Edinburgh Airport Noise Calculations and Comparisons with Measurements

CAP 1736

Published by the Civil Aviation Authority, 2018

Civil Aviation Authority
Aviation House
Gatwick Airport South
West Sussex
RH6 0YR

First published 2018

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

Contents

Background to this document

1. Edinburgh Airport began developing proposals to change its airspace design in 2016. The CAA's airspace change process requires sponsors of airspace change proposals to provide in certain circumstances noise data and analysis to the CAA for the purpose of informing the CAA's decision whether or not to approve the change. Edinburgh's proposal submitted to the CAA for decision, included such noise data and analysis, and was published on the CAA's website. A number of Edinburgh Airport's stakeholders including Edinburgh Airport Noise Advisory Board (EANAB), challenged publicly the validity of the noise modelling within Edinburgh's airspace change proposal.

2. As airspace change decision maker the CAA must reach a view on whether the quality of the noise data and analysis in the proposal is sufficient to enable the CAA to make a decision. As a step towards considering that issue, the CAA required Edinburgh to provide a response to the feedback received for the CAA, as airspace change decision maker to consider.

3. As is explained in more detail below, the CAA's Environmental Research and Consultancy Department (ERCD) carries out noise analysis under contract for a number of airports. ERCD sits in the CAA, but is distinctly separate from the CAA's Airspace Regulation Directorate. In this case Edinburgh commissioned ERCD to produce the noise analysis for the purpose of developing its airspace change proposal. Edinburgh accordingly instructed ERCD to produce a response to the feedback received about that analysis.

4. This document was produced by ERCD for Edinburgh for that purpose.

5. On 22 November 2018 the CAA decided to reject Edinburgh's airspace change proposal (for the reasons set out in the letter containing the CAA's minded to decision on 29 October 2018). https://www.caa.co.uk/Commercial-industry/Airspace/Airspace-change/Decisions/FASI(N)/. Had the CAA not made that decision this document would have been delivered by ERCD to Edinburgh who would have used it to meet the requirement of the airspace change process set out in paragraph 2 above.

6. Notwithstanding that the airspace change proposal for which this document was prepared is no longer active, the CAA considers it important that the response to the feedback received, set out in this document, is shared and published. The analysis methods referred to are likely to be used by Edinburgh or other airports in other airspace design issues, for noise monitoring or related purposes and are used by the wider industry. This document is therefore intended to respond both to EANAB's criticisms and inform wider stakeholders about noise analysis.

Executive Summary

7. A number of Edinburgh Airport's stakeholders including Edinburgh Airport Noise Advisory Board (EANAB), challenged the validity of the noise modelling the Environmental Research and Consultancy Department (ERCD) of the CAA had undertaken on behalf of Edinburgh Airport for its airspace change proposal. We welcome the time stakeholders have invested in this important issue.

8. This report sets out some background to noise modelling, ERCD's response to these challenges and its own assessment of EANAB's analysis. In summary, the CAA believes that ERCD's noise modelling, and the results of its analysis used in Edinburgh's recent airspace change proposal, is robust and that the alternative analysis presented by EANAB contains a number of inaccuracies. This report sets out why.

9. This report also addresses an issue (albeit not raised in external feedback) that ERCD identified with the calculation of one of its supplemental noise indicators – L_{Amax}.

Ways of Calculating aircraft noise

10. The purpose of aviation noise modelling is to represent the level of aviation noise experienced by populations near airports in a quantifiable way. There is international aviation noise modelling best practice guidance set by the global aviation regulator, the International Civil Aviation Organization (ICAO). The UK's Aircraft Noise Contour Model (ANCON) meets internationally recognised best practice guidance and has been benchmarked against other international models that accord with the international best practice guidance. The quality of its outputs, however, depend on the quality of its data inputs.

11. There are a number of ways of modelling aircraft noise. At a basic level, there is the Aircraft Noise and Performance (ANP) database, which is an ICAO sponsored global database of aircraft and their noise and performance characteristics. This data is vital to ERCD's modelling, but the standard assumptions, such as the power aircraft are using when taking off, can under- or over-estimate noise as they do not always match with how aircraft are flown in reality. Therefore, there is a need to adapt ICAO's ANP to reflect local conditions to provide the most accurate reflection of the actual noise experienced.

12. The CAA's advice is that the more local information received, the richer the noise modelling will be. One method of supplying this is through Noise and Track Keeping (NTK) systems. These systems match air traffic control radar data (i.e. aircraft flight paths and flight profiles) to related noise measurements at set ground positions. The UK's three noise designated airports (Heathrow, Gatwick

and Stansted) have made a significant investment in NTK systems and it is longstanding practice that the data sourced at these airports informs modelling at other airports which do not have this equipment or sufficient noise monitors in appropriate locations.

13. Installing NTK systems is a significant investment and the decision about whether to invest in these systems is a question of proportionality related to the size of the airport and the level of noise impact. Balancing this cost against the quality of the data it produces to inform decision and best practices affects all airports in the UK. As a consequence we will be providing guidance to airports about best practice noise measurement in due course.

14. For the Edinburgh airspace change proposal the ERCD used an adapted ANP database based on Gatwick vertical flight profiles for its modelling for Edinburgh Airport. The airlines and aircraft that contribute most to the overall noise exposure at Edinburgh Airport, also operate at Gatwick Airport.

15. Finally, it is worth noting that in noise modelling, the generally accepted margin of error is ±1 dB. Furthermore, in terms of noise measurements, the error margin even on high specification noise measurement devices is of a similar level. Inappropriate use of the instrument can, however, increase the level of measurement uncertainty. Care should therefore be taken in interpreting small differences in dB measures between the results of different studies.

Criticisms and Response

16. Although raw noise measurement data wasn't used in the noise analysis prepared for Edinburgh's airspace change proposal, EANAB was supplied with the raw noise measurement data by Edinburgh Airport and used further information on the flight profiles from Flight Radar 24 to form the basis of its feedback. Through its analysis of this data, EANAB are of the view that the ERCD's use of Gatwick's vertical flight profiles as an assumption for Edinburgh Airport's noise modelling is inappropriate because Edinburgh Airport's actual vertical flight profiles are different. EANAB argued that this resulted in a difference between the calculated noise levels and the actual measured data.

17. The CAA welcomes robust engagement from all its stakeholders, especially on issues as important as noise. However, following further review, we consider ERCD's modelling is robust and we do not consider the EANAB's analysis as a valid comparison against ERCD's for the following reasons:

- Inconsistent time periods - The Gatwick data used by ERCD was for a standard summer period. The data used in EANAB's analysis uses an earlier period in the year. Temperature affects aircraft performance and therefore its noise footprint.

- Inconsistent aircraft destinations – The aircraft used in the Gatwick data are heading to a variety of destinations, both domestic and international. EANAB's data sample is purely Edinburgh to Gatwick flights. Aircraft flying shorter distances such as this tend to carry less fuel and climb more rapidly after take-off, creating different height and noise profiles.
- Incomparable height data - The two datasets use different pressure settings to measure height. Gatwick data is presented on the basis of pressure settings measured at the height above airport runway, EANAB's data relied on standard pressure settings. With heights having considerable impacts on noise levels, it is not an adequate comparison.

18. In addition, the position of one of Edinburgh Airport's three noise monitors when the sound measurements were taken did not meet ISO standards for airport noise monitors as it was located on top of a hard surface (a school roof), meaning that its measurements may be strongly affected by surface reflections, impacting the accuracy of any readings. The CAA would also normally exclude the departure noise measurements taken from one of Edinburgh Airport's other monitors as it is to the side rather than underneath a flight path. Edinburgh Airport confirmed to the CAA that the Livingston school monitor (EDI 01) was relocated on the 19th September 2018 away from large reflecting surfaces. Edinburgh Airport are in the process of installing a monitor under the runway 06 departure flight paths, retaining monitor EDI 03 for monitoring runway 24 arrivals. The CAA understands that Edinburgh Airport has already changed the location of the Livingston microphone.

Edinburgh Airport Noise Measurement Data

19. It is important to stress that Edinburgh's airspace change proposal was not based on any noise measurement data collected by Edinburgh Airport's NTK system.

20. In the course of addressing criticisms from EANAB, ERCD identified an issue with noise measurements recorded prior to the introduction of Edinburgh Airport's new NTK system on the 6 April 2018. ERCD believes that Edinburgh Airport's noise data prior to April 2018 and supplied to EANAB may contain some inconsistencies. We believe the likely cause is a time inconsistency between the radar and noise data, an issue that the new NTK system that Edinburgh Airport has introduced has resolved. Looking at the data available from April 2018, our assessment is that it matches much more closely to the ANCON modelled values, and is certainly well within the margins of error for such calculations. We do not believe that the pre-April 2018 noise measurement data is sufficiently reliable to provide a basis for accurate comparison with noise today and any future airspace change proposals.

21. For all the reasons set out above, our view is that ANCON remains a robust and valid model for the calculation of noise, and that using Gatwick vertical profiles is an acceptable substitution for actual vertical flight profiles. It would, however, be entirely acceptable if Edinburgh Airport measured actual flight profiles and used them in its noise modelling.

L_{Amax} validation issue

22. Since Sound Exposure Level (SEL) is required to calculate L_{Aeq} noise contours, ERCD has always validated SEL calculations against measurement. However, this was not for the maximum sound level measured during the event (L_{Amax}) indicator. ERCD has discovered that previously provided estimates of the L_{Amax} were underestimated across all airports where it provides modelling for some critical aircraft types. Earlier this year when comparing L_{Amax} calculations with measurements for the first time ERCD discovered that calculations over-estimated L_{Amax} for some aircraft types, and under-estimated L_{Amax} by 2-3dB for other aircraft types, particularly the Airbus A320 series[1]. The ERCD understands the cause of the issues and has now addressed it by undertaking the same level of validation as for SEL, i.e. comparing calculated L_{Amax} levels against L_{Amax} measurements on an aircraft type by type basis for departures and arrivals..

Recommendations

23. While the CAA remains confident in the UK's ANCON model, it has a number of actions and recommendations as follows:

- The CAA would like to arrange a seminar with EANAB and other interested stakeholders to discuss the conclusions presented in this report.
- Edinburgh Airport should consider and address as appropriate the noise measurements issues identified in this report such as the location and number of microphones and confirming the time synchronisation issues in the pre-April 2018 data.
- Having addressed these issues, Edinburgh Airport should consider carefully and consciously decide upon the appropriate methodology for the production of noise contours that will inform its stakeholders and any airspace change process.

---

1 Some of these L_{Amax} estimates were used in the consultation from January to May 2017 that formed part of Edinburgh's airspace change proposal. L_{Amax} is not a core measure of noise required under the CAA's airspace change process and is a supplementary measure used by a number of stakeholders. No L_{Amax} information was submitted within Edinburgh Airport's formal Airspace Change Proposal to the CAA which in any event has now concluded.

- Any airport, where noise is an issue or which is contemplating making an airspace change where noise will be a consideration, should satisfy themselves, using a qualified external party if required, about the validity and reliability of their noise data and input data for noise modelling and create a reliable baseline before starting any process and should note that such considerations and validations will form part of the CAA's airspace change decision making analysis.
- CAA will publish a more general form of guidance about how noise can be modelled and measured to inform all airports, particularly important for those considering making airspace change proposals, of:
  - issues to consider, such as avoiding the time synchronisation issue
  - best practice regarding audit and maintenance of noise monitors
  - how airports should publish information about their noise methodology.

24. In conclusion, and save for the now corrected L_{Amax} calculation issue, the CAA is confident in our noise modelling including that used in Edinburgh's recent airspace change proposal. We have set out in this document a number of inaccuracies in EANAB's own noise analysis. However, we strongly welcome the engagement on this issue from all of our stakeholders and we look forward to continuing our engagement with them going forward.

Purpose of this document

25. During Edinburgh Airport's preparation and consultation of its proposed airspace change in 2017 and 2018, the Edinburgh Airport Noise Advisory Board and a number of other interested parties challenged the validity of the noise analysis that the CAA had prepared under contract to Edinburgh Airport and presented their own alternative analysis based on data provided by Edinburgh Airport. This report sets out some context about undertaking noise analysis more broadly, and addresses the specific challenges raised by Edinburgh Airport's stakeholders and assesses the validity of EANAB's own noise analysis. The CAA welcomes the challenge from these stakeholders together with the opportunity to address these directly and publicly.

26. Given that a number of these questions came directly and publicly to the CAA, and the CAA's wider role in aviation regulation, this report is being published on the CAA's website. In due course, the CAA will provide additional guidance to airports about options and best practice for undertaking noise analysis.

Introduction

27. The purpose of estimating aircraft noise levels in the vicinity of an airport is to provide a quantitative assessment of the noise experienced by those living near an airport. A reliable assessment forms part of an important evidence base that informs how aircraft noise is understood and managed. Noise calculations are used to provide historic and forecast trends of noise exposure, as part of the formal planning processes related to airport developments and in the CAA's Airspace Change Process.

28. This note addresses four points in the context of the noise analysis undertaken as part of the Edinburgh Airport Airspace Change Proposal:

- Different ways of calculating aircraft noise
- Calculation approach used for Edinburgh Airport
- Criticisms of the approach taken
- Response to the criticisms

Ways of calculating aircraft noise

Some history

29. Historically, aircraft noise calculations were undertaken using nationally developed calculation models. The earliest models were wholly empirical and relied on measurements obtained around airports. Beginning in the 1980s, the US developed a performance-based calculation model that estimated aircraft performance during landing and take-off and from this estimated the associated noise levels. Being performance-based, the model recognised that aircraft noise levels experienced on the ground are directly linked to aircraft performance and to assumptions regarding the way in which aircraft are flown.

30. The US performance-based calculation model was gradually adopted as the global recommended method for aircraft noise calculation. The method was adopted into guidance published by the International Civil Aviation Organization (ICAO)[2] and the European Civil Aviation Conference (ECAC)[3]. The recommended method, when supported with suitable data, can estimate single event noise levels for a variety of different metrics, including maximum noise level (L_{Amax}) and Sound Exposure Level (SEL) of individual aircraft overflights. The primary metric of interest is the calculation of long-term average day or night noise exposure, using the L_{Aeq} indicator, which takes account of event noise level, duration and how many events occur in a given time period. L_{Aeq} is based on an aggregation of the SEL measurements or calculations, of individual aircraft overflights occurring within a given time period. For example, the average summer day indicator, L_{Aeq16h}, is calculated from the SELs occurring within an average summer day period from 0700 to 2300. Day-Night Level (DNL), Day-Evening-Night Level (L_{den}) and Night Level (L_{night}) are all variants of L_{Aeq} with either weightings applied to different times of day and/or different time periods. Using the recommended method, L_{Amax} plays no role in the calculation of L_{Aeq} type metrics.

The ANCON model and ANP database

31. The UK's Aircraft Noise Contour model, ANCON version 2, developed and maintained by the CAA on behalf of the Department for Transport (DfT) and introduced in 1997, was the first version of ANCON to implement the ECAC

[2] ICAO Doc. 9911, Recommended Method for Computing Noise Contours Around Airports, 2nd Edition, International Civil Aviation Organization, 2018.

[3] ECAC Doc. 29, Report on Standard Method of Computing Noise Contours around Civil Airports, 4th Edition, European Civil Aviation Conference, December 2016.

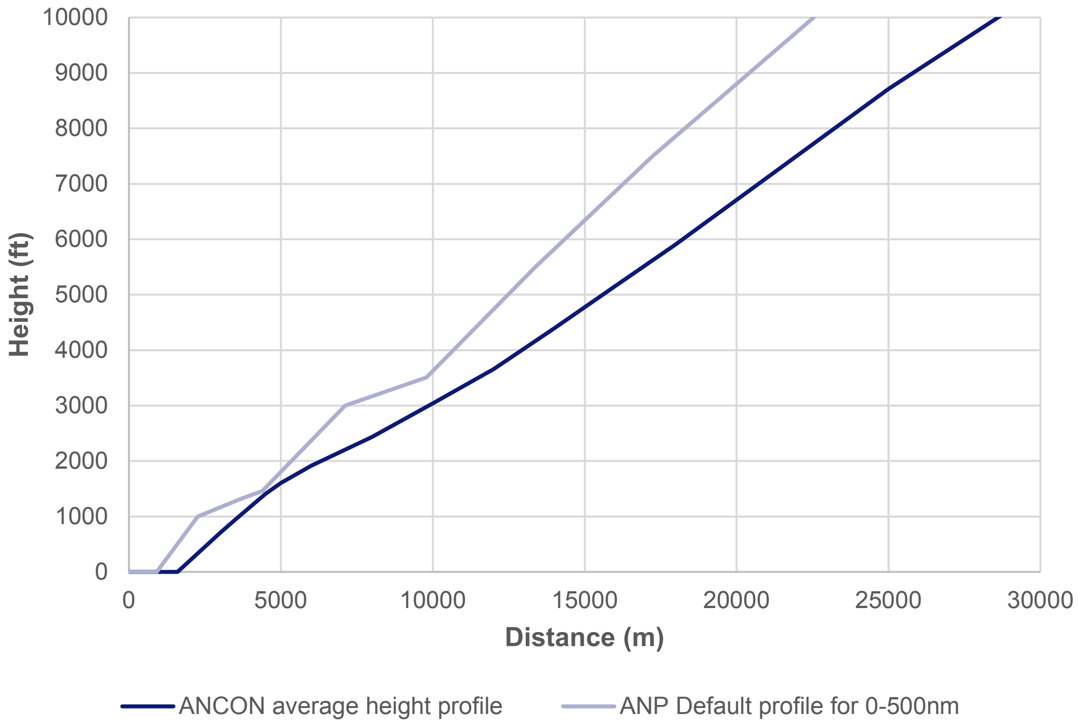
performance-based calculation guidance. In 2005 a supporting global Aircraft Noise and Performance (ANP) database was created by European Civil Aviation Conference (ECAC) and subsequently endorsed by ICAO, based on information provided by the aircraft manufacturers that is necessary to fully utilise the method.

32. The ANP database provides aerodynamic and engine performance characteristic data for over 150 distinct aircraft types and variants of those types. This data describes the physical characteristics of the aircraft and engines, e.g. how much lift and drag are generated and how much thrust is available for take-off and climb. In addition, the data includes nominal information on how take-off weight varies with distance flown, the greater the distance flown requiring greater fuel to be carried, therefore increasing take-off weight. Default take-off weights provided assume the payload (passengers, baggage and cargo) is 65% of the maximum payload. This should not be confused with the more commonly referred to passenger load factor, which in practice can be as high as 90%, since this does not include any cargo allowance. Nevertheless, the 65% may or may not be representative of a particular airline’s operations at any given airport. Take-off weight information, from which passenger load factor may be inferred, is considered commercially sensitive and even average information is rarely made available to the global aircraft noise modelling community.

33. The ANP database also includes standardised assumptions on other aspects of the aircraft performance that affect noise modelling. It assumes aircraft take-off at full power (thrust), which only holds for airports with short runways. Where the runway is longer than necessary and subject to meeting surrounding obstacle clearance requirements, aircraft are routinely operated at less than full take-off thrust to prolong engine life and also to reduce NOx emissions whilst the aircraft is on the runway and during initial climb. Left unadjusted, the ANP database take-off performance assumptions place the aircraft at greater height than observed by radar data, but with higher noise emission close to the airport.

34. Take-off thrust cannot be maintained indefinitely following take-off (even when at a reduced level). Thus in practice all departures will reduce engine thrust to a lower climb thrust setting, when at least 800 ft above the airport level. An incorrect assumption regarding take-off thrust could result in calculations showing that an aircraft is higher than it would actually be, but at the same climb thrust setting. The net result is that the default ANP data and underlying assumptions tend to over-estimate noise directly beneath the flight path close to the airport (below 800 ft and less than 5 km from start of take-off roll), but underestimate noise further away. Figure 1 illustrates the difference between the default ANP profile for an Airbus A319 departure to airports up to 500 nm away (a common aircraft type on a short-haul flight), compared with the ANCON average profile calculated from radar data at Gatwick Airport in 2015.

Figure 1: Comparison of ANP default departure profile for the Airbus A319 and the summer 2015 Gatwick average profile



35. Regarding landing noise, the ANP database assumes a continuous 3-degree descent angle from 6000 ft and a continuously decelerating approach. In essence, the assumptions reflect the quietest approach procedure/profile that could be flown. This is rarely achieved in practice until close-in to the airport when aircraft height and speed are dictated by safety considerations.

36. International guidance recognises these issues and encourages aviation noise modellers to compare the ANP default flight procedures with those in use at a given location, but provides no set process for adapting the ANP database to that specific local situation.

37. ANCON version 2 has been benchmarked against models from Eurocontrol, Norway, Netherlands and the US. For the same input information, all five models calculate noise levels which match the reference noise levels published in ECAC. Doc 29 4th Edition Volume 3[4]. These models are considered to be Doc. 29 *compliant*.

[4] ECAC Doc. 29, Volume 3, 4th Edition, European Civil Aviation Conference, December 2016.

38. Noise calculations undertaken by CAA's Environmental Research and Consultancy Department (ERCD) use the ANCON model, which ERCD maintains under a contract with the Department for Transport. The most recent versions have been ANCON version 2.3, used between 2007-2016, which fully conformed to ECAC Doc. 29 3rd Edition. The methodology refinements in ECAC Doc. 29 4th Edition published in December 2016, were incorporated into ANCON version 2.4, which has been used for calculations from 2017 onwards. The differences in noise levels predicted between the 3rd and 4th Editions are minor. In the UK, other modellers use the US FAA's Integrated Noise Model (INM) or its Aviation Environmental Design Tool (AEDT). AEDT has now replaced INM, however, for the same inputs INM and AEDT produces equivalent results. Referring back to paragraph 37, for the same inputs and noise database, INM and AEDT calculate equivalent results to ANCON and the other Doc. 29 compliant models. The INM and AEDT software are sold with a copy of the ICAO ANP database, which is also freely available for download from the EUROCONTROL website[5]. As such, the CAA is confident that the ANCON calculation methodology complies with international standards, though the validity of the results it produces are dependent on the quality and reliability of the input data.

ANP databases for Heathrow, Gatwick and Stansted

39. As indicated earlier in Figure 1, for most airports there is a need to adapt the ICAO ANP database to reflect local conditions and provide a more accurate reflection of the actual noise experience. ERCD has developed adapted ANP databases for London Heathrow, Gatwick and Stansted airports. These airports are designated under Section 78 of the Civil Aviation Act 1982 giving responsibility for control of noise and vibration to the Secretary of State. In order to provide independent technical advice on noise around the designated airports, ERCD is given direct access by the respective airport operators to the radar data and noise measurements of landings and take-offs recorded by the designated airports. This data is used to develop three localised noise and performance databases to support ANCON calculations.

40. Each year between 750,000 and 1 million noise measurements are collected from across the three airports for the standard 92-day summer assessment period (16 June to 15 September inclusive). Automated Noise and Track Keeping (NTK) systems installed and maintained by the airport operator have vastly increased the number of locations where noise levels are measured and the sample sizes of data collected. NTK systems can provide additional information to refine the assumptions in the ANP. These include one or more of:

5 Eurocontrol ANP website.

a) Actual flight tracks and their dispersion around the Standard Instrument Departure (SIDs) and Standard Arrival Routes (STARs)

b) The vertical flight profiles for dominant aircraft types

c) The vertical flight profiles for other aircraft types

d) Noise measurements to facilitate validation of the noise calculation based on flight tracks and flight profiles (a, b and c above)

41. The data collected under the NTK systems at the three designated airports is now collected in a remote, unattended manner and thus one cannot be wholly certain that all the noise measurements recorded by the noise monitors are actually from aircraft. ERCD goes to significant lengths to analyse the data, including examining noise event duration, the matching of the noise event to an aircraft and its associated position at the time of the noise event and screening for extraneous weather conditions[6]. In addition, ERCD continually works with the three designated airports', their NTK system suppliers and periodically checks the precision of their NTK systems[7,8] that provide the data that is so integral to ANCON in the context of international standards on airport noise monitoring systems published by ISO[9] and SAE International[10].

Other airports

42. For other UK airports, ERCD acts on a paid-for consultancy basis to undertake noise contour analysis on behalf of the relevant airport operator. This includes Edinburgh. In these cases, the CAA cannot mandate whether and how the airport installs NTK systems, nor the level of additional information over and above the ANP that those airports collect.

43. The costs to the London airports of installing NTK systems were at least £1 million, along with ongoing maintenance costs for the system and maintenance and calibration of the noise monitors. One of the benefits of the initial designated airports' system was that a common system was used across all three airports and noise monitoring equipment was shared across the three airports, which at the time were in common ownership. Regional airports did not

6 Precision of Aircraft Noise Measurements at the London Airports, ERCD Report 0506, Civil Aviation Authority, November 2005.

7 Accuracy of Data in the Noise and Track Keeping System at the London Airports, ERCD Report 0906, Civil Aviation Authority, September 2009.

8 Accuracy of data in the Gatwick Noise and Track Keeping System, CAP1246, Civil Aviation Authority, July 2014.

9 Unattended monitoring of aircraft sound in the vicinity of airports, ISO 20906 Amendment 1, International Standards Organization, 2009.

10 Monitoring aircraft noise and operations in the vicinity of airports, SAE Aerospace Recommended Practice ARP-4721, SAE International, 2006.

adopt NTK systems as quickly and as they were not designated, were under no obligation to install such systems. Until such systems were installed it became common practice to re-use data from the London airports' NTK systems for other UK airports. Data from Gatwick Airport is typically used as being representative of other UK airports since its operations were dominated historically by UK and European charter carriers and in the last decade by European low-cost carriers.

44. A critical element of NTK systems is the ability to link aircraft operations to noise events, whilst minimising the risk of capturing non-aircraft noise events and without eliminating quieter aircraft noise events that would skew the average level recorded. In some cases, noise monitoring equipment was installed without any link to flight operations data and thus noise to track matching was performed using the time of the measurement. Most modern NTK systems use level triggers (thresholds), event time and duration, and aircraft position relative to a noise monitor at the time of measurement to improve the matching of a noise event to an aircraft operation. Nevertheless, noise monitors located away from other noise sources, and the large quantity of measurements and statistics are relied upon to ensure that the risks of non-aircraft noise event contamination are minimised.

45. Some UK regional airports, including Edinburgh, have now adopted NTK systems from the same manufacturers as Heathrow, Gatwick and Stansted airports and have the capability to provide stakeholders with export operations, radar trajectory and noise measurement data, although the number and suitability of noise monitor positions generally falls below that of the London airports. This has enabled some noise modelling inputs to be represented by local data, whilst other elements continue to rely on nominal published information or data created by ERCD from Gatwick Airport. This has resulted in a differentiated or 'tiered' approach that best utilises data availability and quality in a cost-effective manner. Third party consultants have adopted similar strategies, whereby, some adjust the ANP database based on measurements, whilst others apply the ANP database unadjusted. The strategy chosen depends on the size of the noise contours being calculated, population density in the vicinity of the airport, the availability and quality of radar, and noise measurement data availability and quality. For small airports, where noise contours are typically much smaller than at busy airports, the uncertainties around using the ANP database also become much smaller. Table 1 summarises the different 'tiers' applied to UK airport noise modelling.

Table 1: UK airport noise modelling input data and model database data sources

Airport	Horizontal flight tracks & track dispersion	Vertical flight profiles for dominant aircraft types	Vertical flight profiles for other aircraft types	Validation flight profiles against noise measurements
Heathrow	Local radar data	Local radar data	Local radar data	Yes
Gatwick	Local radar data	Local radar data	Local radar data	Yes
Stansted	Local radar data	Local radar data	Local radar data	Yes
Other UK Airports	Local radar data	Local radar data	Local radar data	Yes
Birmingham	Local radar data	Local radar data	Gatwick data	No/Gatwick data
Manchester	Local radar data	Local radar data	Gatwick data	No/Gatwick data
Glasgow	Nominal published tracks	Gatwick data	Gatwick data	Gatwick data
Edinburgh	Nominal published tracks	Gatwick data	Gatwick data	Gatwick data
Southampton	Nominal published tracks	Gatwick data	Gatwick data	Gatwick data
Other UK Airports	Nominal published tracks	ICAO ANP data	ICAO ANP data	No

CAA expectations

46. Other than at the three designated airports, the decision about the level of local data collection is for the individual airport operator. As the UK's aviation regulator, the CAA's view is that high quality noise data is fundamental to give confidence to an airport's stakeholders affected by noise and enable robust airspace decisions. The more local data available will lead to richer estimates about noise impacts. That does not mean that high quality estimates can only be made with a full suite of local information. As outlined elsewhere in this paper, there are good reasons why some of the aircraft parameters, such as vertical profiles flown by the same airport operator at different airports, are in fact similar. Collecting and validating local noise and radar data requires investment by the airport operator and therefore there is a legitimate proportionality question.

47. The CAA's view is that airport operators should consciously consider and decide on the level of noise and track keeping they want to undertake, and be satisfied that the level of noise modelling is commensurate with both the size of their

airport and their noise impact on local communities. In any event, the CAA strongly recommends that any noise and track keeping system is high quality, installed in accordance with international standards and its accuracy regularly and independently audited.

48. Finally, it is worth noting that while there are steps that can be taken to create and improve noise analysis, the standard margin of error in calculating long-term average noise exposure is ±1 dB and the uncertainty in noise measurements recorded by high quality noise monitors sited appropriately is of a similar order. Care should therefore be taken in over-relying or interpreting variations or differences within these parameters.

Calculation approach taken by ERCD for Edinburgh

49. As noted in Table 1, for its analysis for Edinburgh ERCD used an adapted noise and performance database based on Gatwick Airport flight profiles and noise measurements. Flight track information is based on the nominal tracks published in the UK Aerodrome Information Publication (AIP). Flight track dispersion around the nominal horizontal tracks for Edinburgh is based on Gatwick Airport data. This is longstanding practice, predating the airport's investment in an NTK system. The noise dominant aircraft operations are by Airbus A319, A320 and Boeing 737-800 aircraft principally operated by easyJet and Ryanair, who are also the dominant operators of these types at Gatwick airport.

50. During 2015/6, Edinburgh Airport had three noise monitors deployed, two directly underneath the westerly departure flight paths and one to the side of the easterly departure flight path, but directly underneath the westerly arrival flight path. For reasons explained later in this note, these are not considered sufficient for undertaking local validation and adjustment of the noise performance database. However, as explained elsewhere in this note, this data was not used in the noise modelling presented in Edinburgh's recent airspace change proposal but was used in EANAB's own analysis.

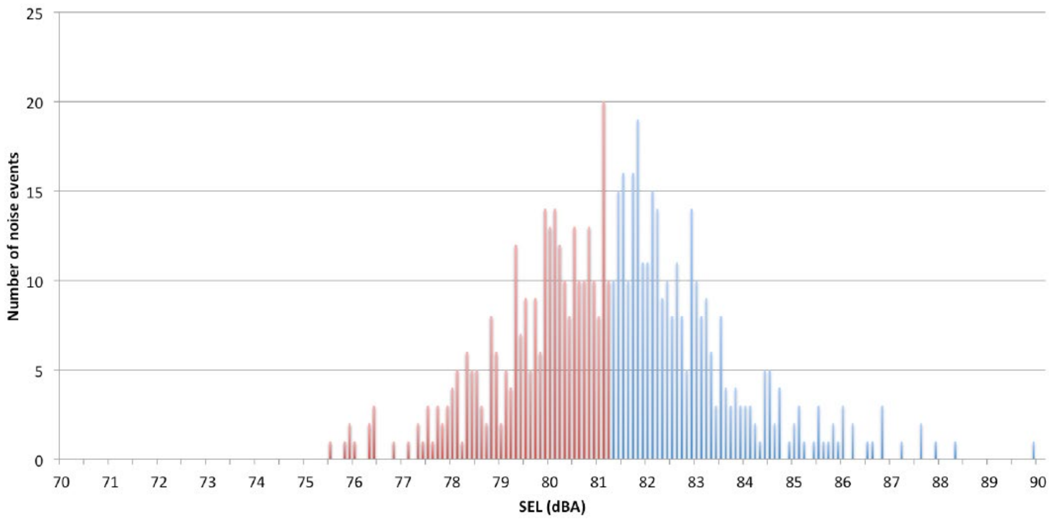
Criticisms of the calculation approach

51. Even though it was not used in Edinburgh's own airspace change proposal, the Edinburgh Airport Noise Advisory Board (EANAB) was provided raw noise measurement data by Edinburgh Airport in the form of single event L_{Amax} and SEL measurements for 2015 and 2016. In addition, members of the EANAB have obtained flight profile data from Flight Radar 24[11], a commercial organisation that collects and aggregates aircraft flight trajectory information transmitted from aircraft using Automatic Dependent Surveillance Broadcast (ADS-B) technology.

Comparison of calculated levels and measured levels

52. The EANAB compared calculated L_{Amax} and SEL noise levels with measured mean levels and measured distributions of noise measurements. An example comparison of calculated levels against the measured distribution of noise measurements is shown in Figure 2.

Figure 2: EANAB comparison of calculated levels vs measurement distribution



(source EANAB document provided to CAA on 14/08/2018)

53. The red coloured bars indicate where Edinburgh airport measured levels are below the ANCON calculated level, and blue bars are where measured levels are above the calculated noise level. In the case above approximately 50 percent of the measured levels exceed the calculated level. Overall the measured levels follow a normal distribution as would be expected and cover a range of 10 dB, typical of outdoor aircraft noise measurement.

11 https://www.flightradar24.com/about

54. EANAB also provided comparisons in tabular format (Table 2) showing mean measured levels, standard deviations and the proportion of Edinburgh Airport measurements that exceeded the ANCON calculated level. Levels for the Airbus A320 are seen to closely match measured levels, however calculated levels for the A319 and B737-800 are lower than measurements.

Table 2: EANAB comparison of ANCON calculated and Edinburgh measured SELs

year	noise monitor	aircraft type	SID	ANCON predicted SEL (dBA)	Aircraft noise events	Measured mean SEL (dBA)	Measured std dev. SEL (dBA)
2016	EDI01	A319	TLA24	79	1012	80.7	2.0
			GOS24	78.7	1863	80.8	1.9
		A320	TLA24	81.3	617	81.5	2.2
			GOS24	81.1	1129	81.4	2.1
		B738	TLA24	81	1430	81.8	2.2
			GOS24	80.7	1983	82.2	2.0
	EDI02	A319	TLA24	83.6	1175	85.4	1.6
			GOS24	83.6	2150	85.0	1.6
		A320	TLA24	85.4	693	85.6	1.8
			GOS24	85.4	1325	85.5	1.7
		B738	TLA24	85.3	1572	86.7	1.9
			GOS24	85.3	2135	86.6	1.9
	EDI03	A319	all	78.7	1831	80.3	2.3
		A320	all	80	1000	80.8	2.0
		B738	all	79.8	2109	83.7	2.2
2015	EDI03	A319	all	78.7	1434	80.5	2.3
		A320	all	80	813	80.8	2.5
		B738	all	79.8	1424	83.6	2.8

55. From Table 2, the EANAB concluded that because the measured mean SELs for the A319 and B737-800 are higher than the ANCON calculated levels, that ANCON under predicts measured noise levels, for both L_{Amax} and SEL. For the reasons set out, the CAA does not consider this a valid comparison and conclusion.

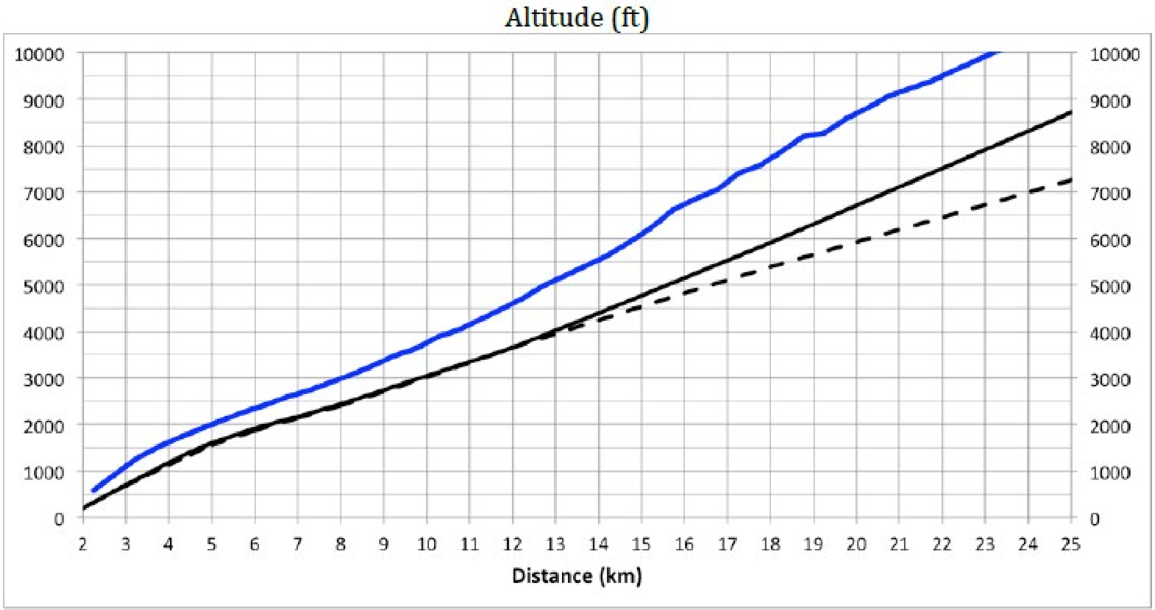
Flight profile comparisons

56. The EANAB provided comparisons of Edinburgh Airport average aircraft height, calculated from Flight Radar 24 ADS-B trajectory data, against the average height profile used for ANCON noise calculations, based on Gatwick Airport departures. Figure 3 taken from the EANAB analysis compares the height profile of A319 departures to Gatwick only operated by easyJet, against all Gatwick A319 departures to all destinations, by all operators.

57.

58. EANAB argued that because this analysis showed the actual vertical profiles from Edinburgh (blue line) were higher than at Gatwick (black line), then the aircraft would require greater thrust and thus create more noise. This would support the hypothesis that ANCON calculations based on the vertical profile at Gatwick underestimate noise at Edinburgh.

Figure 3: Edinburgh A319 departures to Gatwick only, compared with Gatwick A319 departures to all destinations



Blue line – Edinburgh departure average height for Edinburgh to Gatwick flights (May to July 2016 and March to April 2017)

Black solid line – Gatwick departure average height to all destinations (mid June to mid Sept 2015)

Black dotted line – Gatwick departure average height to all destinations (mid June to mid Sept 2016)

(source: EANAB document provided on 27/08/2018)

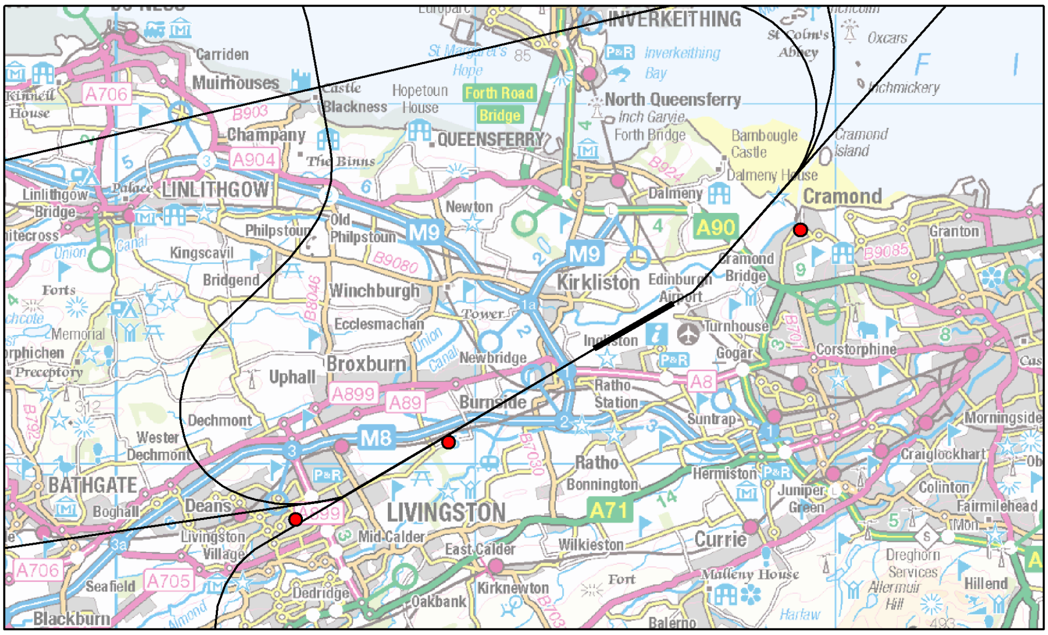
Response to the criticisms

Departure and Arrival Flight Tracks

59. Departure and arrival flight tracks for Edinburgh Airport noise calculations are based on the nominal published SIDs for departures and extended runway centreline for arrivals. Because of prevailing westerly winds, the airport operates 70% of the time in a westerly direction (runway 24), where the SIDs continue in a straight direction on runway heading until 11 km from start of take-off roll (Figure 3). There are no turns that materially affect the distribution of noise within the noise contours to the west of the airport. For the less dominant easterly departures (runway 06) all SIDs make an immediate shallow left turn. A radar track plot provided by the Edinburgh Airport on 15 August 2018 shows that although there is some track dispersion either side of the nominal track, aircraft generally follow the published SIDs. The CAA is not aware that this conclusion has been challenged by EANAB or other stakeholders.

60. Figure 4 shows the disposition of Edinburgh Airport's three permanent noise monitors published in AD 2.21 of the Edinburgh Airport Aerodrome Publication Information. Monitor 01 is the most distant monitor located in Livingston, monitor 02 is between monitor 01 and the runway and monitor 03 is located north-east of the airport in Cramond, to the right of the easterly departure tracks and directly underneath the runway 06 arrival flight path. Monitor 01 was relocated 1.3 km east along the flight track on the 19th September 2018 to site away from large reflecting surfaces.

Figure 4: Edinburgh Airport departure and arrival tracks



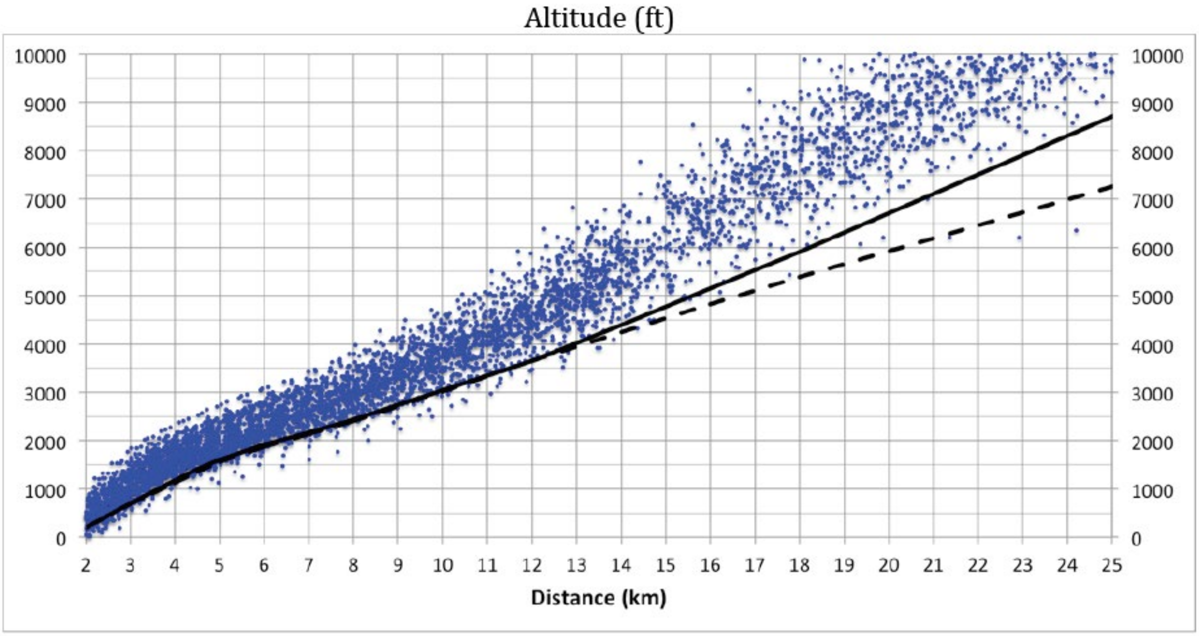
Departure and Arrival Flight Profiles

61. The flight profile is the vertical component of the aircraft's trajectory, describing height gained or lost, governing aircraft speed and engine thrust (power) setting that links to the source noise emitted by the engines and airframe. As already explained, noise on the ground is linked to aircraft performance which is in turn related to the aircraft type, its take-off mass, and how it is operated. There is a need to tailor the standardised assumptions provided to modellers through the ICAO ANP database.

62. ERCD considers that applying 'Gatwick data' to Edinburgh (and Birmingham, Manchester, Southampton and Newcastle) is reasonable and proportionate, since most operations at the airport are easyJet Airbus A319/A320s and Ryanair Boeing 737-800, which are some of the most common operators of these types at Gatwick Airport. Moreover, safety requirements incorporated into individual airline Standard Operating Procedures dictate that an airline has no more than two Noise Abatement Departure Procedures, one being a default, which has a standardising effect on operational performance across different airports. As such, we would expect pilots from the same airline to fly the same vertical profile irrespective of the airport that they are flying from.

63. The comparison of departure height information provided by the EANAB represent very short distance flights from Edinburgh to Gatwick and from March to July and March to April respectively. It is not clear why data covering the standard summer period, mid-June to mid-September, were not used for comparison. This is important, because temperature has a significant bearing on aircraft take-off performance, with warmer summer temperatures known to reduce aircraft height compared with other times of the year. Secondly, both Edinburgh and Gatwick have seasonal traffic patterns with flights to the southern Mediterranean dominating in the summer season. Longer distance flights require more fuel resulting in heavier aircraft and poorer take-off performance. Finally, although the EANAB findings show significant scatter in aircraft height as expected (Figure 5), the final comparison and conclusion make no allowance for this.

Figure 5: Airbus A319 departure height variation compared with mean ANCON Gatwick height profile



(source: EANAB document provided on 27/08/2018)

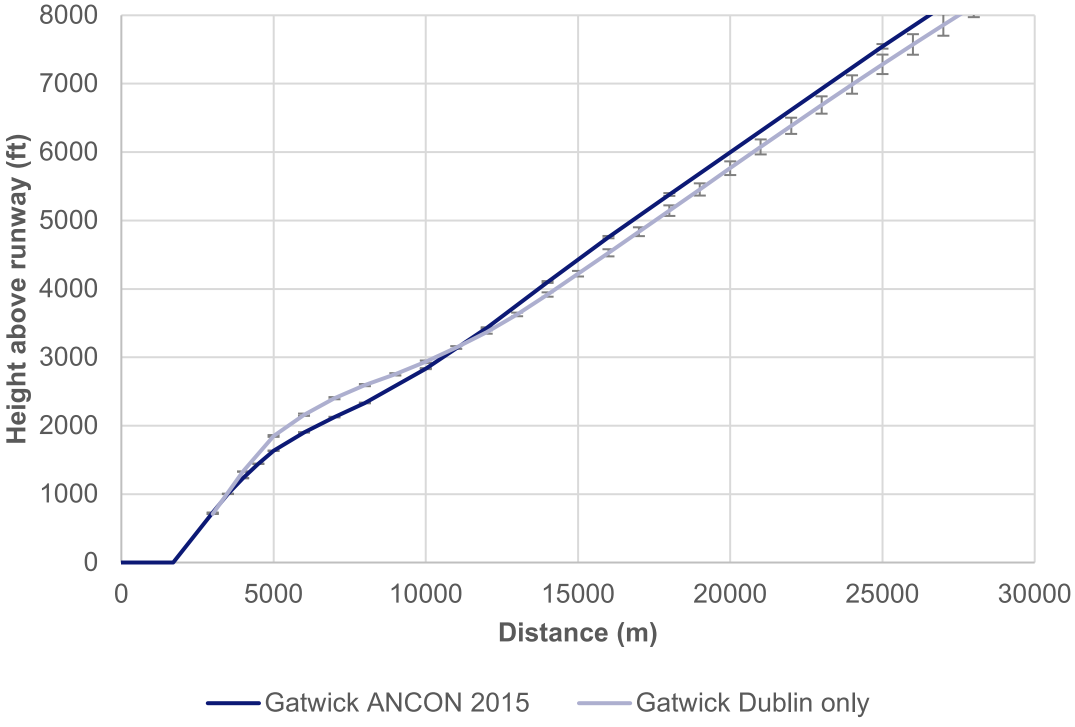
64. The EANAB confirmed to Edinburgh Airport on 23/08/2018 that they made no adjustments to the data they obtained from Flight Radar 24. Altitude data collected by Flight Radar 24 is pressure altitude above mean sea-level referenced to international standard pressure, 1013.25 hPa. At 7,000 ft and above, aircraft maintain an altitude relative to the standard pressure setting of 1013.25 hPa, and the resulting altitudes are referred to as Flight Levels, FL70 roughly being equivalent to 7,000 ft. Below FL70, aircraft fly at an altitude that is corrected to the local airfield or regional pressure setting by inputting the local pressure provided by ATC, the pressure altitude being dynamically corrected by both the aircraft's onboard systems and by ATC. This corrects the standardised pressure altitude to give true altitude above sea-level, which is then further corrected by airfield height to give height above airfield.

65. The data presented by the EANAB for Edinburgh Airport is thus pressure altitude and not, as ANCON data is, height above the airfield. Summer average atmospheric pressure differs between Edinburgh and Gatwick airports and thus the correction from pressure altitude to airfield height is not the same for both airports – height would be lower than the pressure altitude reported for Edinburgh, but higher for Gatwick, closing the gap on the difference reported by the EANAB.

66. Further analysis of Gatwick radar data by ERCD has found that easyJet flights to Edinburgh have almost the same departure height profile as the Gatwick average. This does not necessarily corroborate the EANAB findings, because of the different sampling periods used. In contrast, Figure 6 shows how there can

be significant differences in height profile when comparing one airline/destination against the airport average.

Figure 6: Height profile of Dublin departures compared with Gatwick average



Vertical error bars show 95% confidence intervals about the mean

67. In summary, the CAA does not consider that EANAB's comparison between Edinburgh and Gatwick profiles is valid because it has not been undertaken on a like for like basis:

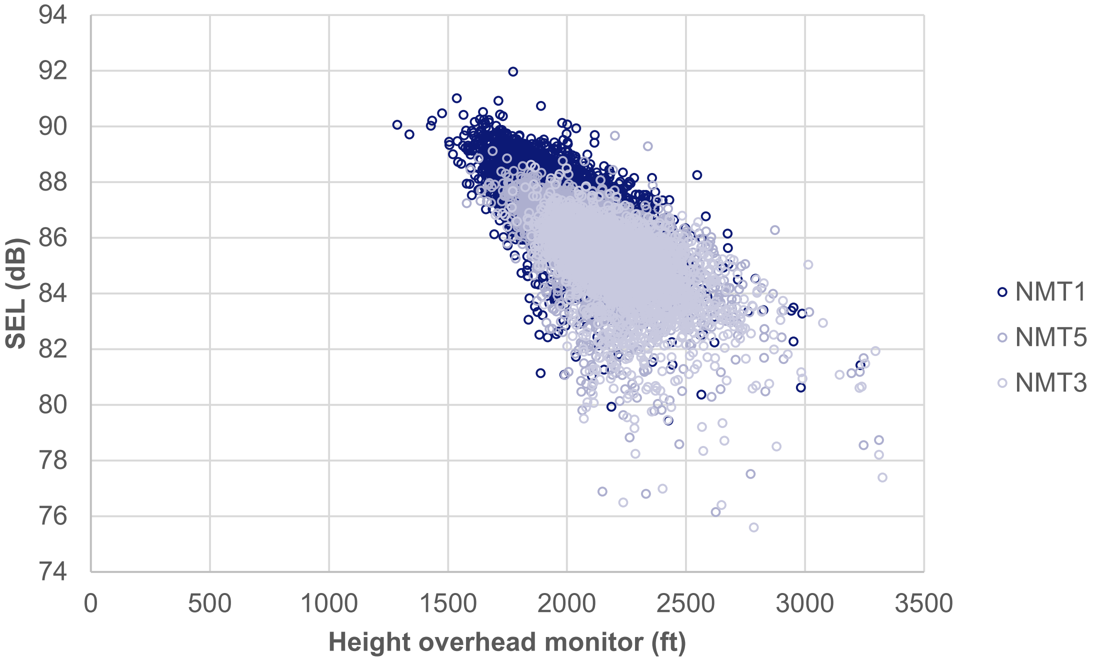
- Different time periods for comparison – with different temperature conditions affecting noise measurements
- Different destinations, meaning Gatwick departures are likely to have a higher level of weight
- Inconsistent height measurements between the Gatwick and Edinburgh samples because of different pressure assumptions

68. Notwithstanding this, we acknowledge there is some indication that departing aircraft at Edinburgh are, on average, higher at a given distance after departure than at Gatwick Airport. The EANAB argues this means higher engine thrust and higher noise levels. The shorter runway at Edinburgh will require some increase in take-off thrust, but at 1,000 ft, approximately 4 km after start of take-off roll, most airlines reduce engine thrust to save engine wear and increase engine life. Thus, beyond 4 km, thrust levels are likely to be similar across different airports,

even if aircraft are higher, leading to similar or reduced noise levels at ground level.

69. Examining our own Gatwick height and noise measurement data, it is clear that higher aircraft are quieter on the ground for the same aircraft noise abatement procedures, the main effect being take-off weight – lighter aircraft are higher and thus quieter (Figure 7).

Figure 7: Relationship between aircraft height and measured noise levels 6-7km after start of take-off roll at Gatwick for Airbus A319



source: ERCD analysis of Gatwick summer 2017 noise measurement data

Differences between calculated and measured levels

70. The EANAB presented measured noise levels from 2015, 2016 and 2017 for its three permanent noise monitors sited at Edinburgh Airport:

- EDI 01 is under the westerly (runway 24) departure SIDs, 12.1 km from start of take-off roll, sited on a school roof with hard reflecting surfaces all round
- EDI 02 is under the westerly (runway 24) departure SIDs, 7.3 km from start of take-off roll, sited on soft ground with no surrounding obstacles
- EDI 03 is to the side of the easterly (runway 06) departure SIDs, 6.3 km from start of take-off roll, sited on soft ground with no surrounding obstacles

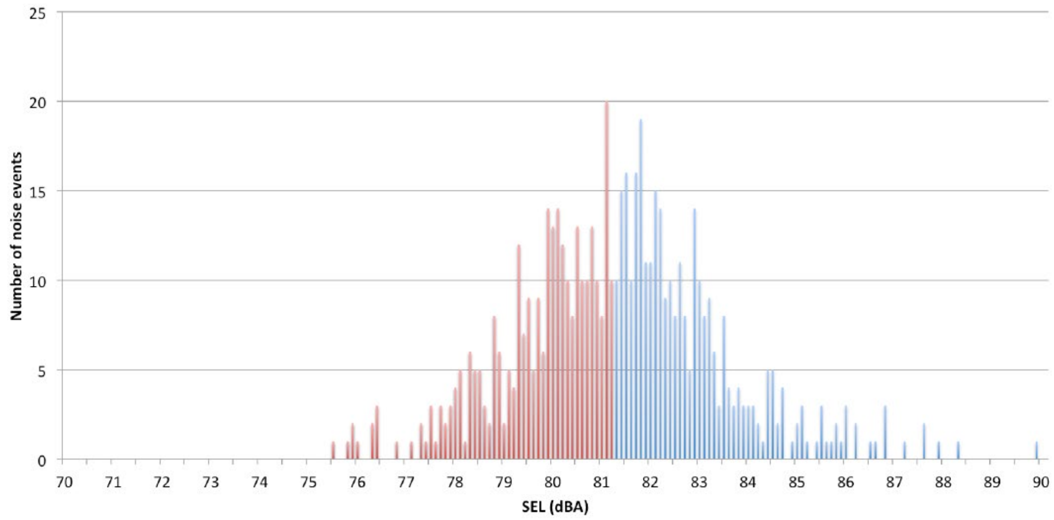
71. Edinburgh Airport to ERCD confirmed on 06/09/2018 that its noise monitors are subject to periodic verification that is traceable to National Standards.

72. Because Monitor EDI 01 is positioned on a school roof with nearby reflecting surfaces, it does not conform to the requirements set out in ISO 20906[7]. As noted in paragraph 60, EDI 01 was relocated to a site away from large reflecting surfaces on 19th September.

73. Monitor EDI 03 is sited to the side of the departure flight path (under the 06 arrival flight path) and as aircraft are at relatively low altitude compared with the distance to the side, measurements are subject to greater variability and uncertainty. ERCD normally excludes these measurements from its measurement analysis, unless a specific study is being carried out, which normally includes at least two microphones, one directly underneath the flight path and one to the side. This leaves only Monitor EDI 02 as a representative monitor location for comparison with calculated noise levels.

74. Measurement variability is an important factor and we welcome the EANAB providing measurement standard deviations alongside the average noise levels. Unfortunately Figure 2, reproduced below as Figure 8 for ease, conflates measurement uncertainty with a calculated average value. Aircraft noise calculations provide estimates of long-term average noise levels (L_{Amax} or SEL). Thus, in Figure 8, for a calculated average level that matches the mean level of a normally distributed set of measurements, one would expect half of the measurements to exceed the mean and half to be below the mean calculated level. This is not an underestimation of the impact, since studies that link noise levels with noise attitude surveys or other health impact assessments use average calculated or measured levels as the correlating parameter.

Figure 8: EANAB comparison of calculated levels vs measurement distribution

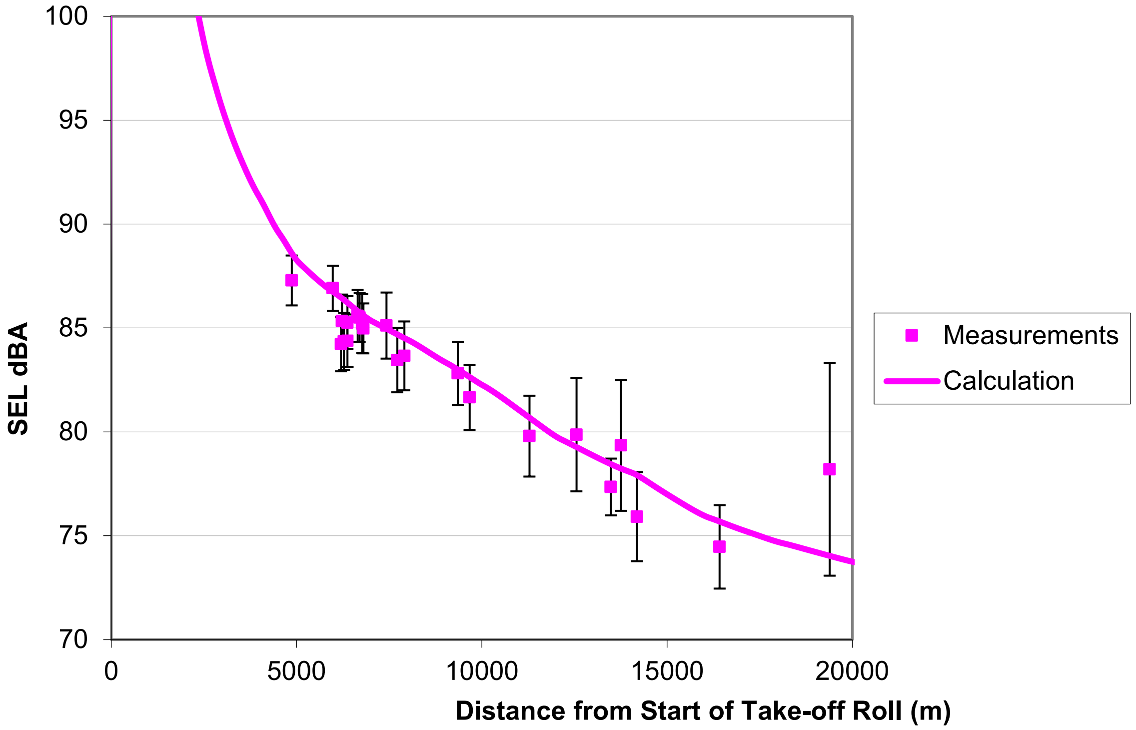


75. Secondly measurement uncertainty is different to calculation uncertainty. Measurement uncertainty relates to the precision of the instrument, the surroundings in the vicinity of the monitor, and atmospheric effects. Whilst atmospheric effects such as temperature and relative humidity that affect sound propagation through air, are part of local exposure, high windspeeds can

themselves generate high noise levels in the vicinity structures, e.g. nearby buildings or trees. Despite being precision instruments, two Class 1 Sound Level Meters, even from the same manufacturer, will not measure identical noise levels. ERCD has found mean measured differences of up to 0.8 dB between two monitors at the same site[4]. ERCD mitigates this by ensuring that, wherever possible, measurements are obtained as part of an array, minimising reliance on a single instrument.

76. Even when monitors are sited according to ISO 20906, we see that within an array of several monitors along a given SID, individual monitors may not align with overall trends. An illustration of this is provided in Figure 9, where some of the more distant average measured levels are inconsistent with the other monitors (i.e. they do not follow the shape of the calculation curve), but even then, the error bars show that some of the other monitors exhibit up to ±2 dB variability at similar track distances.

Figure 9: Example of measurement variability



source: ERCD analysis of summer 2017 Heathrow airport noise measurements

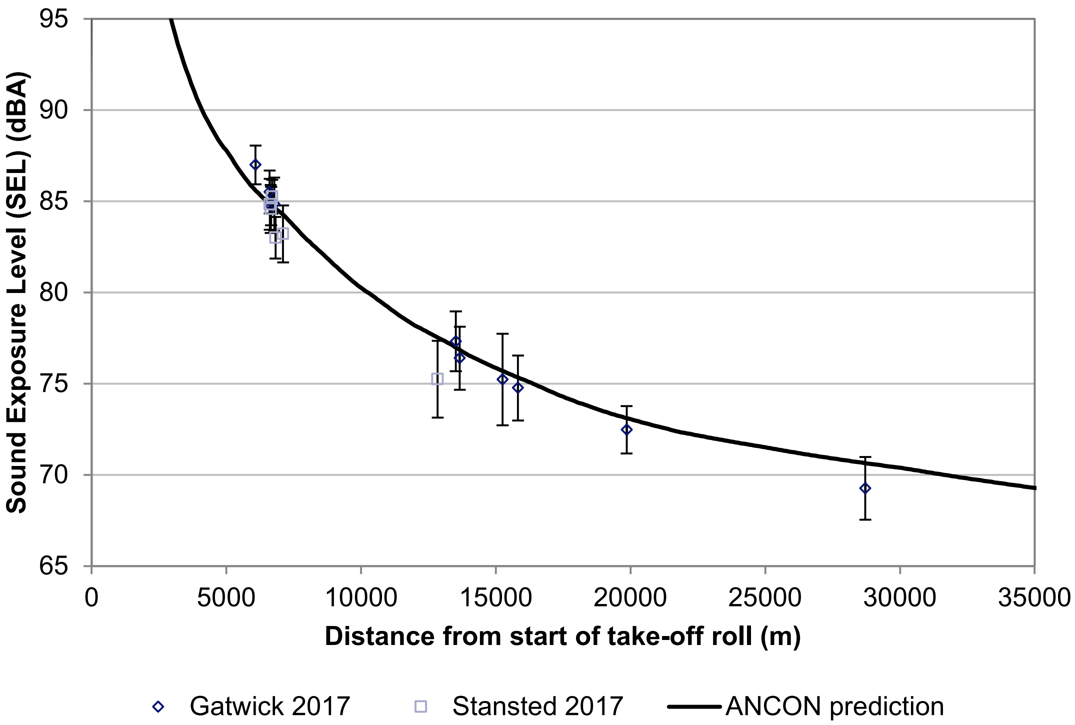
Measured noise level comparison across airports

77. Addressing the main criticism that measurements from another airport, Gatwick, are not representative of operations at Edinburgh Airport, Figure 10 compares noise measurements for the Airbus A319 (with CFM engines) from London Gatwick and Stansted airports. At 6.5 km from start of take-off roll, measurements are identical. At 12 km, there is a difference in the average noise

level of around 1 dB. However the Stansted measurements have large standard deviations (illustrated by the error bars), which overlap with the Gatwick measurements. Therefore, noting also the comments made previously regarding the ±1 dB uncertainty in noise measurements, one can conclude that the Stansted and Gatwick measurements are not significantly different.

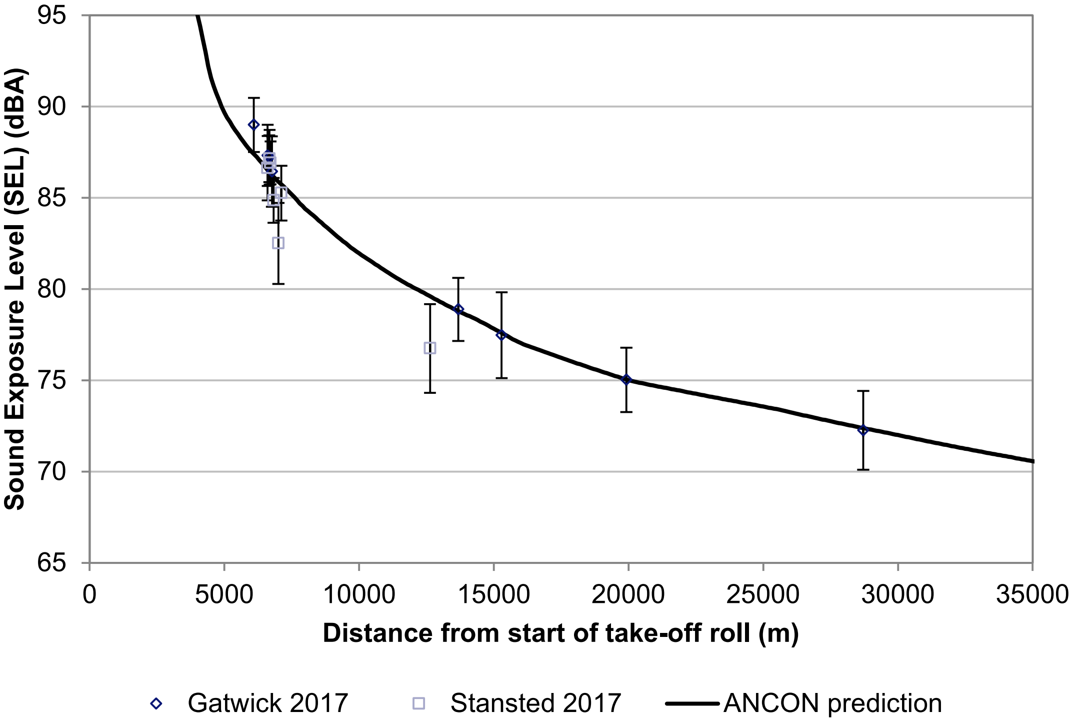
78. Figure 11 presents similar information for the Boeing 737-800 aircraft. Measurements at 6.5 km from start of take-off roll are nearly identical, as for the Airbus A319. At 12 km there is greater difference of around 2 dB, however the standard deviations, which indicate the variation in measurement values, are over 2 dB and thus it is difficult to justify that the mean measured values are different. Closer scrutiny of the data shows that B737-800 aircraft at Stansted are on average 9% higher at 12 km, again confirming that higher aircraft are less noisy on the ground for a given aircraft type and departure procedure.

Figure 10: Comparison of noise measurements from Gatwick and Stansted airports for the Airbus A319/CFM56 engines



source: ERCD analysis of summer 2017 Gatwick and Stansted airport noise measurements

Figure 11: Comparison of noise measurements from Gatwick and Stansted airports for the Boeing 737-800



source: ERCD analysis of summer 2017 Gatwick and Stansted airport noise measurements

Edinburgh Airport Noise Measurement Data

79. Edinburgh Airport recently provided noise measurement data from 2016 through to 2018 to EANAB and on 23/10/2018 to the CAA. The CAA had not previously requested this information as on the basis of the preferred methodology, it was not required. Figure 12 shows L_{Amax} noise measurements plotted against slant distance to NMT 1 for the Bombardier Dash 8 aircraft type. Slant distance is the closest distance between the aircraft and the noise monitor – it is the hypotenuse of the right-angle triangle formed by the aircraft height when nearest the noise monitor and the lateral distance of the aircraft to the side of the monitor. Directly overhead a monitor, the slant distance is almost the same as the aircraft height. There is a marked difference between noise measurements prior to April 2018 and from April 2018, when the Edinburgh NTK system was upgraded to a system provided by CASPER[12]. CASPER is the software system that integrates radar data and noise measurements and performs the noise event to aircraft operation matching. CASPER is also installed at London Gatwick airport. Noise levels for the Bombardier Dash 8 fall on average by more than 5 dB for post 5 April 2018 measurements compared with pre April 2018 measurements.

80. Figure 13 shows similar L_{Amax} noise measurements for the Airbus A319. The measurements appear much similar prior to April 2018 and after 5 April 2018. However, measurement scatter is reduced in the 2018 dataset. However, what is most striking is how similar the pre April 2018 measurements look to those of the Dash 8 in Figure 12. The findings indicate an issue with matching noise event to aircraft type prior to April 2018, most likely a time synchronisation issue between the noise measurements and the radar/operational data.

81. This becomes even more apparent in Figure 14, which shows Saab 340 aircraft noise events, also at NMT 1. The Saab 340 aircraft are operated by Loganair on the Highlands and Islands flights and rarely fly directly over NMT 1. However, even when many miles from NMT 1, prior to April 2018 they were often being assigned measurements around 70dB L_{Amax} similar to the A319. The A319 is the most common aircraft type operating at Edinburgh and thus it is not surprising, if there was a timing issue in the past, that noise measurements of the A319 (and other types) might be assigned to other aircraft operations. Time synchronisation issues are not uncommon; over the decades, the London airports' NTK systems have suffered from the same issue.

[12] http://casper.aero/index.php/products/casper-noise

82. Referring back to Table 2, SEL noise measurement information provided by the EANAB demonstrated close agreement with ANCON calculated values for the Airbus A320 using the Gatwick Airport noise and performance data. However, calculated levels for the Airbus A319 and Boeing 737-800 underpredicted measurements by 2-3dB. However, Figure 13 shows from April 2018, measured A319 noise levels have fallen by 1 dB reducing the difference to 1 dB, well within the measurement standard deviation. Post April 2018 measurements for the Dash 8 turboprop are within 1 dB of calculated levels. Although we have not been provided B737-800 measurement data, we believe the post April 2018 measurement data closely matches with ANCON calculated SEL values, demonstrating that the Gatwick Airport noise and performance data is representative of performance at Edinburgh Airport.

83. It is important to stress that the pre-April 2018 noise measurement data was not used in the ERCD's noise analysis model so the discrepancies did not impact our analysis used in Edinburgh Airport's recent airspace change proposal.

Figure 12: Bombardier Dash 8 noise levels at Edinburgh NMT 1

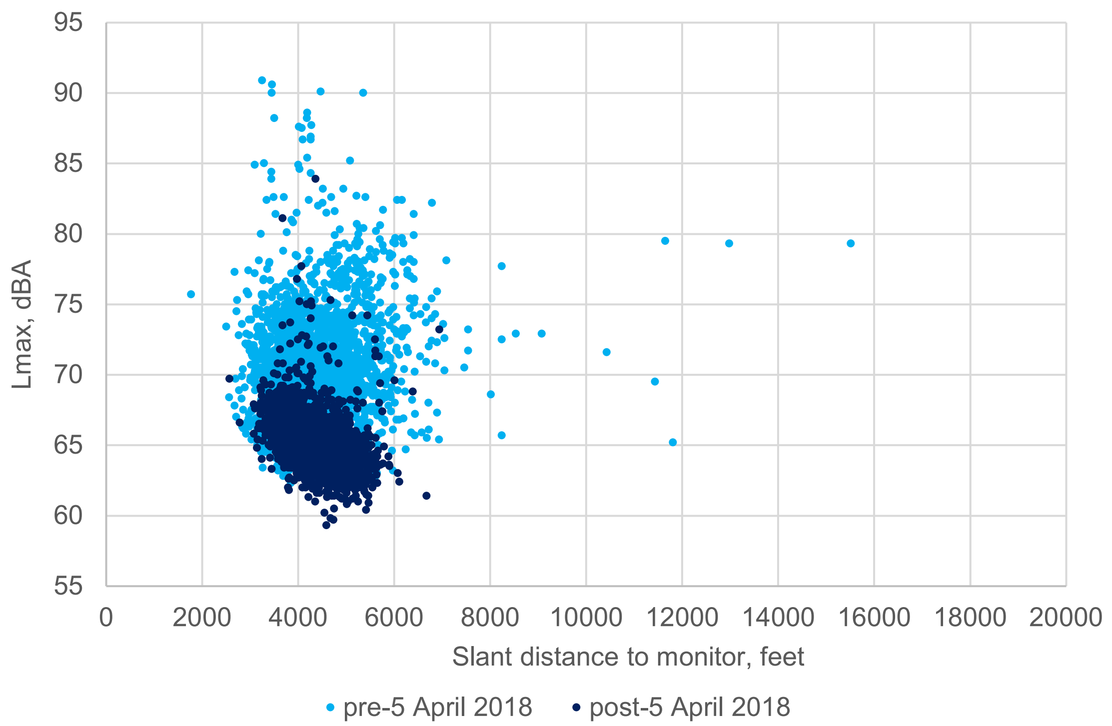


Figure 13: Airbus A319 noise levels at Edinburgh NMT 1

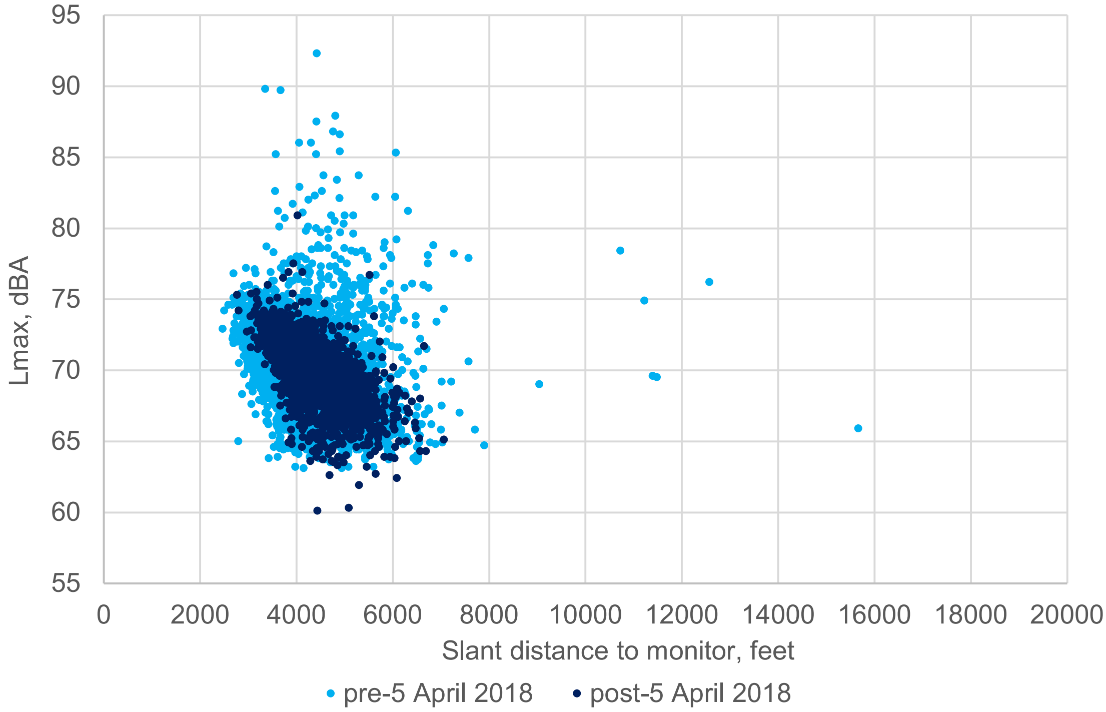
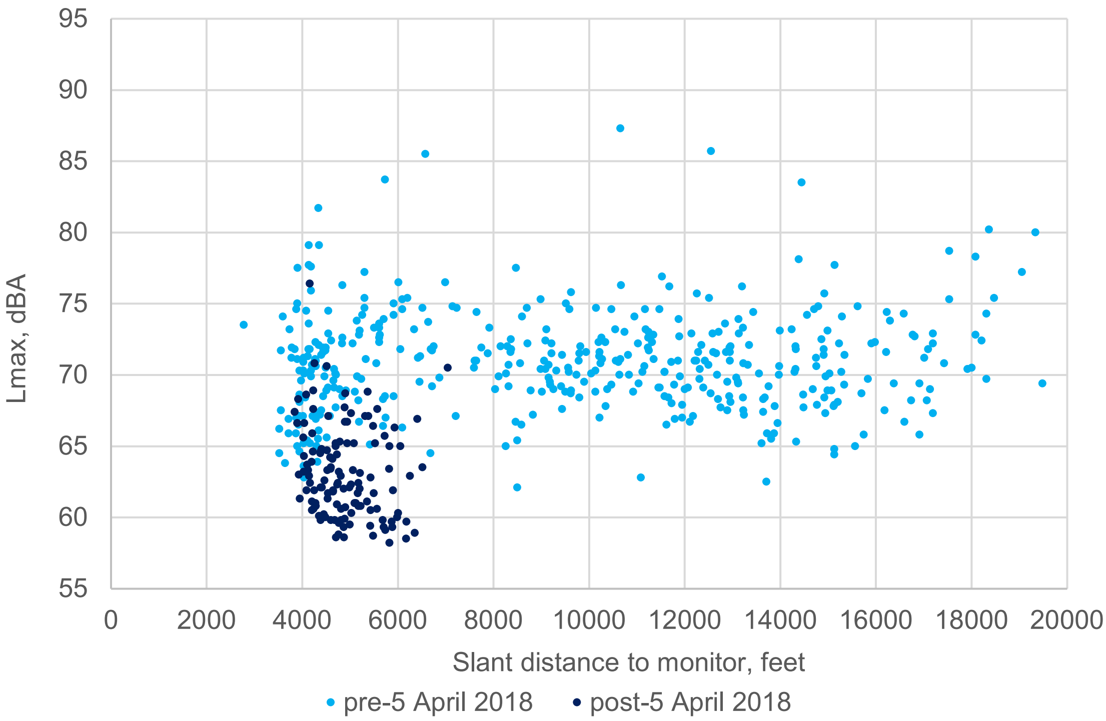


Figure 14: Saab 340 noise levels at Edinburgh at NMT 1



ANCON L_{Amax} validation issue

84. The EANAB calculation and measurement comparison highlighted differences for the L_{Amax} noise metric. Calculations under predicted measurements, even for the Airbus A320, where SEL measurements matched calculated values.

85. L_{Amax} represents the maximum noise level of an event. It is empirically related to the Sound Exposure Level (SEL), which also reflects how long a noise event lasts for. Typical aircraft noise events last 20-40 seconds. For two events with the same L_{Amax} but one with twice the duration, the SEL of the event lasting twice as long will 3 dB higher than the shorter event.

86. As explained earlier, SEL is the 'building block' required to calculate L_{Aeq}, whereas L_{Amax} has no direct relationship with L_{Aeq} and is not required to calculate L_{Aeq}. As a consequence, for 25 years the ANCON noise model has been validated against measurements for SEL only (i.e. comparing calculated SEL values with SEL measurements). No direct comparison of L_{Amax} calculations and measurements has been performed until recently. But, where adjustments are made to SEL values to match to measurements, the same adjustments were historically also applied to calculated L_{Amax} values. This was considered proportionate in view of L_{Amax} being a supplemental indicator, and of the additional resources necessary to undertake the separate validation of the L_{Amax} indicator.

87. Despite L_{Amax} continuing to be a supplementary noise indicator, it gained greater status in the government's recent airspace and noise consultation[13]. In light of the increased importance placed on the L_{Amax} measure, in Q1 2018 ERCD carried out a formal comparison of L_{Amax} calculations and measurements using summer 2017 noise measurement data from Heathrow, Gatwick and Stansted airports. For some aircraft, the L_{Amax} calculations were found to be a close match with measurements, some were overestimated by up to 3 dB, but for the most common aircraft types, the Airbus A319 and A320 flown by easyJet and British Airways, measured L_{Amax} values were found to be underestimated by 2-3 dB. The ANCON database has thus been updated.

88. The update carried out in 2018 does not undermine or adversely affect assessments completed in earlier years. Edinburgh Airport presented L_{Aeq}, SEL and L_{Amax} noise information in its second airspace consultation between January and May 2017 (but not its first and third consultation, nor its final proposal

[13] UK Airspace Policy: A framework for balanced decisions: on the design and use of airspace, CM 9397, Department for Transport, February 2017.

submitted to the CAA in August 2018). This data was calculated in 2016 using the latest available L_{Amax} estimates from 2015. Because ERCD undertakes annual comparisons with noise measurements, data are subject to refinement and adjustment on an annual basis. We are also clear that we use the latest available information and in the case of the Edinburgh Airport's second airspace change consultation, our supporting document indicated that the data was validated using summer 2015 noise data measured at Gatwick.

89. Comparisons using summer 2017 Gatwick noise and performance databases, validated against both L_{Amax} and SEL measurements, show calculated levels of both L_{Amax} and SEL to be within 1 dB of measurements for the Airbus A319, A320 and the Bombardier Dash 8.

Conclusions and Recommendations

90. This note has outlined the international guidance on the calculation of noise in the vicinity of airports and information provided by the aircraft manufacturers through the associated ICAO Aircraft Noise and Performance database referred to in the guidance.

91. UK's ANCON version 2 aircraft noise calculation model fully conforms to international guidance. However, aircraft performance at UK airports is seen to differ from the standard operating assumptions and noise characteristic data contained in the ANP database. Continuing the tradition established with empirical aircraft noise models, the ANP database is adapted to better reflect local UK airport conditions. The adaptation requires access to large volumes of radar trajectory data and noise measurements made at a number of positions under the take-off and landing flight paths, in order to capture the different phases of flight.

92. Except for smaller airports where noise contours do not extend far beyond the airfield boundary, and/or expose relatively few people to aircraft noise, the CAA's view is that it is necessary to adapt the ANP database to the local situation, and not use the default data provided.

93. However, not all UK airports have the capability to provide the information required to adapt the ANP database. Although one option is to define a minimum level of information that would facilitate the ANP database being adjusted on a per airport basis, there would be costs of doing so.

94. Measured noise levels for the same airline/aircraft type operating at two different UK airports were shown to be in close agreement, reflecting the standard operating procedures used by airlines to ensure a high degree of safety. Such findings show that it is reasonable, proportionate and cost-effective, to base noise calculations on an ANP database based on adjustments calculated at another airport.

95. Whilst we have some concerns about the previous number and siting of noise monitors at Edinburgh Airport, based on the latest available noise measurements since the CASPER Noise and Track Keeping system was installed at Edinburgh Airport in April 2018, SEL noise measurements show good agreement with calculated levels based on an ANP database adapted using Gatwick Airport radar and noise measurement information. However, calculated L_{Amax} noise levels for key aircraft types such as the Airbus A319 and A320 were underestimated by up to 3 dB, affecting calculations for several UK airports, including Edinburgh. Because L_{Amax} is not required for the calculation of L_{Aeq} or

L_{den} the underestimation of L_{Amax} has had no effect on long-term average noise contours used for airport master-planning and fulfilling the requirements of the Environmental Noise Directive.

Recommendations

96. While the CAA remains confident in its ANCON model, it has a number of recommendations that it will implement following the conclusion of the Edinburgh Airport airspace change process:

- The CAA would like to arrange a seminar with EANAB and other interested stakeholders to discuss the conclusions presented in this report.
- Edinburgh Airport should consider and address as appropriate the noise measurements issues identified in this report such as the location and number of microphones and confirming the time synchronisation issues in the pre-April 2018 data.
- Having addressed these issues, Edinburgh Airport should consider carefully and consciously decide upon the appropriate methodology for the production of noise contours that will inform its stakeholders and any airspace change process.Any airport where noise is an issue or is contemplating making an airspace change where noise will be a consideration should satisfy themselves, using a qualified external party if required, about the validity and reliability of their noise data and input data for noise modelling and create a reliable baseline before starting any process.
- CAA will publish a more general form of guidance about how noise can be modelled and measured to inform other airports, particularly important for those considering making airspace change proposals, of:
  - issues to consider, such as avoiding the time synchronisation issue
  - best practice regarding audit and maintenance of noise monitors
  - how airports should publish information about their noise methodology.