UK Civil Aviation Authority

The UK Civil Aircraft Noise Contour Model ANCON: Version 3

CAP 3294



Published by the Civil Aviation Authority 2026

Civil Aviation Authority
Aviation House
Beehive Ring Road
Crawley
West Sussex
RH6 0YR

You can copy and use this text but please ensure you always use the most up to date version, credit the CAA and use it in context so as not to be misleading,

November 2026

Enquiries regarding the content of this publication should be addressed to: noise@caa.co.uk

The latest version of this document is available in electronic format at: www.caa.co.uk/CAP3294

Contents

Contents 3
Summary 5
Chapter 1 7
Introduction 7
Purpose and status of this report 7
Chapter 2 9
Development of ANCON-3 9
Aircraft noise calculation methodology 11
Chapter 3 13
Assurance of ANCON-3 13
Verification against ECAC Doc 29 reference cases 13
ECAC Doc 29 verification conclusion 15
Comparison with ANCON-2 15
Comparison with ANCON-2 conclusion 16
Inter-model comparison 16
Inter-model comparison conclusion 17
Independent peer review 17
Peer review conclusion 19
Overall assurance conclusions 19
Chapter 4 20
Governance and operational implementation 20
Governance conclusion 20
Chapter 5 21
Conclusions 21
Glossary 22
Appendix A 23
ECAC Doc 29 reference case verification 23
A1 Purpose 23

A2 Reference-case combinations **24**
A3 Segmental verification **24**
A4 Receptor-based SEL verification **25**
A5 Grid-based SEL verification **26**
A6 Verification conclusion **26**
Appendix B **28**
Noise-designated airport comparison between ANCON-2 and ANCON-3 **28**
B1 Purpose of the comparison **28**
B2 Airports, years and metrics **28**
B3 Presentation of results **29**
B4 Summary of 2022 and 2023 comparisons **29**
B5 Heathrow 2024 comparison **29**
B6 Gatwick 2024 comparison **34**
B7 Stansted 2024 comparison **38**
B8 Overall findings from the ANCON-2 and ANCON-3 comparison **42**
Appendix C **43**
Inter-model comparison between ANCON-3, IMPACT and AEDT **43**
C1 Purpose of the inter-model comparison **43**
C2 Scenario and aligned modelling assumptions **43**
C3 Inter-model contour area comparison **44**
C4 Inter-model comparison findings **44**

Summary

This report describes Version 3 of the UK Civil Aircraft Noise Contour Model, referred to as ANCON-3. ANCON is developed, maintained and operated by the CAA's Environmental Research and Consultancy Department (ERCD) on behalf of the Department for Transport (DfT). ANCON is used to generate aircraft noise exposure contours that support statutory reporting, policy assessment, airport planning and other public decision-making.

ANCON-3 succeeds the previous version (ANCON-2). This CAP summarises what has changed from ANCON-2 and the evidence used to establish confidence in ANCON-3 as a robust successor for future UK aircraft noise contour studies.

ANCON-3 has been developed to modernise the software implementation of ANCON while retaining the established aircraft noise calculation methodology prescribed by ECAC Doc 29. The transition from ANCON-2 to ANCON-3 is therefore a controlled modernisation of the software implementation, not a change in the underlying aircraft noise calculation method. ANCON-3 also provides improved operational resilience, maintainability, efficiency and capability to support future aircraft noise assessment requirements.

Verification against the ECAC Doc 29 Volume 3 reference cases demonstrates that ANCON-3 closely reproduces the published reference results and meets the recommended grid-based RMS value. Additional verification undertaken by ERCD provided further assurance at lower noise levels relevant to UK aircraft noise contour studies.

ANCON-3 was developed and verified against the Fourth Edition of ECAC Doc 29. The Fifth Edition of ECAC Doc 29 was published on 19 May 2026, with no change to the underlying noise calculation method implemented in ANCON-3.

Additional assurance was obtained through comparison with other recognised aircraft noise models and through independent technical peer review. Together, these activities demonstrated that ANCON-3 produces results consistent with recognised implementations of the ECAC Doc 29 methodology.

Comparisons between ANCON-3 and ANCON-2 were undertaken for Heathrow, Gatwick and Stansted across three reporting years: 2022, 2023 and 2024. The comparisons considered contour area, population exposure and contour alignment across the L_{Aeq} and N-above metrics used in UK aircraft noise assessment. The results provide evidence that the transition does not materially affect operational contour results when equivalent input data and modelling assumptions are used. These comparisons provide a continuity assessment and are supplementary to the formal ECAC Doc 29 verification.

Taken together, the verification, comparison and peer-review evidence provide assurance that ANCON-3 correctly implements the ECAC Doc 29 methodology and can be used with confidence for future UK aircraft noise contour studies.

Chapter 1

Introduction

1.1 The UK Civil Aircraft Noise Contour Model, known as ANCON, is used to calculate aircraft noise exposure around civil airports. It is developed, maintained and operated by the CAA's Environmental Research and Consultancy Department (ERCD) on behalf of the Department for Transport (DfT).

1.2 ANCON is primarily used to generate aircraft noise outputs for the UK airports designated for noise management by the Secretary of State for Transport and other UK airport assessments. These outputs support contour production, statutory reporting, policy assessment, airport planning and other public decision-making. ANCON is recognised within DfT as a business-critical analytical model and is therefore subject to appropriate technical assurance, governance, documentation and quality control.

1.3 This report describes ANCON Version 3 (ANCON-3), the latest operational version of ANCON. It summarises what has changed from its predecessor, ANCON Version 2 (ANCON-2), the aircraft noise calculation methodology implemented by ANCON-3, and the evidence used to establish confidence in its outputs.

Purpose and status of this report

1.4 This report provides the technical and assurance summary for ANCON-3. It explains the model's relationship to previous versions of ANCON, summarises the calculation methodology implemented by ANCON-3, and presents the verification, comparison, independent peer review and governance evidence supporting its operational use.

1.5 ANCON-2 was developed during the late 1990s and documented in R&D Report 9842, *The UK Civil Aircraft Noise Contour Model ANCON: Improvements in Version 2*, published in 1999. The report documented the changes from ANCON Version 1 and remains the reference document for the changes introduced in ANCON-2.

1.6 Both ANCON-2 and ANCON-3 implement the aircraft noise calculation methodology prescribed in the European Civil Aviation Conference (ECAC) Report on Standard Method of Computing Noise Contours around Civil Airports, ECAC Doc 29[1]. The transition to ANCON-3 is therefore a modernisation of the

[1] ECAC Doc 29, Report on Standard Method of Computing Noise Contours around Civil Airports, Fifth Edition, published May 2026, European Civil Aviation Conference

software implementation, not a change in the underlying aircraft noise calculation methodology.

1.7 ECAC Doc 29 is internationally recognised guidance for assessing aircraft noise exposure around airports. It sets out a common approach to preparing noise assessments, including the calculation method, the information needed to apply it and procedures for checking that noise-modelling software implements the method correctly. It is published by the European Civil Aviation Conference (ECAC) and is widely used to support consistent and technically robust aircraft noise assessment.

1.8 ECAC Doc 29 is structured in three volumes:

- Volume 1 provides a general introduction and practical guidance for users.
- Volume 2 defines the methodology for calculating aircraft noise exposure around civil aerodromes.
- Volume 3 provides reference cases and procedures for verifying software implementations of the methodology.

1.9 This report describes the implementation of the Volume 2 calculation methodology in ANCON-3 and the verification of that implementation using the Volume 3 reference cases, together with the additional comparison, peer-review and governance evidence supporting its operational use.

Chapter 2

Development of ANCON-3

2.1 Since the early 1990s, ANCON has supported the assessment of aircraft noise around UK airports. ANCON-2 was developed during the late 1990s as the successor to ANCON Version 1. The technical improvements introduced in ANCON-2, including the transition from the Reference Noise Level (RNL) approach to the Noise-Power-Distance (NPD) approach adopted in ANCON-2, are documented in R&D Report 9842[2].

2.2 ANCON-2 remained technically robust and continued to provide the established operational implementation of the ECAC Doc 29 methodology through minor updates to the model, the latest of which was ANCON Version 2.4. However, its legacy software environment had become increasingly difficult to maintain, support and develop. This reduced long-term resilience, created knowledge retention and testing challenges, limited opportunities to introduce new functionality, and constrained the ability to respond efficiently to future modelling requirements and changes in international guidance.

2.3 ANCON-3 has therefore been redeveloped in the C# software language using a modern architecture with modular software components, version-controlled source code, improved automated testing capability and more flexible data handling. These changes improve maintainability, supportability and future capability while preserving the underlying ECAC Doc 29 calculation methodology.

2.4 The legacy software implementation also placed increasing practical constraints on computational performance and on the scale and complexity of analyses that could be undertaken efficiently. Future aircraft noise assessments are expected to require larger modelling domains, calculations to lower noise levels, finer computational grids, batch processing and more detailed operational scenarios. A modern software implementation was therefore needed to preserve and strengthen the long-term capability of the UK Civil Aircraft Noise Contour Model. Consequently, ANCON-3 reduces these constraints, allowing larger and more detailed analyses to be undertaken efficiently and providing a stronger basis for future development.

2.5 ANCON-2 also constrains the wider modelling workflow. Its bespoke input and output formats are embedded in established upstream data-preparation and

[2] Civil Aviation Authority, R&D Report 9842, The UK Civil Aircraft Noise Contour Model ANCON: Improvements in Version 2, 1999.

downstream processing. As further development of the legacy implementation is constrained, those interfaces and supporting processes cannot readily be adapted. This limits opportunities to improve automation, integration, operational resilience and efficiency across the end-to-end modelling process.

2.6 The modernisation provides the practical capability and performance benefits summarised in Table 1.

Table 1: Comparison of ANCON-2 and ANCON-3 software capabilities

Characteristic	ANCON-2	ANCON-3
Software implementation	Legacy FORTRAN 77 architecture	Modern C# architecture
Operational resilience	Reliant on legacy software, limited specialist expertise and established bespoke processes	Modern architecture designed to improve supportability, continuity and knowledge transfer
Workflow and data integration	Bespoke input and output formats constrain changes to upstream data preparation and downstream processing	Flexible data handling supports controlled improvement of inputs, outputs and wider modelling workflows
Analysis capacity	Fixed or practical limits on routes, receptor points and grid size	Practical limits on routes, receptor points and grid size increased
Automated testing support	No automated test framework	Supports automated, repeatable software tests
Future enhancement capability	Severely limited by the legacy codebase and availability of relevant expertise	Modular architecture supports controlled modification and extension
Long-term maintainability	Dependent on legacy FORTRAN 77 code and specialist expertise	C# codebase, version control and modular components support routine maintenance

2.7 The software changes summarised in Table 1 do not change the underlying ECAC Doc 29 aircraft noise calculation methodology. They improve the operational resilience, maintainability and flexibility of the model and provide a basis for improving the wider end-to-end modelling workflow. This includes the preparation of data for ANCON and the subsequent processing, reporting and analysis of model outputs. The verification and comparison evidence presented in Chapter 3 demonstrates that the transition from ANCON-2 to ANCON-3 does not materially affect operational contour results when equivalent input data and modelling assumptions are used.

2.8 ECAC Doc 29 is the primary reference for the ANCON-3 calculation methodology and verification framework. It is harmonised with the corresponding ICAO guidance in ICAO Doc 9911, *Recommended Method for Computing Noise Contours Around Airports*[3]. The CAA has contributed to the development and maintenance of ECAC Doc 29 through ERCD's technical expertise and practical experience developing, maintaining and applying ANCON in UK and international studies. This helps ensure that ANCON continues to reflect recognised international practice while meeting the requirements of UK aircraft noise assessment.

Aircraft noise calculation methodology

2.9 ANCON-3 implements the aircraft noise calculation methodology prescribed in ECAC Doc 29. Aircraft noise emissions are described using NPD relationships, which relate noise level to aircraft engine power setting and distance from the aircraft. ANCON applies these data along modelled flight paths and combines noise calculated from individual aircraft movements to produce cumulative noise exposure metrics and number-above metrics used in UK aircraft noise assessment.

2.10 ANCON calculates aircraft noise exposure using aircraft movement data, aircraft type information, flight tracks, vertical flight profiles, aircraft noise and performance data, runway use, and meteorological and terrain information. Modelled noise contours may subsequently be combined with population data to estimate the number of people exposed at different noise levels. The development of study inputs should be proportionate to the purpose and potential impact of the assessment, consistent with the modelling sophistication principles set out in CAP 2091 – *CAA Policy on Minimum Standards for Noise Modelling*[4].

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

[4] Civil Aviation Authority, CAP 2091, CAA Policy on Minimum Standards for Noise Modelling, January 2021.

2.11 This report focuses on the implementation and assurance of ANCON-3. The development and assurance of study-specific inputs are outside its scope, although the quality and suitability of those inputs remain essential determinants of overall study quality.

2.12 Aircraft noise contour outputs depend on both the calculation methodology and the input data used in each study. The reliability of any contour study therefore depends on the quality, suitability and traceability of the study inputs, including movements, fleet allocation, routes, tracks, flight profiles, noise and performance data, runway modal splits, terrain and population datasets.

2.13 Where equivalent input data and modelling assumptions are used, the two model versions are therefore expected to produce closely comparable results.

2.14 The following section describes the verification, comparison and assurance undertaken to demonstrate that ANCON-3 correctly implements ECAC Doc 29 and produces results consistent with ANCON-2 and other recognised aircraft noise models.

Chapter 3

Assurance of ANCON-3

3.1 Operational use of ANCON-3 requires assurance that it correctly implements ECAC Doc 29 and produces results consistent with other recognised implementations when comparable input data and assumptions are used.

3.2 ERCD established this assurance through four complementary assurance activities:

- Verification against the ECAC Doc 29 Volume 3 reference case scenarios to demonstrate that ANCON-3 correctly implements the published methodology.
- Comparison with ANCON-2 using aircraft noise contour studies for Heathrow, Gatwick and Stansted to understand practical continuity between model versions.
- Inter-model comparison with recognised aircraft noise models that also implement the ECAC Doc 29 methodology or the harmonised ICAO Doc 9911 methodology, namely EUROCONTROL's IMPACT and the Federal Aviation Administration's (FAA) Airport Environmental Design Tool (AEDT) respectively.
- Independent peer review by the Netherlands Aerospace Centre (NLR), providing external technical assessment of the implementation, verification evidence and supporting model comparisons, including comparison with NLR's Tuna model.

3.3 Together, these activities confirm that ANCON-3 correctly implements the ECAC Doc 29 methodology and produces results consistent with other compliant models. The following sections report on these activities in turn.

Verification against ECAC Doc 29 reference cases

3.4 ECAC Doc 29 Volume 3 provides reference cases for testing software implementations of the Volume 2 aircraft noise calculation methodology. These reference cases use defined aircraft, route and operating inputs together with published reference results, so that a model can be checked against known outputs.

3.5 The verification framework contains three types of checks:

- Segmental results evaluate whether the flight path is constructed correctly.

- Receptor-based Sound Exposure Level (SEL) results test event-level noise at specified locations.
- Grid-based SEL results evaluate calculated noise levels across a wider grid of receptor points.

3.6 In total, the reference cases comprise twelve combinations of three hypothetical fixed-wing aircraft types operating on arrival and departure procedures over straight and curved routes.

3.7 The segmental checks confirm that ANCON-3 correctly constructs the flight path segments required by the ECAC Doc 29 methodology. The checks covered the segmental calculation parameters defined in the ECAC Doc 29 Volume 3 reference case specification, including geometry, propagation, directivity and noise-energy calculations.

3.8 The receptor-based SEL results evaluate the calculation of event noise levels for individual aircraft operations. SEL is an important verification metric because it is the event-level building block from which exposure metrics such as L_{Aeq} are derived. Correct SEL calculation requires integration of noise contributions across all relevant trajectory segments, not simply the segment closest to the receptor. For five of the twelve reference cases, one or more receptor locations showed a difference of -0.01 dB compared with the reference result. For the remaining cases, differences were less than 0.005 dB. The maximum absolute receptor-based SEL difference reported in this verification was 0.01 dB.

3.9 The grid-based SEL results provide the most comprehensive verification test because they compare calculated noise levels across a grid of receptor locations. ECAC Doc 29 applies this comparison to grid points where calculated noise levels are 80 dB SEL or more. Differences between the development model and the reference grid results are summarised using the root-mean-square (RMS) difference so that positive and negative differences do not cancel each other out and therefore contribute equally to the magnitude of the difference. ECAC Doc 29 states that the aim is to reduce the RMS difference to the order of 0.01 dB or less. ANCON-3 achieved a maximum RMS difference of 0.008 dB across the published reference-grid results and therefore met the recommended RMS value.

3.10 ERCD also undertook additional verification beyond the published reference-grid comparison. ERCD extended this comparison beyond the 80 dB SEL threshold by using the complete reference grid generated from EUROCONTROL's IMPACT implementation, which was developed as part of the ECAC Doc 29 verification framework. This enabled comparison before applying the 80 dB SEL threshold used in the published reference-grid verification. The extended comparison produced a maximum RMS difference of 0.003 dB, providing

additional assurance that ANCON-3 maintains numerical consistency at lower noise levels relevant to aircraft noise contour studies.

3.11 These differences are numerical measures used to verify the software implementation; they are much smaller than differences normally considered in the interpretation of environmental noise due to measurement and operational uncertainties. The detailed ECAC Doc 29 reference case verification results are provided in **Appendix A**.

ECAC Doc 29 verification conclusion

3.12 Verification against the ECAC Doc 29 Volume 3 reference cases demonstrated that ANCON-3 closely reproduces the published reference results and meets the recommended RMS value.

Comparison with ANCON-2

3.13 The ECAC Doc 29 reference case verification is the primary test of whether ANCON-3 correctly implements the prescribed calculation methodology. The comparison with ANCON-2 was undertaken as a continuity check to understand the practical effect of moving from the previous operational version of ANCON (specifically ANCON Version 2.4) to ANCON-3. ANCON-2 and ANCON-3 both implement the ECAC Doc 29 methodology, so close agreement would be expected when equivalent input data and modelling assumptions are used.

3.14 The comparison used aircraft noise contours produced using ANCON-3 and corresponding contours generated using ANCON Version 2.4 for Heathrow, Gatwick and Stansted. Together, outputs from these airports provide a robust basis for comparison because they comprise different airport layouts, runway configurations, traffic mixes, route structures, operating patterns and surrounding population distributions.

3.15 The comparison was undertaken for aircraft noise metrics commonly used in UK aircraft noise assessment, including $L_{Aeq,16h}$, $L_{Aeq,8h}$ and N-above metrics such as N65 and N60, where corresponding results calculated using ANCON Version 2.4 were previously published. The assessment considered contour area, population exposure and contour shape and alignment.

3.16 Greater emphasis was placed on L_{Aeq} contour area and contour alignment because these are direct model outputs and provide a stable basis for assessing continuity between model versions. Population exposure is derived by overlaying modelled contours on population datasets and is therefore additionally influenced by the spatial distribution of population around contour boundaries. Small changes in contour area and/or shape can consequently produce larger relative changes in reported population exposure without indicating a substantive change in model performance. Population results were therefore interpreted accordingly alongside contour-area and contour-alignment comparisons.

3.17 Comparisons were first undertaken for 2022, with further comparisons made for 2023 and 2024 to evaluate whether the conclusions remained valid across subsequent annual contour studies. The detailed comparison tables and contour maps presented in **Appendix B** use the 2024 results, as these were the most recent annual contour results available at the time the analysis was undertaken. The 2022 and 2023 comparisons showed the same overall agreement.

3.18 Across Heathrow, Gatwick and Stansted, the comparison demonstrated that ANCON-3 produces results consistent with ANCON-2. For the 2024 L_{Aeq} comparisons, contour area differences ranged from -1.6% to +0.1%, and population exposure differences ranged from -0.1% to +0.3%. The -1.6% contour area difference related to the Heathrow 72 dB $L_{Aeq,8h}$ contour, which enclosed less than 0.7 km² and had no exposed population in the results of either model.

3.19 For the 2024 N-above comparisons, contour-area differences ranged from -0.3% to +4.9%, and population-exposure differences ranged from -1.5% to +2.0%. The largest contour-area difference occurred for the Gatwick N60 night-time >100 events contour, which enclosed less than 1.2 km² and fewer than 100 people according to either model.

Comparison with ANCON-2 conclusion

3.20 The comparison considered three airports, three reporting years and multiple aircraft noise metrics. For the 2024 L_{Aeq} comparisons, contour-area differences ranged from -1.6% to +0.1%, and population-exposure differences ranged from -0.1% to +0.3%. The largest percentage contour-area difference related to a contour of less than 0.7 km² with no exposed population.

3.21 For the 2024 N-above comparisons, contour-area differences ranged from -0.3% to +4.9%, and population-exposure differences ranged from -1.5% to +2.0%. The largest percentage difference related to a small contour with no material difference in population exposure.

3.22 These results are well within and will not materially contribute to the 1 dB overall uncertainty that is accepted for L_{Aeq} noise contour calculations. 1 dB equates to approximately 20% in noise contour area. The results therefore demonstrate that the transition from ANCON-2 to ANCON-3 does not materially affect the operational contour results.

Inter-model comparison

3.23 The inter-model comparison was undertaken as supplementary assurance at airport-study scale. It evaluates contour production using a representative traffic scenario.

3.24 The inter-model comparison used the Heathrow summer 2023 daytime traffic scenario. Heathrow was selected because it represents the largest and most

complex UK operational aircraft noise modelling application, with high traffic volumes, a diverse fleet mix, extensive route structures, radar-derived tracks and large exposed populations. It therefore provides a demanding airport-level test case for inter-model comparison.

3.25 The scenario used the same radar-derived tracks and operational flight profiles as were used in the ANCON-2 comparison for 2023 as reported in the previous section.

3.26 The comparison was first undertaken between ANCON-3, ANCON-2 and IMPACT. The ANCON results included terrain, while the IMPACT comparison did not. Following NLR's review, ERCD refined the comparison by applying consistent terrain assumptions and adding AEDT. The final comparison presented in Appendix C compares outputs with terrain excluded from all three models.

3.27 In the no-terrain comparison, IMPACT contour areas differed from ANCON-3 by -0.2% to +0.2% across the reported contour levels. AEDT contour areas were lower than ANCON-3 at all reported noise levels, with differences ranging from -1.9% to -1.1%.

3.28 These percentage differences in contour area are equivalent to decibel changes of less than ±0.1 dB. These results are therefore well within the overall ±1 dB uncertainty that is commonly accepted for noise contour calculations. The detailed inter-model comparison results between ANCON-3, IMPACT and AEDT are provided in **Appendix C**.

Inter-model comparison conclusion

3.29 The airport-level inter-model comparison demonstrated that ANCON-3 produces aircraft noise contour results consistent with IMPACT and AEDT when aligned modelling assumptions are used.

Independent peer review

3.30 An independent technical peer review of ANCON-3 was commissioned and undertaken by NLR. This provides external assurance from an organisation with expertise in aircraft noise modelling and implementation of the ECAC Doc 29 calculation method. The peer review focused on the implementation of the ECAC Doc 29 aircraft noise calculation methodology in ANCON-3 and the supporting verification and comparison evidence.

3.31 The peer review comprised three main elements:

- Comparison of ANCON-3 with the ECAC Doc 29 Volume 3 reference case results.

- Review of the Heathrow inter-model comparison between ANCON-3, ANCON-2 and EUROCONTROL's IMPACT model.
- Comparison of ANCON-3 outputs with NLR's Tuna model using a reference-case based L_{den} scenario to evaluate cumulative contour results beyond the standard ECAC Doc 29 Volume 3 reference case outputs.

3.32 NLR's independent comparison of ANCON-3 with the ECAC Doc 29 Volume 3 reference case results found that 86 of the 99 applicable receptor results were identical at the precision of the published reference results. Thirteen receptor results showed minor differences ranging from -0.01 dB to +0.03 dB. NLR investigated these differences using the segmental results and concluded that they were small and not material.

3.33 NLR independently confirmed that the grid-based RMS differences were within the ECAC Doc 29 recommended value, providing strong evidence that ANCON-3 correctly implements the ECAC Doc 29 Volume 2 method.

3.34 NLR also reviewed ERCD's Heathrow comparison between ANCON-3, ANCON-2 and EUROCONTROL's IMPACT model. NLR concluded that the comparison showed similar contour locations and contour areas between ANCON-3 and the other recognised ECAC Doc 29 implementations, noting only small differences that were consistent with differences in model setup and contour-generation approaches.

3.35 NLR additionally compared ANCON-3 outputs with its Tuna model using a reference-case-based L_{den} scenario extending beyond the standard ECAC reference-case domain. NLR found the resulting contour lines to be practically identical and reported relative contour-area differences of 0.0% at all contour levels considered.

3.36 NLR concluded that, based on its review, ANCON-3 correctly implements the ECAC Doc 29 Volume 2 method, is compliant with the standard and can be used with confidence to produce ECAC Doc 29-compliant aircraft noise results.

3.37 The peer review was a technical verification of ANCON-3 against the ECAC Doc 29 Volume 2 method, based on input data and results provided by the CAA. NLR did not have access to the ANCON-3 software or its source code. The review focused on verification and did not include validation against measured aircraft noise.

3.38 The full NLR peer review report[5] is available alongside this report.

[5] Netherlands Aerospace Centre, NLR-CR-2026-113, Peer Review of ANCON-3 Noise Model: An ECAC Doc 29 Compliance Review, March 2026.

Peer review conclusion

3.39 The independent peer review by NLR confirmed that ANCON-3 correctly implements the ECAC Doc 29 Volume 2 aircraft noise calculation methodology, is compliant with the standard and can be used with confidence to produce ECAC Doc 29-compliant aircraft noise results.

Overall assurance conclusions

3.40 The assurance activities described in this chapter provide complementary evidence that ANCON-3 correctly implements the ECAC Doc 29 aircraft noise calculation methodology and is suitable for operational use. Verification against the ECAC Doc 29 reference cases demonstrated that ANCON-3 closely reproduces the published reference results and meets the recommended RMS value.

3.41 Comparisons with ANCON-2 confirmed practical continuity with the previous operational version of ANCON, while inter-model comparisons demonstrated consistency with other recognised implementations of the harmonised ECAC Doc 29 and ICAO Doc 9911 methodology.

3.42 Independent peer review by NLR provided external confirmation of these findings and concluded that ANCON-3 correctly implements the ECAC Doc 29 Volume 2 method and can be used with confidence to produce ECAC Doc 29-compliant aircraft noise results.

3.43 Taken together, the verification, comparison and peer review evidence provide assurance that ANCON-3 correctly implements the ECAC Doc 29 methodology and can be used with confidence for future UK aircraft noise contour studies.

Chapter 4

Governance and operational implementation

4.1 ANCON is recognised within DfT as a business-critical analytical model. Its development, maintenance and operational use are therefore subject to governance and assurance arrangements.

4.2 The transition from ANCON-2 to ANCON-3 has been managed as a controlled operational change to the software implementation of the model, not as a change in the prescribed aircraft noise calculation methodology.

4.3 As a business-critical model, ANCON is subject to assurance expectations consistent with the principles set out in the Macpherson Review of Government Analytical Models[6]. These include clarity of purpose, transparency of method, proportionate quality assurance, independent challenge and arrangements that support long-term sustainability. Within DfT, oversight of business-critical analytical models is provided through the DfT Model Board.

4.4 Operational use of ANCON-3 is supported by ERCD's model governance arrangements. These include controlled model versioning, configuration management, documented input assumptions, quality assurance of model runs, retention of modelling records, and review of outputs before publication or use in advice. These arrangements ensure that ANCON-3 is applied consistently, that modelling outputs remain traceable and reproducible, and that future changes to ANCON-3 will continue to be subject to proportionate testing, documentation and governance review before operational deployment.

Governance conclusion

4.5 Taken together, these arrangements provide a controlled basis for the operational use and future development of ANCON-3. The modern software implementation also improves maintainability and supportability, reduces reliance on legacy software expertise and provides a more resilient platform for future updates.

[6] HM Treasury, Review of Quality Assurance of Government Analytical Models, 2013.

Chapter 5

Conclusions

5.1 ANCON-3 is the latest version of ANCON. It has been developed to provide a modern, maintainable and supportable implementation of the ECAC Doc 29 aircraft noise calculation methodology.

5.2 ANCON-3 has been evaluated against the ECAC Doc 29 reference cases, compared with its predecessor ANCON-2, compared with other recognised aircraft noise models and independently peer reviewed by NLR.

5.3 Verification against the ECAC Doc 29 Volume 3 reference cases demonstrated that ANCON-3 closely reproduces the published reference results and meets the recommended grid-based RMS value. Additional verification beyond the published reference-grid comparison provided further assurance at lower noise levels.

5.4 Comparisons with ANCON-2 at Heathrow, Gatwick and Stansted covered three reporting years and multiple L_{Aeq} and N-above metrics. The results provide evidence that the transition from ANCON-2 to ANCON-3 does not materially affect operational contour results when equivalent input data and modelling assumptions are used.

5.5 The inter-model comparison confirmed that ANCON-3 produces results consistent with recognised international implementations of the harmonised ECAC Doc 29 and ICAO Doc 9911 methodology. The airport-level comparison with IMPACT and AEDT showed close agreement under aligned modelling assumptions.

5.6 The independent peer review by NLR provides external assurance of the ANCON-3 implementation. NLR concluded that ANCON-3 correctly implements the ECAC Doc 29 Volume 2 method, is compliant with the standard and can be used with confidence to produce ECAC Doc 29-compliant aircraft noise results.

5.7 ANCON-3 builds on the established ANCON modelling basis and strengthens the model’s long-term resilience, maintainability, supportability, performance and future capability.

5.8 Taken together, the verification, comparisons and peer-review evidence provide assurance that ANCON-3 correctly implements the ECAC Doc 29 Volume 2 methodology and can be used with confidence for future aircraft noise contour studies.

Glossary

AEDT	Aviation Environmental Design Tool
ANCON	The UK Civil Aircraft Noise Contour Model
CAA	Civil Aviation Authority
DfT	Department for Transport
ECAC	European Civil Aviation Conference
ECAC Doc 29	Report on Standard Method of Computing Noise Contours around Civil Airports
ERCD	Environmental Research and Consultancy Department of the Civil Aviation Authority
FAA	United States Federal Aviation Administration
ICAO	International Civil Aviation Organization
ICAO Doc 9911	Recommended Method for Computing Noise Contours Around Airports
IMPACT	EUROCONTROL aircraft noise and emissions modelling platform
L_{Aeq}	A-weighted equivalent continuous sound level, which represents average sound energy over a stated period
L_{Amax}	Maximum A-weighted sound level during a noise event
L_{den}	Day-evening-night noise level
N60	Number-above metric exceeding 60 dB LAmax
N65	Number-above metric exceeding 65 dB LAmax
N-above	Number of aircraft noise events above a specified threshold
NLR	Netherlands Aerospace Centre
NPD	Noise-Power-Distance relationship
RMS	Root-mean-square
SEL	Sound Exposure Level, representing the total sound energy of one aircraft event

APPENDIX A

ECAC Doc 29 reference case verification

A1 Purpose

This appendix presents the ECAC Doc 29 Volume 3 reference case verification results for ANCON-3. The reference cases test software implementations of the ECAC Doc 29 Volume 2 aircraft noise calculation methodology using defined aircraft, route and operating inputs and published reference results.

ERCD verified ANCON-3 using the ECAC Doc 29 reference cases. The verification included segmental checks, receptor-based Sound Exposure Level (SEL) checks and grid-based SEL checks. The results are presented below.

The reference cases comprise twelve combinations of three hypothetical fixed-wing aircraft types operating on arrival and departure procedures over straight and curved routes:

- Jet fuselage-mounted engines
- Jet wing-mounted engines
- Propeller engines

The verification comprises three types of check:

- Segmental verification – test flight path segment construction.
- Receptor-based SEL verification – test event-level noise at specified receptor locations.
- Grid-based SEL verification – test event noise levels across a wider receptor grid against the ECAC Doc 29 reference results.

A2 Reference-case combinations

The ECAC Doc 29 noise-model reference cases comprise twelve combinations of three hypothetical fixed-wing aircraft configurations: a jet aircraft with fuselage-mounted engines, a jet aircraft with wing-mounted engines and a propeller aircraft. Each configuration is modelled in arrival and departure operations over straight and curved routes.

The reference cases provide defined inputs and reference results for testing different elements of the ECAC Doc 29 Volume 2 noise-calculation methodology implemented in software. Full details of the reference-case inputs, case identifiers and prescribed results are provided in ECAC Doc 29 Volume 3.

Table 2: Reference-case aircraft

Proxy Aircraft Type	Operation	Route	Case ID
Jet fuselage-mounted engines	Arrival	Curved	JETFAC
Jet fuselage-mounted engines	Arrival	Straight	JETFAS
Jet fuselage-mounted engines	Departure	Curved	JETFDC
Jet fuselage-mounted engines	Departure	Straight	JETFDS
Jet wing-mounted engines	Arrival	Curved	JETWAC
Jet wing-mounted engines	Arrival	Straight	JETWAS
Jet wing-mounted engines	Departure	Curved	JETWDC
Jet wing-mounted engines	Departure	Straight	JETWDS
Propeller engines	Arrival	Curved	PROPAC
Propeller engines	Arrival	Straight	PROPAS
Propeller engines	Departure	Curved	PROPDC
Propeller engines	Departure	Straight	PROPDS

A3 Segmental verification

The ECAC Doc 29 methodology divides aircraft flight path trajectories into segments. Noise at a receptor is calculated from the contribution of relevant trajectory segments, so correct construction of the three-dimensional flight path is a prerequisite for the subsequent noise calculation.

Noise models implementing ECAC Doc 29 construct three-dimensional flight path segments by combining two-dimensional ground track segments with two-dimensional vertical flight profile segments. The segmental checks therefore evaluate whether

ANCON-3 correctly constructs the trajectory geometry, distance and related parameters required by the Doc 29 method.

Through comparison with the ECAC Doc 29 segmental reference results during development and testing, ANCON-3 was confirmed to correctly calculate the segmental parameters required by the methodology.

A4 Receptor-based SEL verification

The receptor-based SEL checks test event-level noise calculations at specified receptor locations. SEL is an important verification metric because it is the event-level building block from which cumulative metrics such as L_{Aeq} are derived. Correct SEL calculation requires integration of noise contributions across all relevant trajectory segments, not only the segment closest to the receptor.

ECAC Doc 29 defines eighteen receptor positions for the reference-case verification. Not all receptor positions are relevant to every case, and reference results are provided only for the relevant receptors. Across the twelve reference cases, 99 receptor results are applicable. The receptor positions are designed to evaluate different elements of the calculation method for arrivals and departures, including lateral directivity, runway sub-segmentation and the finite-segment noise-energy fraction.

For five of the twelve reference cases, one or more receptor locations showed a difference of -0.01 dB compared with the reference result. For the remaining cases, differences were less than 0.005 dB. The maximum absolute receptor-based SEL difference reported in this verification was 0.01 dB.

The receptor-based SEL differences for the eighteen receptor locations in each reference case are presented in Table 3. A dash indicates that no reference result is presented for that receptor and reference case.

Table 3: Receptor-based SEL differences

Recep-tor	JET FAC	JET FAS	JET FDC	JET FDS	JET WAC	JET WAS	JET WDC	JET WDS	PRO PAC	PRO PAS	PRO PDC	PRO PDS
R01	-	-	0.00	-0.01	-	-	0.00	-0.01	-	-	0.00	0.00
R02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
R03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
R04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01
R05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R06	-	-	0.00	-	-	-	0.00	-	-	-	0.00	-

Recep-tor	JET FAC	JET FAS	JET FDC	JET FDS	JET WAC	JET WAS	JET WDC	JET WDS	PRO PAC	PRO PAS	PRO PDC	PRO PDS
R07	-	-	0.00	-	-	-	0.00	-	-	-	0.00	-
R08	-	-	0.00	-	-	-	0.00	-	-	-	0.00	-
R09	-	-	0.00	-	-	-	0.00	-	-	-	0.00	-
R10	-	-	0.00	-	-	-	0.00	-	-	-	0.00	-
R11	-	-	0.00	-	-	-	0.00	-	-	-	0.00	-
R12	0.00	-	-	-	0.00	-	-	-	0.00	-	-	-
R13	0.00	0.00	-	-	0.00	0.00	-	-	0.00	0.00	-	-
R14	0.00	-	-	-	0.00	-	-	-	0.00	-	-	-
R15	0.00	-	-	-	0.00	-	-	-	0.00	-	-	-
R16	-0.01	-	-	-	0.00	-	-	-	0.00	-	-	-
R17	0.00	-	-	-	0.00	-	-	-	0.00	-	-	-
R18	0.00	0.00	-	-	0.00	0.00	-	-	0.00	0.00	-	-

A5 Grid-based SEL verification

The grid-based SEL checks compare ANCON-3 results with the ECAC Doc 29 reference-grid results. ECAC Doc 29 Volume 3 applies this comparison to grid points where calculated results are 80 dB SEL or more. Differences between the model and the reference results are summarised using the root-mean-square (RMS) difference.

ECAC Doc 29 states that the aim is to reduce the RMS difference to the order of 0.01 dB or less. ANCON-3 achieved a maximum RMS difference of 0.008 dB across the published reference-grid results and therefore met the recommended RMS value.

ERCD also undertook additional verification using the complete reference grid generated from EUROCONTROL's IMPACT implementation. ECAC Doc 29 publishes reference results only for grid points at or above 80 dB SEL. The complete grid therefore enabled comparison at lower noise levels than those included in the published reference results. The maximum RMS difference for the full-grid comparison was 0.003 dB.

A6 Verification conclusion

The ECAC Doc 29 reference-case verification demonstrated that ANCON-3 closely reproduces the published reference results. The RMS difference was within the

recommended value for all twelve reference cases, with a maximum of 0.008 dB for the published grid results at or above 80 dB SEL. Additional full-grid comparison produced a maximum RMS difference of 0.003 dB, providing further assurance at lower noise levels relevant to aircraft noise contour studies.

APPENDIX B

Noise-designated airport comparison between ANCON-2 and ANCON-3

B1 Purpose of the comparison

This appendix presents the comparison between ANCON-2 and ANCON-3 for the UK noise-designated airports: Heathrow, Gatwick and Stansted. The comparison was undertaken as a continuity check to understand the practical effect of moving from ANCON-2 to ANCON-3 using equivalent input data and modelling assumptions.

The comparison considered contour area, population exposure and contour alignment for aircraft noise metrics commonly used in UK aircraft noise assessment.

Because ANCON-2 and ANCON-3 implement the same underlying ECAC Doc 29 methodology, no single numerical acceptance criterion was defined for the continuity assessment. Instead, judgement was based on consistency of contour area, contour alignment and population exposure across multiple airports, years and metrics. The observed differences were considered in the context of the practical equivalence expected between two implementations of the same prescribed methodology.

B2 Airports, years and metrics

The comparison covered Heathrow, Gatwick and Stansted for annual reporting cycles for 2022, 2023 and 2024. These airports provide a range of airport layouts, runway configurations, traffic mixes, route structures, operating patterns and surrounding population distributions.

The comparison used the metrics, contour levels and reporting periods available in the published airport contour reports. These vary between airports and, in some cases, between reporting years. Table 4 summarises the comparison coverage.

Table 4: Contour comparison coverage

Airport	Years reviewed	Metrics reviewed	Notes
Heathrow	2022, 2023 and 2024	$L_{Aeq,16h}$; $L_{Aeq,8h}$; N65; N60	N-above metrics presented on an annual basis.
Gatwick	2022, 2023 and 2024	$L_{Aeq,16h}$; $L_{Aeq,8h}$; N65; N60	N-above metrics presented on a 92-day basis.
Stansted	2022, 2023 and 2024	$L_{Aeq,16h}$ and $L_{Aeq,8h}$ for 2022–2024; N65 daytime for 2022; N60 daytime and night-time for 2023–2024	N-above metrics are presented on a 92-day basis.

B3 Presentation of results

Contour areas and population values are presented rounded in accordance with established UK aircraft noise reporting practice. Percentage differences are calculated using the underlying unrounded values and presented to one decimal place. The percentage differences may therefore not be reproducible exactly from the rounded values shown in the tables.

B4 Summary of 2022 and 2023 comparisons

For the 2022 comparison, Heathrow contour area differences ranged from -0.5% to +14.5%. The largest differences occurred for the higher-level $L_{Aeq,8h}$ contours, which enclosed small areas largely within the airport boundary. Excluding the 72 dB $L_{Aeq,8h}$ contour, the maximum Heathrow difference was +6.3%. Across the three airports, differences for larger contour areas greater than 1.5 km² ranged from -0.5% to +3.0%. These larger contour areas generally correspond to lower noise levels. Gatwick contour-area differences ranged from -0.3% to +1.3%, while Stansted differences ranged from -0.3% to +1.9%.

For population exposure, the Heathrow 63 dB $L_{Aeq,8h}$ contour showed a -7.6% difference, equivalent to 78 people. All other Heathrow contours were within ±2.9%, Gatwick differences were within ±0.8%, and the Stansted results showed no difference at one decimal place.

The 2023 comparison showed the same overall conclusion. For Heathrow, $L_{Aeq,16h}$ contour-area differences ranged from 0.0% to +1.2%, and $L_{Aeq,8h}$ contour-area differences ranged from -0.1% to +15.0%. The +15.0% case was the 72 dB $L_{Aeq,8h}$ contour, where the contour areas were 0.79 km² for ANCON-3 and 0.687 km² for ANCON-2. Heathrow N-above contour-area differences ranged from -0.5% to +0.4%.

For Gatwick 2023, contour-area differences ranged from -0.2% to +1.0% across the reported L_{Aeq} and N-above metrics. For Stansted 2023, contour-area differences ranged from -0.1% to +1.2% across the reported L_{Aeq} and N-above metrics. Population exposure differences in 2023 ranged from -3.7% to +12.0% at Heathrow, -1.9% to +1.0% at Gatwick, and -1.1% to +0.2% at Stansted. The +12.0% Heathrow population difference related to the 72 dB $L_{Aeq,16h}$ contour, where the reported populations were 28 and 25 people.

The 2022 and 2023 comparisons therefore provide supporting evidence that the 2024 results presented below are representative of the observed relationship between ANCON-2 and ANCON-3 across multiple annual contour studies.

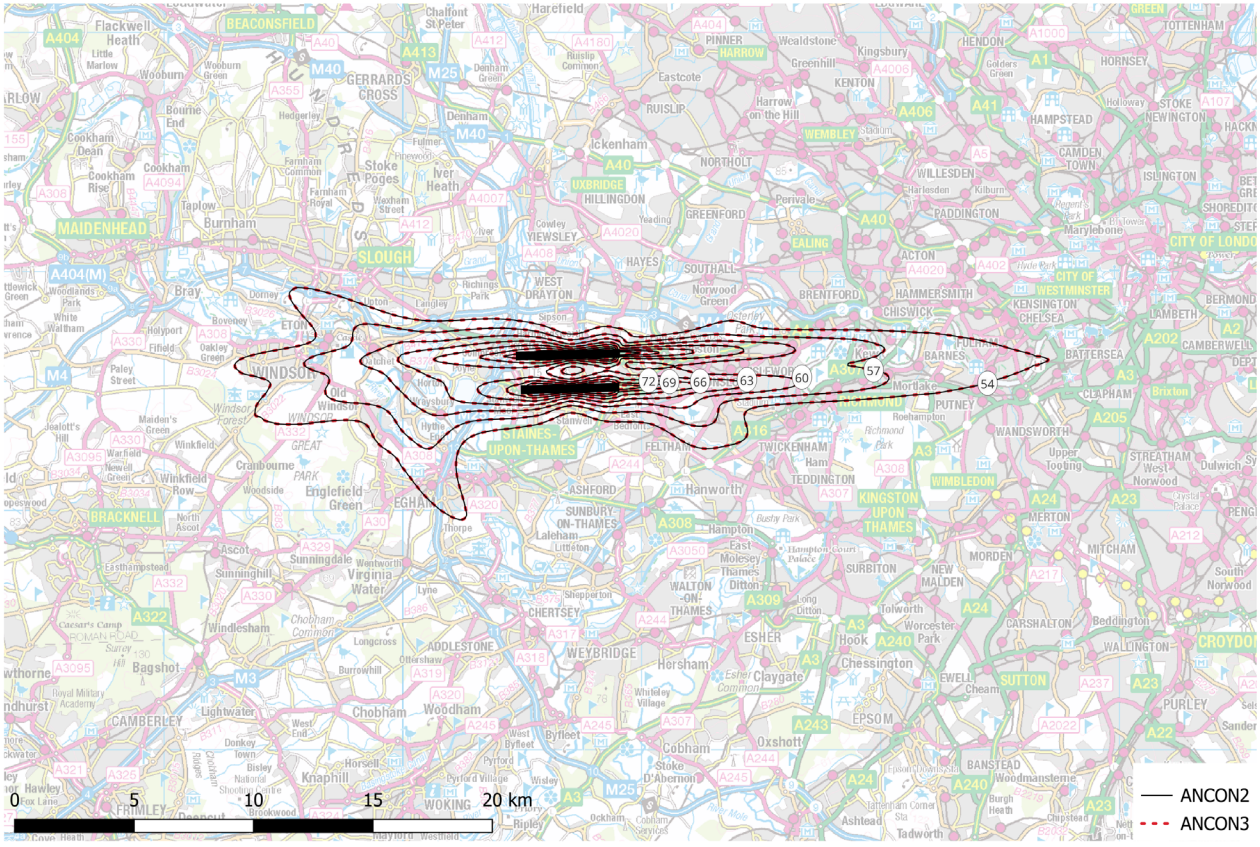
B5 Heathrow 2024 comparison

The Heathrow 2024 comparison included $L_{Aeq,16h}$, $L_{Aeq,8h}$, N65 and N60 contours. For legacy reporting reasons, Heathrow N-above metrics are presented on an annual basis.

Table 5: Heathrow 2024 $L_{Aeq,16h}$ comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 54 dB	128.7	128.7	0.0%	396,700	396,700	0.0%
> 57 dB	73.6	73.7	0.0%	197,100	197,100	0.0%
> 60 dB	41.6	41.6	0.0%	91,600	91,600	0.0%
> 63 dB	24.4	24.4	-0.1%	38,400	38,400	-0.1%
> 66 dB	12.2	12.2	-0.1%	9,000	9,000	0.0%
> 69 dB	6.1	6.1	0.0%	1,500	1,500	0.0%
> 72 dB	3.3	3.3	0.0%	<100	<100	0.0%

Figure 1: Heathrow 2024 $L_{Aeq,16h}$ contour comparison

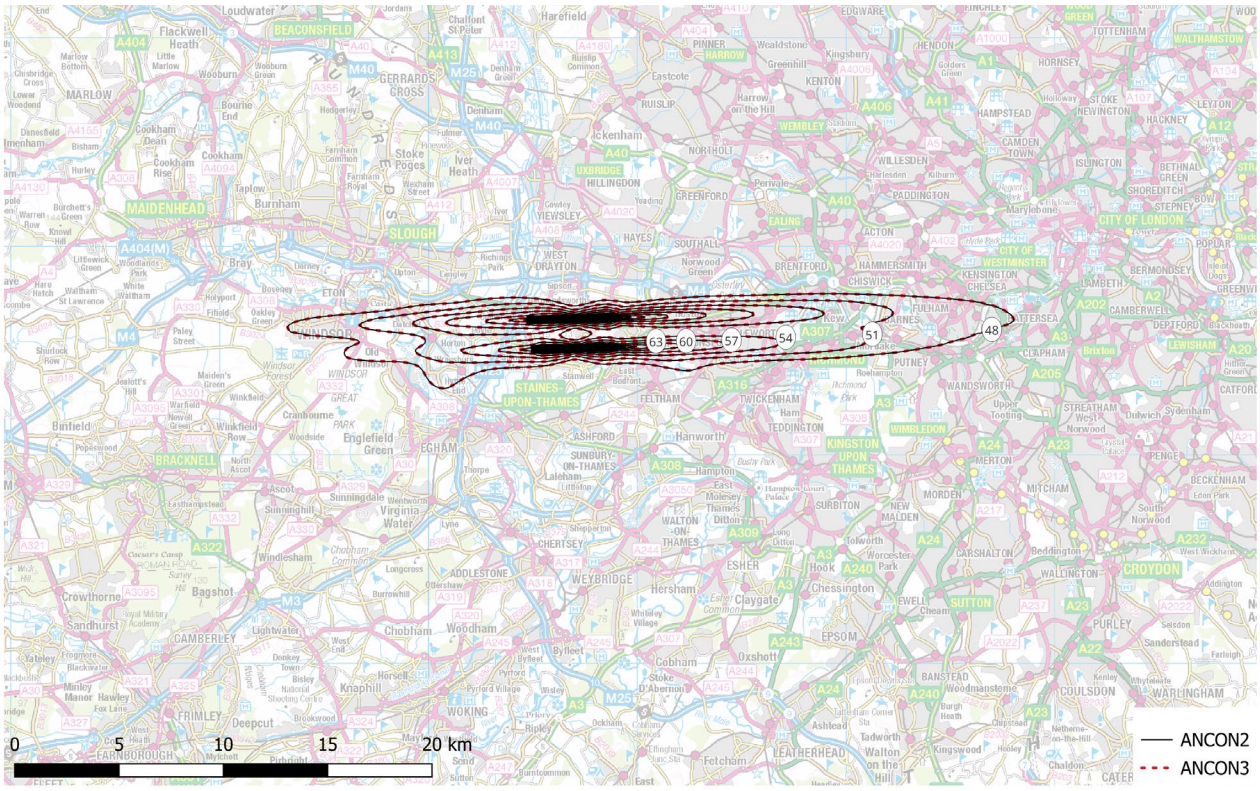


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 6: Heathrow 2024 $L_{Aeq,8h}$ comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 48 dB	94.1	94.1	0.0%	372,400	372,400	0.0%
> 51 dB	57.4	57.4	0.0%	189,400	189,400	0.0%
> 54 dB	28.9	29.0	-0.1%	89,000	89,000	0.0%
> 57 dB	14.2	14.2	-0.1%	39,800	39,900	-0.1%
> 60 dB	6.9	6.9	0.0%	10,400	10,400	0.0%
> 63 dB	3.6	3.6	0.0%	2,600	2,600	0.0%
> 66 dB	2.0	2.0	0.0%	400	400	0.0%
> 69 dB	1.2	1.2	-0.5%	0	0	0.0%
> 72 dB	0.7	0.7	-1.6%	0	0	0.0%

Figure 2: Heathrow 2024 $L_{Aeq,8h}$ contour comparison

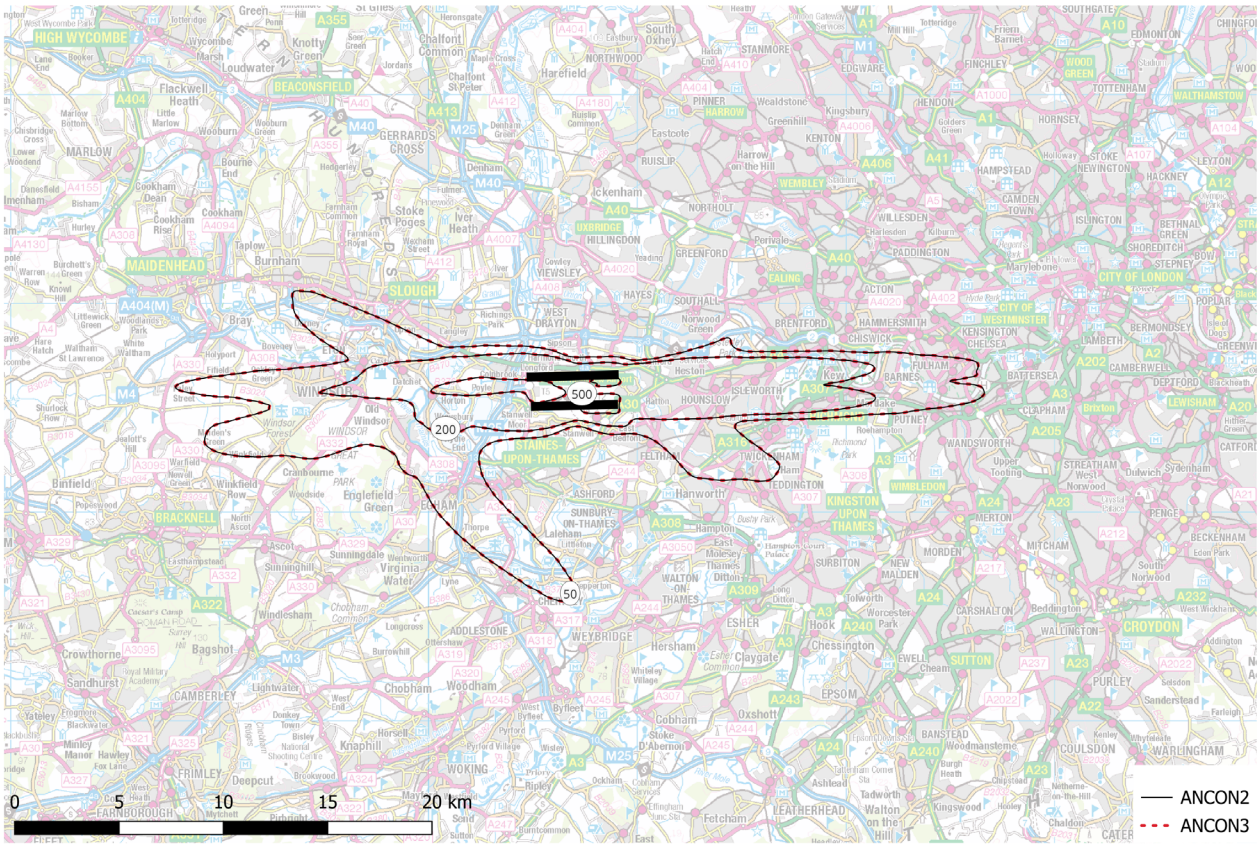


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 7: Heathrow 2024 N65 annual 16-hour day comparison

Level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 50 events	182.5	182.3	+0.1%	509,600	509,000	+0.1%
> 100 events	122.4	122.2	+0.1%	341,900	341,800	0.0%
> 200 events	69.6	69.5	+0.1%	210,300	209,900	+0.2%
> 500 events	6.7	6.7	+0.6%	700	700	0.0%

Figure 3: Heathrow 2024 N65 annual daytime contour comparison

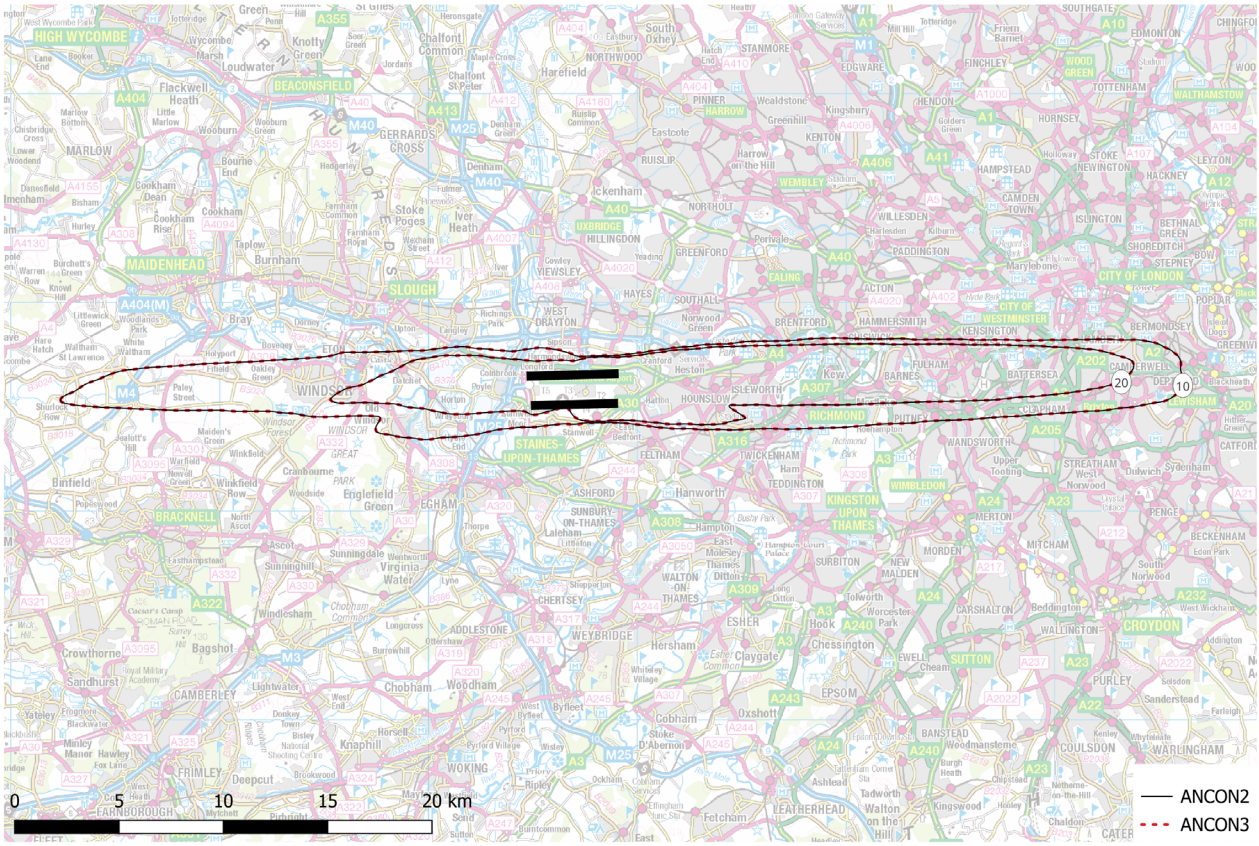


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 8: Heathrow 2024 N60 annual 8-hour night comparison

Level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 10 events	178.9	178.8	+0.1%	907,500	906,900	+0.1%
> 20 events	98.8	98.8	+0.1%	551,700	551,300	+0.1%
> 50 events	0.6	0.6	0.0%	<100	<100	0.0%

Figure 4: Heathrow 2024 N60 annual night-time contour comparison



Crown copyright 2023. All rights reserved. Licence number 100016105.

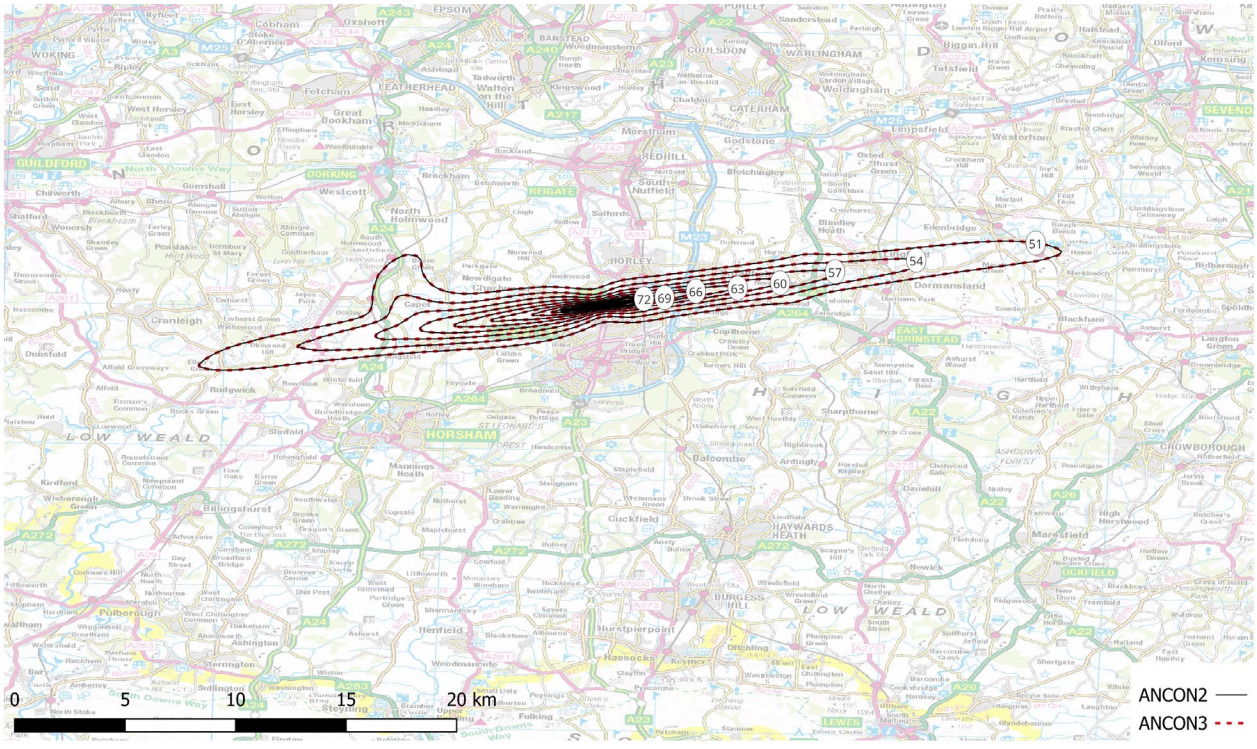
B6 Gatwick 2024 comparison

The Gatwick 2024 comparison included $L_{Aeq,16h}$, $L_{Aeq,8h}$, N65 and N60 contours. N-above metrics are presented on a 92-day basis.

Table 9: Gatwick 2024 $L_{Aeq,16h}$ comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 51 dB	113.8	113.8	0.0%	17,600	17,600	0.0%
> 54 dB	59.9	59.9	0.0%	7,200	7,200	0.0%
> 57 dB	33.0	33.0	0.0%	1,900	1,900	0.0%
> 60 dB	18.6	18.6	0.0%	1,100	1,100	0.0%
> 63 dB	10.0	10.0	0.0%	300	300	0.0%
> 66 dB	5.2	5.1	0.0%	100	100	0.0%
> 69 dB	2.5	2.5	0.0%	<100	<100	0.0%
> 72 dB	1.4	1.4	0.0%	0	0	0.0%

Figure 5: Gatwick 2024 $L_{Aeq,16h}$ contour comparison

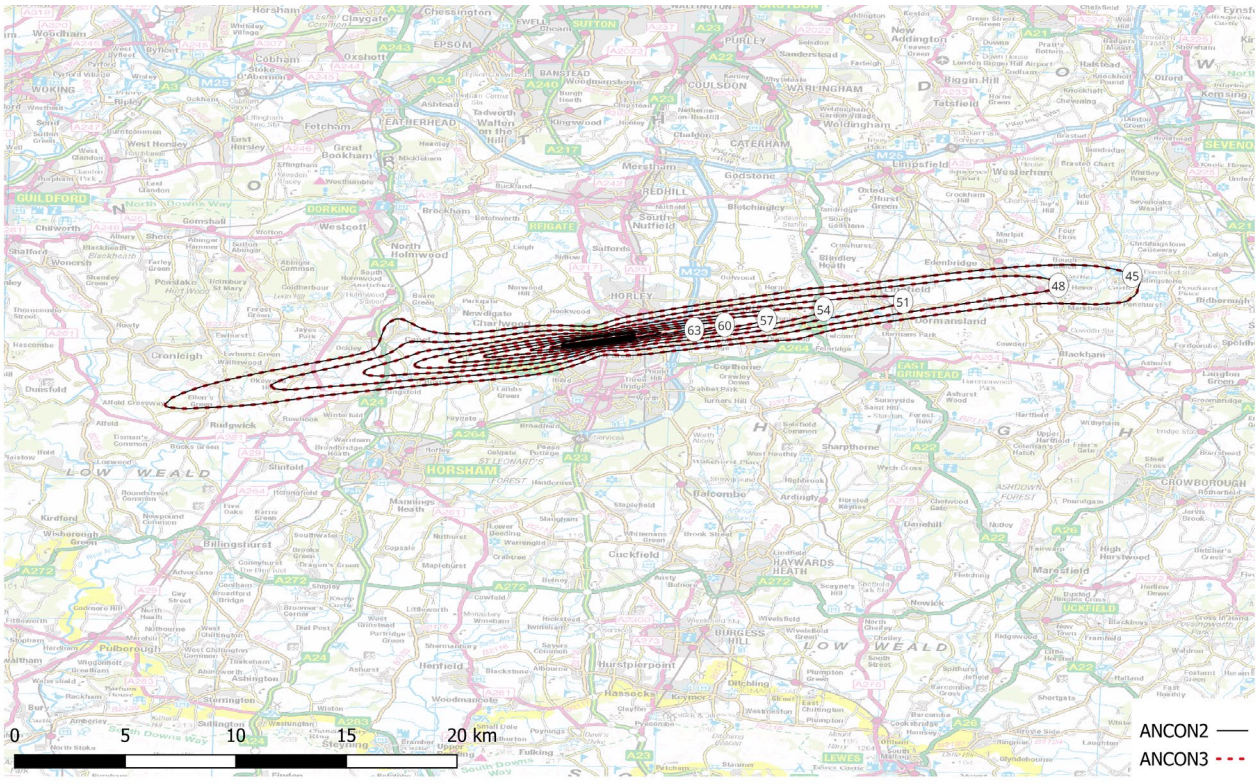


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 10: Gatwick 2024 $L_{Aeq,8h}$ comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 45 dB	125.1	125.1	0.0%	17,300	17,300	0.0%
> 48 dB	71.4	71.4	0.0%	8,600	8,600	0.0%
> 51 dB	36.1	36.1	0.0%	4,400	4,400	0.0%
> 54 dB	19.9	19.9	0.0%	1,100	1,100	0.0%
> 57 dB	10.9	10.9	0.0%	500	500	0.0%
> 60 dB	5.7	5.7	0.0%	100	100	0.0%
> 63 dB	2.8	2.8	0.0%	100	100	0.0%
> 66 dB	1.6	1.6	+0.1%	0	0	0.0%
> 69 dB	0.9	0.9	+0.1%	0	0	0.0%
> 72 dB	0.5	0.5	-0.2%	0	0	0.0%

Figure 6: Gatwick 2024 $L_{Aeq,8h}$ contour comparison

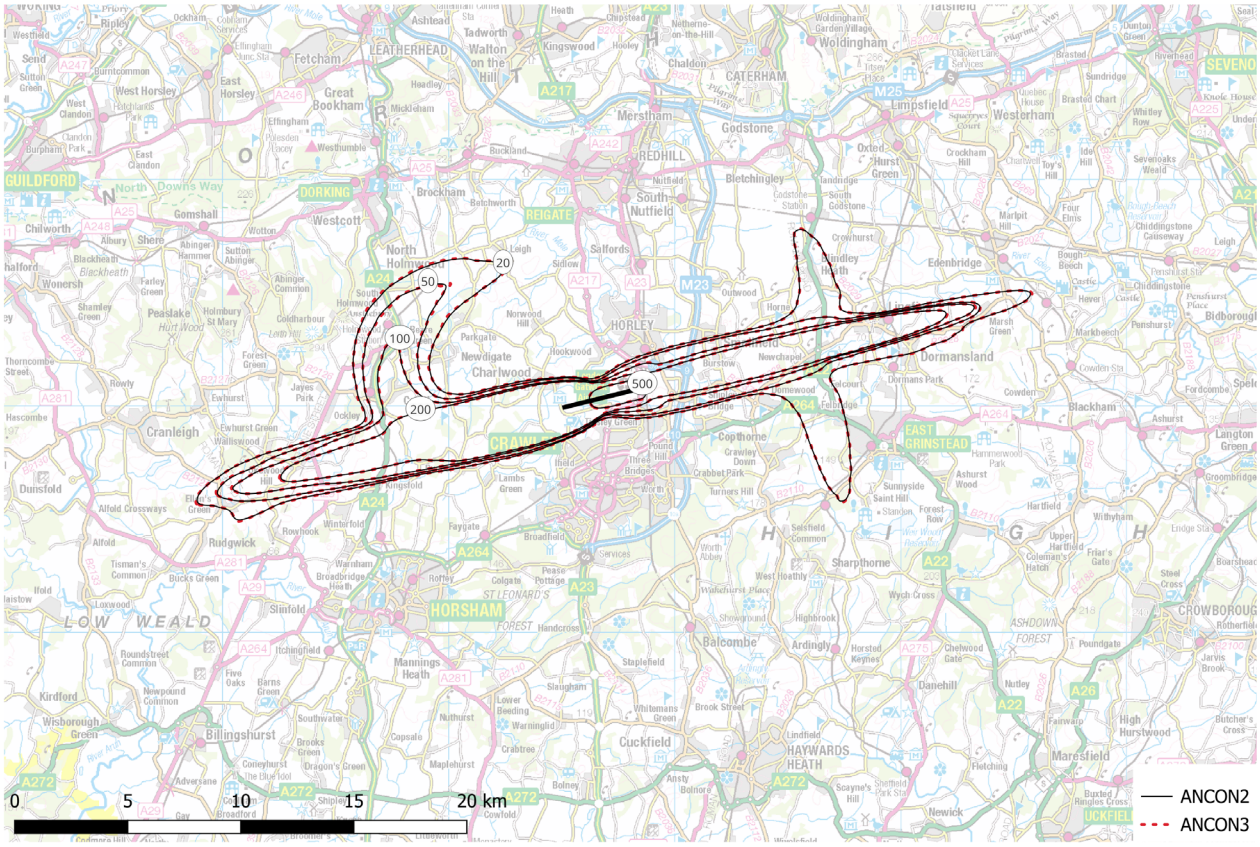


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 11: Gatwick 2024 N65 92-day comparison

Level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 20 events	130.3	129.8	+0.4%	19,200	19,100	+0.6%
> 50 events	88.8	88.7	+0.1%	12,100	12,100	0.0%
> 100 events	65.2	65.1	+0.2%	7,700	7,600	+2.0%
> 200 events	47.4	47.3	+0.2%	5,100	5,100	0.0%
> 500 events	2.1	2.1	+2.7%	<100	<100	0.0%

Figure 7: Gatwick 2024 N65 92-day daytime contour comparison

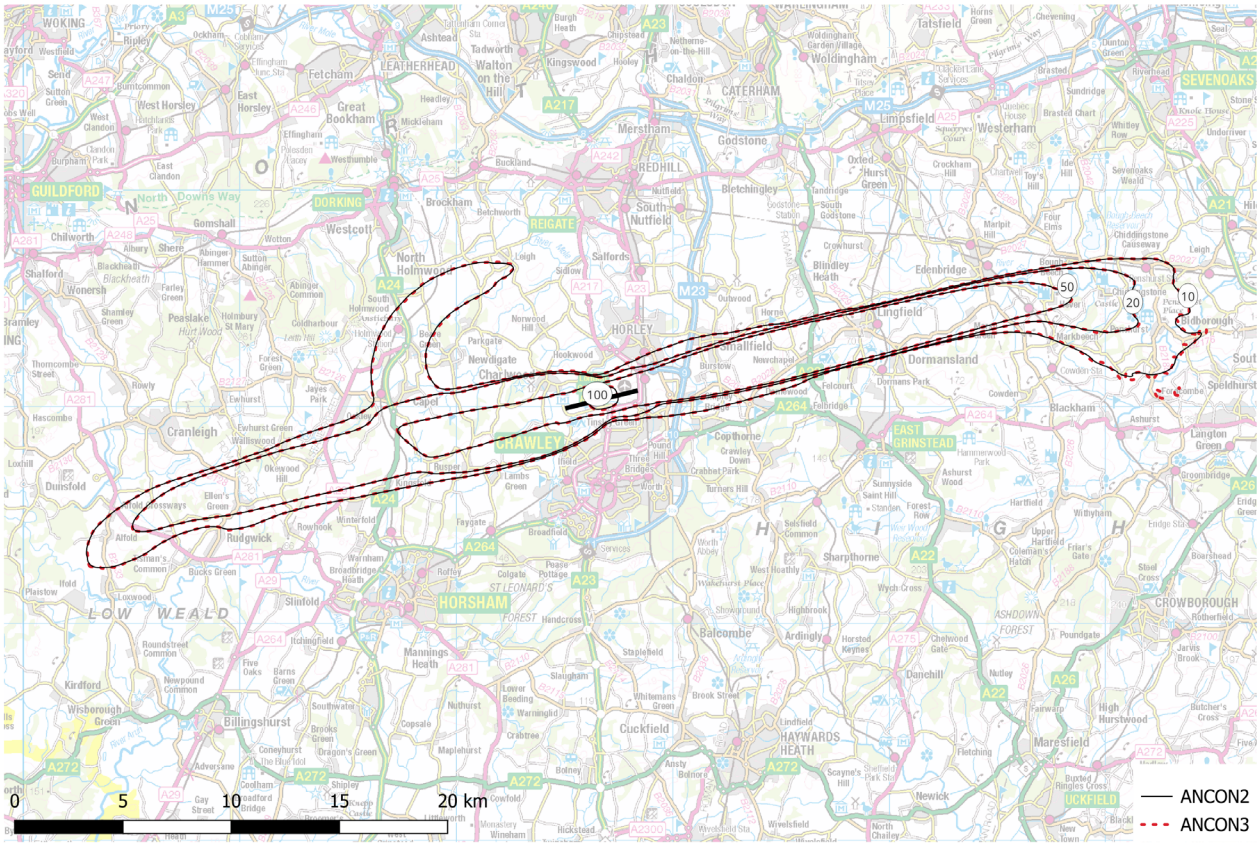


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 12: Gatwick 2024 N60 92-day comparison

Level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 10 events	186.2	185.6	+0.3%	24,400	24,300	+0.3%
> 20 events	120.8	120.7	+0.1%	13,200	13,100	+0.5%
> 50 events	55.9	55.9	0.0%	7,900	7,900	0.0%
> 100 events	1.2	1.1	+4.9%	<100	<100	0.0%

Figure 8: Gatwick 2024 N60 92-day night-time contour comparison



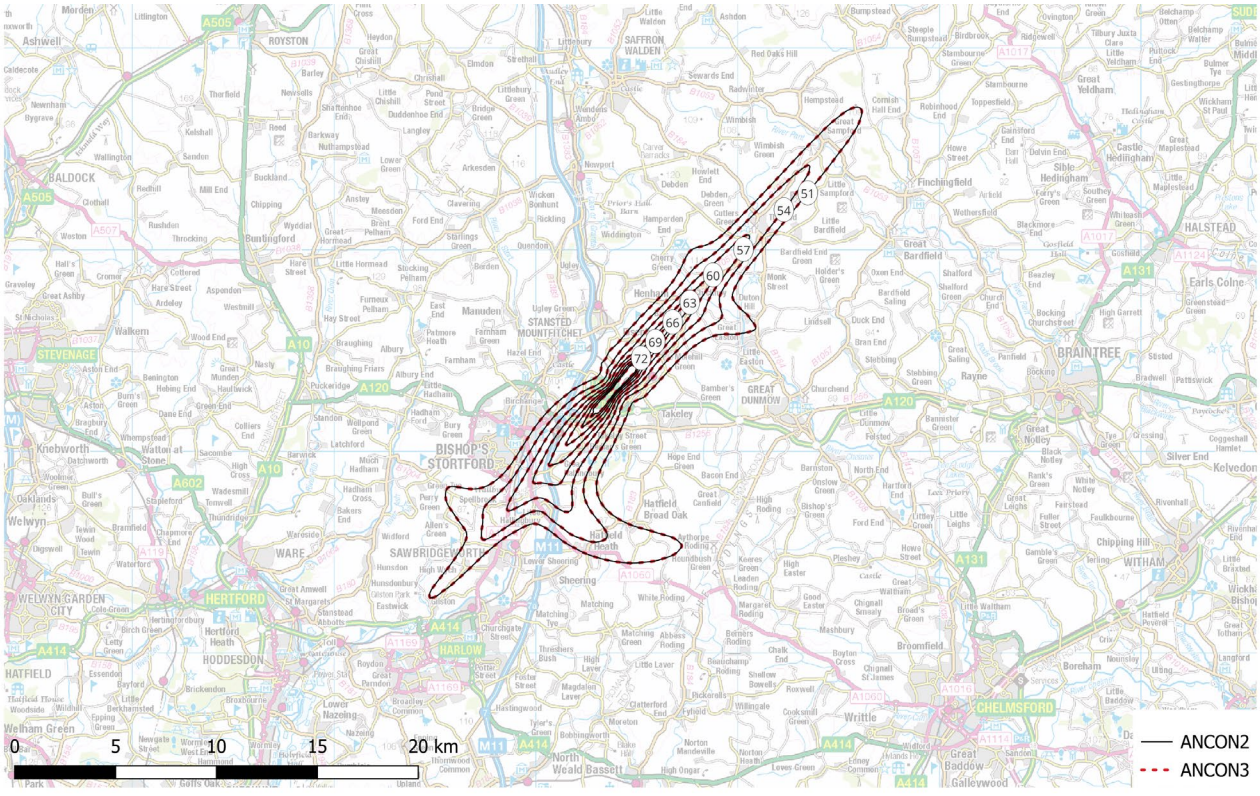
Crown copyright 2023. All rights reserved. Licence number 100016105.

B7 Stansted 2024 comparison

Table 13: Stansted 2024 $L_{Aeq,16h}$ comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 51 dB	91.1	91.1	0.0%	13,700	13,700	0.0%
> 54 dB	49.1	49.1	0.0%	6,400	6,400	0.0%
> 57 dB	26.1	26.1	0.0%	2,000	2,000	0.0%
> 60 dB	13.9	13.9	0.0%	700	700	0.0%
> 63 dB	7.2	7.2	0.0%	300	300	0.0%
> 66 dB	3.6	3.6	0.0%	100	100	0.0%
> 69 dB	1.9	1.9	0.0%	0	0	0.0%
> 72 dB	1.0	1.0	0.0%	0	0	0.0%

Figure 9: Stansted 2024 $L_{Aeq,16h}$ contour comparison

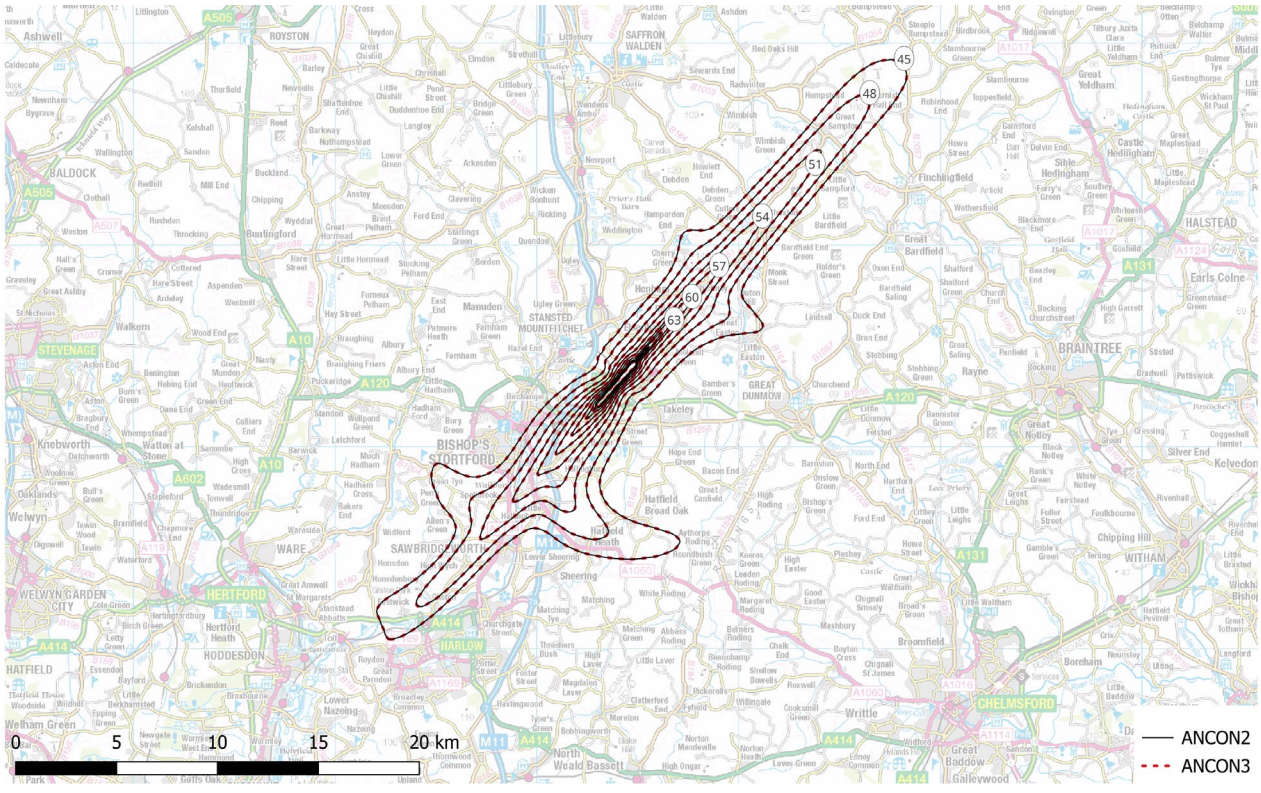


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 14: Stansted 2024 $L_{Aeq,8h}$ comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 45 dB	129.9	129.9	0.0%	22,700	22,700	+0.3%
> 48 dB	75.8	75.8	0.0%	9,700	9,700	0.0%
> 51 dB	41.3	41.3	0.0%	5,500	5,500	0.0%
> 54 dB	21.8	21.8	0.0%	2,100	2,100	0.0%
> 57 dB	11.2	11.2	0.0%	500	500	0.0%
> 60 dB	5.7	5.7	0.0%	100	100	0.0%
> 63 dB	2.9	2.9	0.0%	0	0	0.0%
> 66 dB	1.5	1.5	0.0%	0	0	0.0%
> 69 dB	0.9	0.9	0.0%	0	0	0.0%
> 72 dB	0.5	0.5	0.0%	0	0	0.0%

Figure 10: Stansted 2024 $L_{Aeq,8h}$ contour comparison

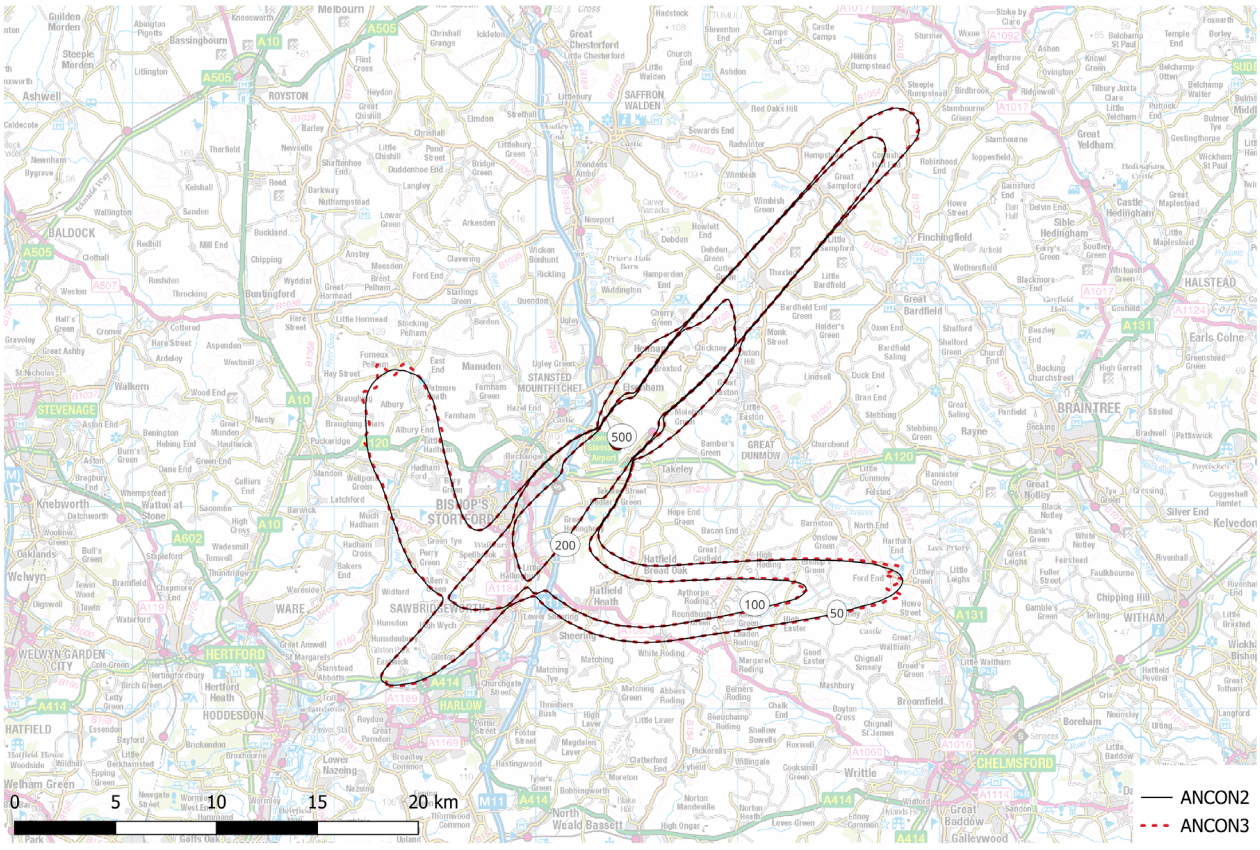


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 15: Stansted 2024 N60 daytime 92-day comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 50 events	206.2	205.3	+0.4%	34,100	33,900	+0.3%
> 100 events	106.9	106.6	+0.3%	19,700	19,700	0.0%
> 200 events	36.3	36.3	0.0%	2,800	2,800	0.0%
> 500 events	0.5	0.5	0.0%	0	0	0.0%

Figure 11: Stansted 2024 N60 92-day daytime contour comparison

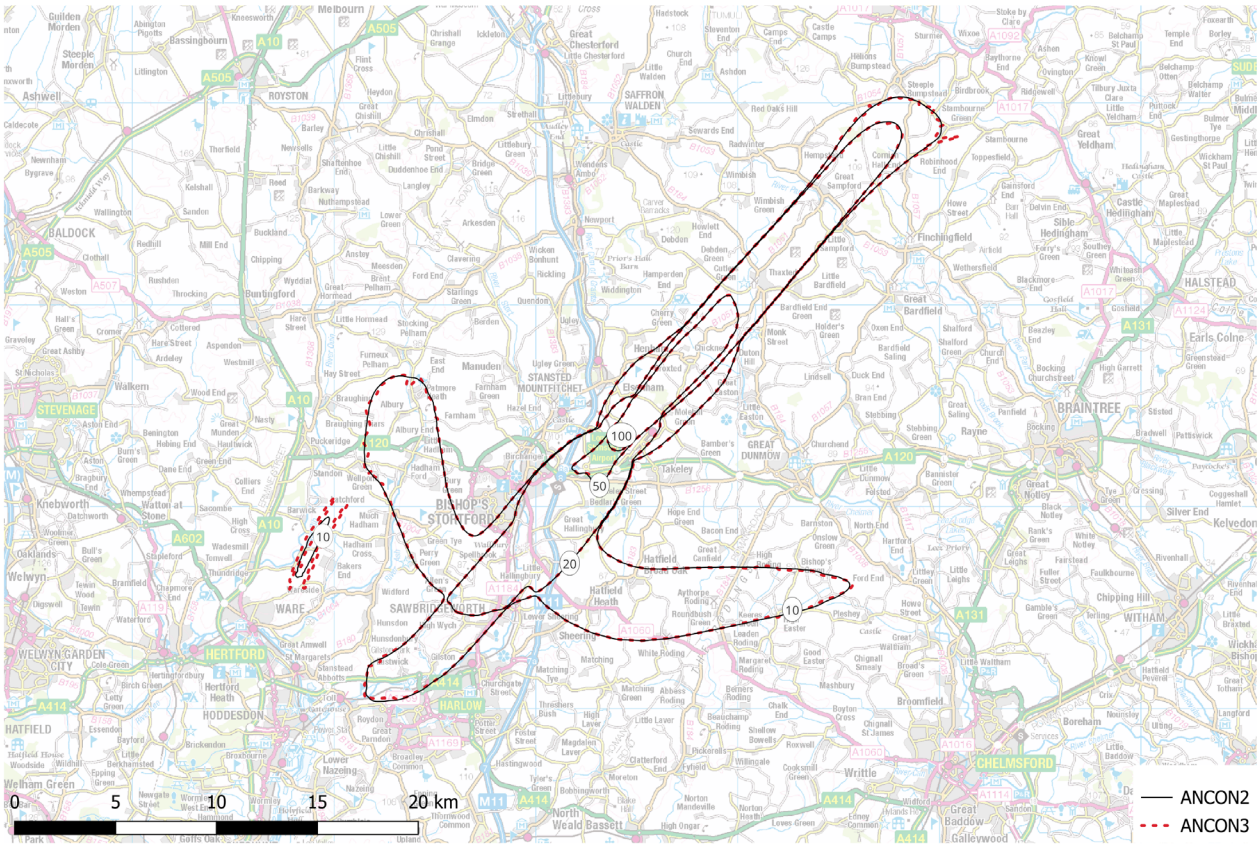


Crown copyright 2023. All rights reserved. Licence number 100016105.

Table 16: Stansted 2024 N60 night 92-day comparison

Contour level	Area ANCON-3 (km²)	Area ANCON-2 (km²)	Difference	Population ANCON-3	Population ANCON-2	Difference
> 10 events	198.4	199.1	−0.3%	34,400	34,900	−1.5%
> 20 events	84.7	84.7	0.0%	17,100	17,100	0.0%
> 50 events	17.8	17.8	−0.2%	700	700	0.0%
> 100 events	0.6	0.6	0.0%	0	0	0.0%

Figure 12: Stansted 2024 N60 92-day night-time contour comparison



Crown copyright 2023. All rights reserved. Licence number 100016105.

B8 Overall findings from the ANCON-2 and ANCON-3 comparison

The comparison considered contour area, population exposure and contour alignment. Greater emphasis was placed on contour area and contour alignment because these are direct model outputs and provide a stable basis for assessing continuity between model versions. Population exposure is derived by combining modelled contours with population datasets and is therefore also influenced by the spatial distribution of population around contour boundaries.

For the 2024 L_{Aeq} comparisons, contour-area differences ranged from -1.6% to +0.1%, and population-exposure differences ranged from -0.1% to +0.3%. The -1.6% contour-area difference related to the Heathrow 72 dB $L_{Aeq,8h}$ contour, which enclosed less than 0.7 km² and had no exposed population under either model.

For the 2024 N-above comparisons, contour-area differences ranged from -0.3% to +4.9%, and population-exposure differences ranged from -1.5% to +2.0%. The largest contour-area difference occurred for the Gatwick N60 night-time >100 events contour, which enclosed less than 1.2 km² and fewer than 100 people under either model. For the larger N-above contours greater than 2 km², generally associated with lower event-count thresholds, contour-area differences did not exceed +2.7%.

The 2022, 2023 and 2024 comparisons provide evidence that the transition from ANCON-2 to ANCON-3 does not materially affect operational contour results when equivalent input data and modelling assumptions are used.

APPENDIX C

Inter-model comparison between ANCON-3, IMPACT and AEDT

C1 Purpose of the inter-model comparison

This appendix presents a Heathrow 2023 inter-model comparison between ANCON-3, EUROCONTROL's IMPACT model and the United States Federal Aviation Administration's Aviation Environmental Design Tool (AEDT). The comparison was undertaken to assess whether ANCON-3 produces results consistent with recognised implementations of the harmonised ECAC Doc 29 and ICAO Doc 9911 aircraft noise calculation methodology when modelling assumptions are aligned.

The Heathrow scenario provides an airport-level test case involving high traffic volumes, a complex fleet mix, runway operations, radar-derived tracks and operational flight profiles.

C2 Scenario and aligned modelling assumptions

The comparison in this appendix uses a Heathrow 2023 inter-model scenario. Published Heathrow operational contours are normally produced with terrain included, so the ANCON-3 and ANCON-2 results with terrain are shown for context.

The NLR peer review considered a Heathrow 2023 comparison between ANCON-3, ANCON-2 and IMPACT. This appendix extends that comparison by also presenting AEDT results. AEDT is included as a recognised international implementation of the harmonised ICAO Doc 9911 aircraft noise calculation methodology.

In the NLR-reviewed comparison, the ANCON results included terrain, while the IMPACT comparison case did not. The area around Heathrow is mostly flat, but includes some locally higher ground and lower-lying land along the Thames and its tributaries. These differences can affect calculated noise levels by changing the distance between the aircraft and the ground receptor. ANCON-3 was therefore also run without terrain, so that ANCON-3, IMPACT and AEDT could be compared on the same no-terrain basis.

This appendix therefore presents ANCON-2 and ANCON-3 results with terrain, and ANCON-3, IMPACT and AEDT results without terrain. The no-terrain results provide a like-for-like comparison of the software implementations using aligned modelling assumptions.

Key modelling assumptions were aligned as far as practicable across the models, including aircraft movement inputs, flight tracks, vertical profiles, aircraft noise and performance data and operational assumptions.

Locally representative radar-derived flight profiles and mean tracks were developed for IMPACT and AEDT to support a like-for-like operational comparison. The purpose of

aligning these assumptions was to compare the software implementations while minimising differences arising from separate study inputs or operational reporting assumptions.

C3 Inter-model contour area comparison

Table 17 presents $L_{Aeq,16h}$ contour area comparisons for the controlled Heathrow inter-model scenario. Percentage differences for IMPACT and AEDT are calculated relative to ANCON-3 no terrain, because this is the aligned basis for the inter-model comparison.

Table 17: Heathrow inter-model $L_{Aeq,16h}$ contour area comparison

Contour level	ANCON-3 with terrain (km²)	ANCON-2 with terrain (km²)	ANCON-3 no terrain (km²)	IMPACT no terrain (km²)	IMPACT difference	AEDT no terrain (km²)	AEDT difference
> 54 dB	129.62	129.61	129.73	129.41	-0.2%	127.82	-1.5%
> 57 dB	74.44	74.44	74.79	74.66	-0.2%	73.82	-1.3%
> 60 dB	41.96	41.95	42.30	42.26	-0.1%	41.75	-1.3%
> 63 dB	24.92	24.91	24.91	24.88	-0.1%	24.52	-1.6%
> 66 dB	12.64	12.64	12.68	12.67	-0.1%	12.44	-1.9%
> 69 dB	6.22	6.22	6.24	6.25	+0.2%	6.17	-1.1%
> 72 dB	3.41	3.37	3.42	3.42	0.0%	3.38	-1.2%

C4 Inter-model comparison findings

In the no-terrain comparison, IMPACT contour areas differed from ANCON-3 by -0.2% to +0.2% across the reported contour levels. AEDT contour areas were lower than ANCON-3 at all reported contour levels, with differences ranging from -1.9% to -1.1%.

The ANCON-3 no-terrain run removed terrain treatment as a source of difference between the models and provided a like-for-like comparison with IMPACT and AEDT under aligned modelling assumptions.