, though some measures can lead to increased NO_x and CO_2 emissions. Local air quality is not likely to be a critical factor at this location so there may be greater opportunity to trade-off noise reductions against increased NO_x emissions. Such methods include noise preferential routes and runways, and noise abatement take-off, approach and landing procedures.

Operating restrictions

Again, these are taken into account in the modelling of a future fleet. Where appropriate, and so long as significant adverse economic implications can be avoided, older and noisier aircraft may be banned from operating at the airport. This has the potential to ensure that fleet of aircraft using the airport are kept up to date, and broadly speaking, the quietest practicable within reasonable limits.

Noise related charging and other penalties and/or incentives (financial or otherwise) could also be put in place to influence the behaviour of operators to reduce the noise impact of their operations.

Noise impact on tranquil areas

The effect of noise from the proposal on tranquil areas in the vicinity of the site is addressed in the Landscape and Visual Impact Appraisal Technical Note. This identifies that the extent of the noise contours, and the potential to adversely affect the tranquillity, includes a number of open spaces and residential areas, but overall covers an area of medium to low tranquillity. It concludes that the overall magnitude in relation to the airport boundary is therefore considered to be medium, due to the extension of an existing airport character balanced with the loss to key landscape components across a generally medium to low tranquil area.

FIGURE 1

Noise exposure contours, L_{den}

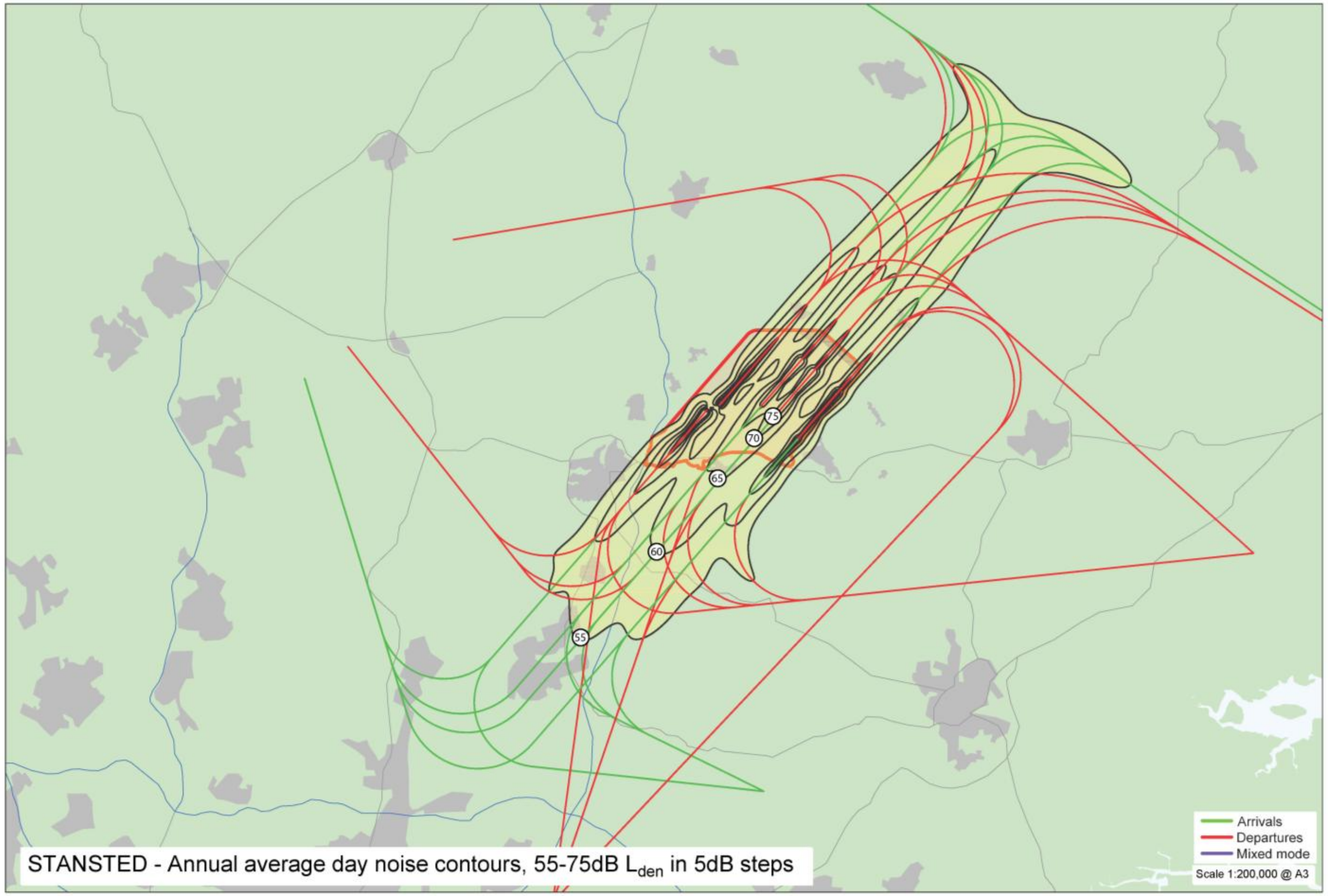

Figure prepared by Atkins

FIGURE 2

Noise exposure contours, L_{night}

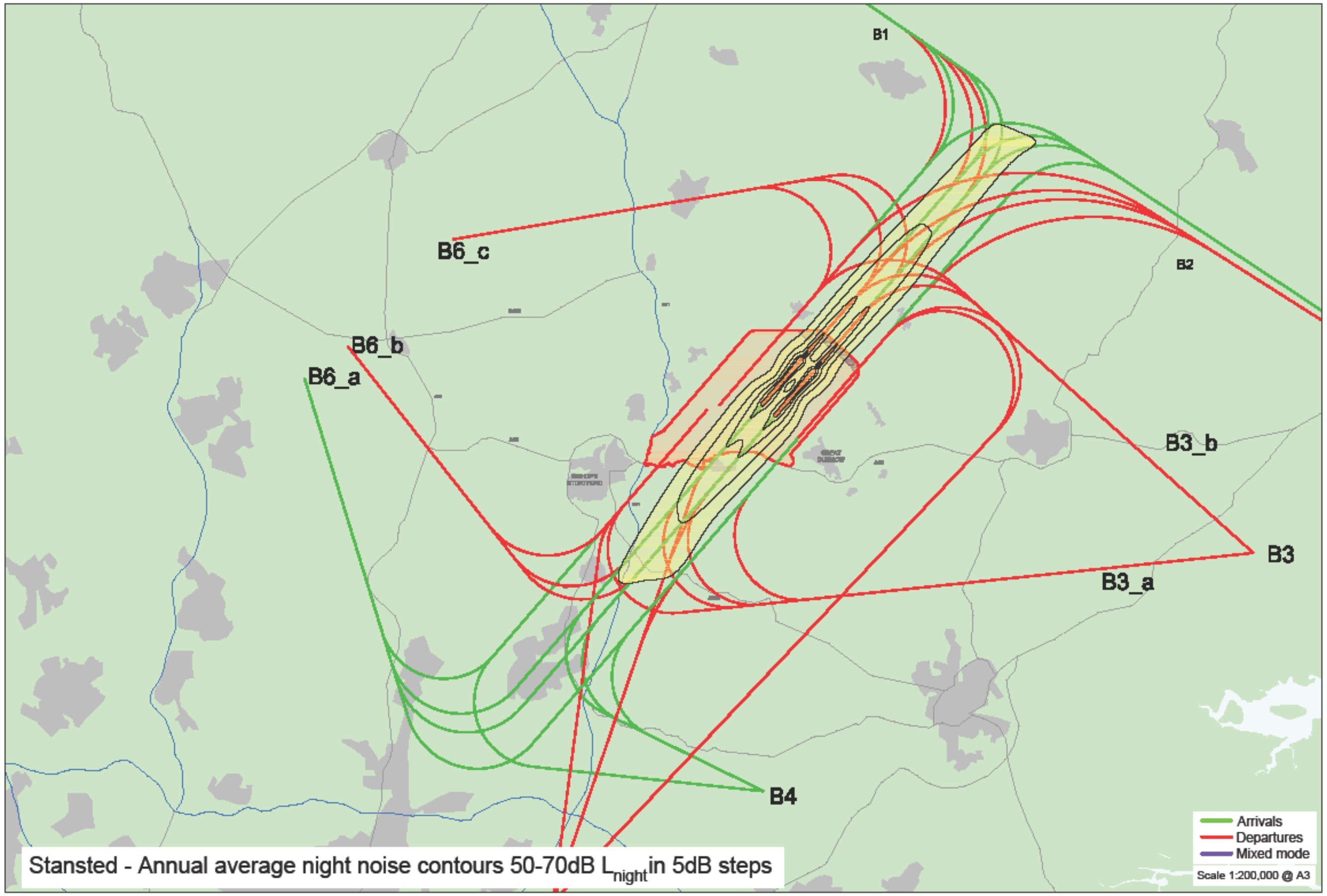

Figure prepared by Atkins

FIGURE 3

Noise exposure contours, $L_{Aeq,16h}$

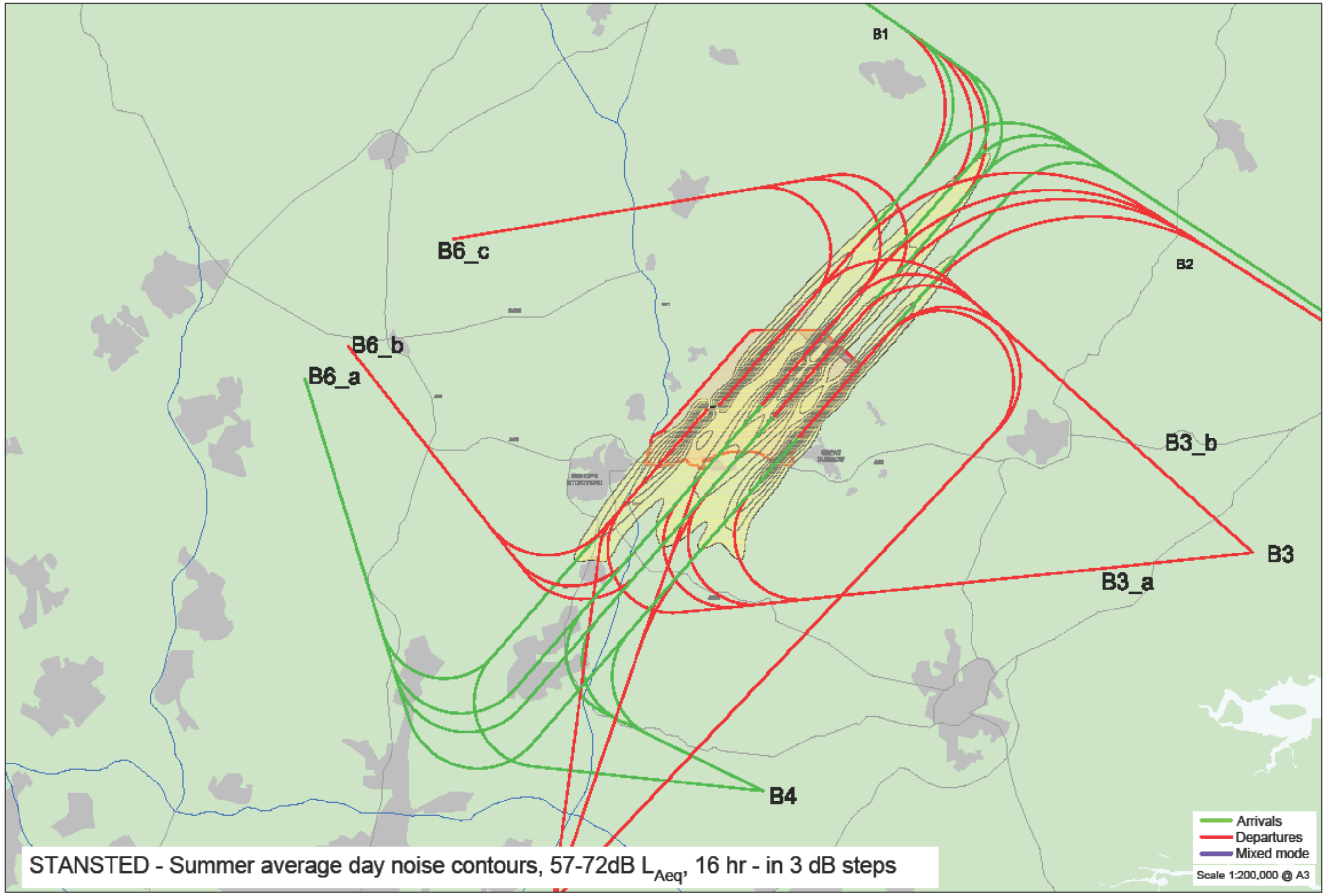

Figure prepared by Atkins

APPENDIX A

Glossary of Technical Terms

ANCON	The UK civil aircraft noise contour model, developed and maintained by ERCD.
APF	Aviation Policy Framework.
CAD	Computer Aided Design.
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.
DfT	Department for Transport (UK Government).
ECAC	European Civil Aviation Conference.
ERCD	Environmental Research and Consultancy Department of the Civil Aviation Authority.
EU	European Union.
$L_{Aeq,16h}$	Equivalent sound level of aircraft noise in dBA, often called ‘equivalent continuous sound level’. For conventional historical contours this is 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.
L_{day}	Equivalent sound level of aircraft noise in dBA for the 12-hour annual average day (0700-1900 local time) period.
L_{den}	Equivalent sound level of aircraft noise in dBA for the 24-hour annual average period with 5 dB weightings for $L_{evening}$ and 10 dB weightings for L_{night}.
$L_{evening}$	Equivalent sound level of aircraft noise in dBA for the 4-hour annual average evening (1900-2300 local time) period.
L_{night}	Equivalent sound level of aircraft noise in dBA for the 8-hour annual average night (2300-0700 local time) period.
NPPF	National Planning Policy Framework.
NPSE	Noise Policy Statement for England.

APPENDIX B

24-hour Movement Data

Ancon Type	24h Ops
B7377MAX	77.5
B7377N2	29.3
B7378MAX	172.9
B7378N2	257.8
B7379MAX	152.3
B7379N2	257.8
B748	6.4
B748N2	187.3
B773G	1.2
B7810	37.2
B7810N2	85.1
B788	30.6
B788N2	78.5
B789	30.6
B789N2	78.5
EA319N2	67.8
EA319NEO	47.5
EA320N2	296.3
EA320NEO	153.9
EA321N2	296.3
EA321NEO	141.3
EA358	31.0
EA358N2	78.9
EA359	29.8
EA359N2	77.7
EA389	13.7
EA389NEO	4.1

EA38NEO	4.1
ERJ170N2	67.8
ERJ170NEO	69.1
ERJ190N2	67.8
ERJ190NEO	70.3
EXE3	58.1
LTT	108.4

APPENDIX C

Future Aircraft Types for Forecasting

Introduction

The requirement to forecast aircraft noise exposure to 2050 necessitates the definition of future aircraft types and their associated noise characteristics.

Historical trends clearly show that each generation of aircraft are quieter than their predecessor, significantly so in some cases. This is a reflection of the introduction of new technologies, of which some are aimed purely at reducing aircraft noise, whilst others are, for example, aimed at reducing fuel burn.

This changing of noise performance over time necessitates the need to take into account how the aircraft fleet will change.

Methodology

For each future aeroplane type, an explicit ‘surrogate’ has been chosen; a similar aircraft type whose certificated noise levels are known. For a given future type, the noise model data for this surrogate aircraft are then adjusted based on the differences between the future type’s predicted certification data and the surrogate aircraft’s known data.

The same approach has been used as in previous assessments such as the noise study undertaken in support of the Department for Transport’s (DfT) Consultation: Adding Capacity at Heathrow Airport, which formed part of the Project for the Sustainable Development of Heathrow (PSDH)[4].

Future aircraft types

The assumptions on the noise characteristics of the future aircraft types presented in this assessment are based on the latest available data. They update the assumptions used in the previous ERCD studies and are aligned to the guidance in The SA Noise Road-Map[5]. There are two categories of future aircraft:

[4] ERCD Report 0705, Revised Future Aircraft Noise Exposure Estimates for Heathrow Airport, November 2007. www.caa.co.uk/ERCDreport0705

[5] The SA Noise Road-Map, A Blueprint for Managing Noise from Aviation Sources to 2050. 2013, Sustainable Aviation.

- *Imminent* aircraft types incorporating Generation 1 technology with significant fuel burn and noise benefits. These have recently entered, or are currently offered for sale to the market, and include all-new aircraft as well as re-engined aircraft.
- *Future* aircraft types incorporating Generation 2 technology, which aim to achieve the noise goals set out in Flightpath 2050[6]. These types are envisaged to eventually replace the Imminent Generation 1 aircraft.

In the former case, the noise characteristics are well-defined. In the latter case, the assumptions are based on expected technological advances and underlying trends as well as the entry into service (EIS) date of the Generation 2 aircraft type relative to Generation 1 predecessors.

Use has been made of the Sustainable Aviation assumption of a 0.1 dB/year baseline rate of improvement from the Generation 1 introduction dates (assuming no technology step-changes or major configurational changes).

Descriptions of the basic characteristics of the Imminent (Generation 1) and Future (Generation 2) types are given in The SA Noise Road-Map. **Tables C1 and C2** below identify the new types, presenting the surrogate types and corresponding adjustments used to model them. These relate to the Ancon Types listed in Appendix B.

[6] Flightpath 2050, Europe's Vision for Aviation. 2011, European Commission.

Table C1: Generation 1 *Imminent* aircraft types and modelling assumptions

Aircraft category	Aircraft type	New ANCON model	ANCON model surrogate	Adjustment, dB	
				Departure	Arrival
Airbus single-aisle	A319 NEO	EA319NEO	A319V	-2.6	-1.9
Airbus single-aisle	A320 NEO	EA320NEO	A320V	-2.6	-2.2
Airbus single-aisle	A321 NEO	EA321NEO	A321V	-2.7	-1.0
Airbus twin-aisle	A350-800	EA358	EA33	-4.1	0.1
Airbus twin-aisle	A350-900	EA359	EA33	-4.2	0.4
Airbus twin-aisle	A350-1000	EA3510	EA33	-1.8	1.6
Airbus very large	A380-900	EA389	EA38	0.0	0.0
Boeing single-aisle	B737-700 MAX	B7377MAX	B736	-3.5	-1.0
Boeing single-aisle	B737-800 MAX	B7378MAX	B738	-3.9	-0.4
Boeing single-aisle	B737-900 MAX	B7379MAX	B738	-2.7	-0.1
Boeing twin-aisle	B787-8	B788	B763G	-4.3	-2.3
Boeing twin-aisle	B787-9	B789	B763G	-2.3	-1.1
Boeing twin-aisle	B787-10	B7810	B763G	-1.0	-0.3
Boeing very large	B747-8	B748	B744G	-4.65	-2.9
Generic regional jet	E170 NEO	ERJ170NEO	ERJ170	-6.5	-2.8
Generic regional jet	E190 NEO	ERJ190NEO	ERJ170	-4.6	-0.3

Table C2: Generation 2 *Future* aircraft types and modelling assumptions

Aircraft category	Aircraft type	New ANCON model	ANCON model surrogate	Adjustment, dB	
				Departure	Arrival
Airbus single-aisle	A319 NEO G2	EA319N2	EA319NEO	-0.7	-0.2
Airbus single-aisle	A320 NEO G2	EA320N2	EA320NEO	-0.7	-0.2
Airbus single-aisle	A321 NEO G2	EA321N2	EA321NEO	-0.7	-0.2
Airbus twin-aisle	A350-800 G2	EA358N2	EA358	-1.7	-0.4
Airbus twin-aisle	A350-900 G2	EA359N2	EA359	-2.1	-0.4
Airbus twin-aisle	A350-1000 G2	EA3510N2	EA3510	-2.0	-0.4
Airbus very large	A380-800 NEO G2	EA38NEO	EA38	-1.0	0.0
Airbus very large	A380-900 NEO G2	EA389NEO	EA389	-1.0	0.0
Boeing single-aisle	B737-700 MAX G2	B7377N2	B7377MAX	-0.7	-0.1
Boeing single-aisle	B737-800 MAX G2	B7378N2	B7378MAX	-0.6	-0.1
Boeing single-aisle	B737-900 MAX G2	B7379N2	B7379MAX	-0.6	-0.1
Boeing twin-aisle	B787-8 G2	B788N2	B788	-1.9	-0.4
Boeing twin-aisle	B787-9 G2	B789N2	B789	-2.2	-0.4
Boeing twin-aisle	B787-10 G2	B7810N2	B7810	-1.9	-0.4
Boeing very large	B747-8 G2	B748N2	B748	-2.3	-0.5
Generic regional jet	E170 NEO G2	ERJ170N2	ERJ170NEO	-1.4	-0.3
Generic regional jet	E190 NEO G2	ERJ190N2	ERJ190NEO	-1.4	-0.3