



HEPWORTH
ACOUSTICS
Noise and Vibration Consultants

**SOUTHEND AIRPORT
REVIEW OF NOISE ASPECTS OF PLANNING APPLICATION FOR RUNWAY EXTENSION**

**On behalf of:
Southend-on-Sea Borough Council**

**Report no: 30639.1R1
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1.0 INTRODUCTION

- 1.1 Hepworth Acoustics was commissioned by Southend-on-Sea Borough Council to carry out an independent assessment of noise impacts of the proposals to extend the runway length at Southend Airport.
- 1.2 The assessment has been commissioned following the submission of a planning application (Application No: 09/01960/FULM) with associated documents for the extension of the runway and other associated works.
- 1.3 The proposals are to extend the runway by approximately 300m, to divert Eastwoodbury Lane, demolish six residential properties, and carry out accommodation works.
- 1.4 An assessment is made of the ground and air noise impacts of the proposals, including reviewing the prediction methodologies, the assessment methodologies and the noise mitigation measures proposed. The review assesses the information submitted in the Environmental Statement (ES) and supporting documents
- 1.5 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 BRIEF

2.1 The scope of the work contained in this report was contained in a ‘Briefing Note for Acoustic Consultant’ prepared by Southend-on-Sea Borough Council Environmental Health Department.

2.2 The following objectives for the project were provided:

Review and evaluate the submissions made in respect of the planning application for London Southend Airport Application No: 09/01960/FULM available via the link below, relating to Noise impact. The application includes for the extension of the runway and diversion of Eastwoodbury Lane.

Advise on the methodology used and validity of the conclusions. Advise regarding what would be considered to be a suitable monitoring regime to monitor aircraft noise post development including suitable equipment for the monitoring.

Advise regarding the proposed noise insulation measures for the assessment of eligible noise insulation /purchase of properties.

Advise on controls/ planning conditions/ section 106 measures to avoid adverse impact of noise from aircraft, construction noise and road traffic as necessary. Advise regarding proposed night working for construction activity.

Advise on adequacy of proposed during and post development control measures and give additional advice where proposed measures are considered to be insufficient.

Advise regarding the appropriate trigger for noise insulation and the extent of the insulation required ie windows/roof/doors and question of whether attenuated alternative ventilation would be required. Advise on standard of insulation that should be sought.

2.3 The work to be carried out by Hepworth Acoustics was confirmed in an offer letter reference 30369.0 dated 23rd November 2009. This letter confirmed the scope of work as documented above. The proposal has not included detailed checking of noise calculations or Hepworth Acoustics carrying out their own calculations.

2.4 In reviewing the noise aspects of the application, reference has been made to the following documents

- Environmental Statement Volume 1
- Environmental Statement Appendix F Noise Appendices
- Environmental Statement – Non Technical summary
- Environmental Statement Appendix B – Southend Air Traffic Report and Forecasts Book
- Health Impact Assessment
- Planning Statement

2.5 This report deals with the four acoustic aspects of the planning application. These are construction noise; road traffic noise; ground noise of airport operations; and air noise from airport operations. The term noise includes vibration where appropriate.

3.0 PREDICTION METHODOLOGY

Construction Noise

- 3.1 The construction noise predictions in the Environmental Statement use the methodology contained in British Standard 5228 ‘Code of practice for noise and vibration control on construction and open sites’. This is the correct prediction methodology to use. It is not explicitly stated that the latest version of the standard (2009) has been used but this does not have any impact on the predictions carried out. The noise chapter makes the point that whilst typical types of construction plant can be assumed, no contractor has been appointed and therefore precise working methods are not available. This is true of virtually every project where an Environmental Statement is carried out.
- 3.2 A very simple prediction is carried out for construction noise levels in the Environmental Statement. The methodology assumes a source noise level of 80 dB L_{Aeq} at 10m for total construction noise. This is despite some of the individual construction sources listed generating higher noise levels. In order to predict noise levels at the nearest properties, a simple distance attenuation calculation is carried out to determine the noise levels at the nearest properties. The noise level predictions do not specify what the time period T is in the values provided in Table 9.17 of the Environmental statement.
- 3.3 It is accepted that detailed construction working methods are not available at this stage of the project. However, it is clear that more than one item of construction plant will be operating at a time, and it would be anticipated that an assessment of the total noise level generated by typical combinations of working plant would be carried out, and noise levels at the nearest properties would be calculated from this ‘source’ level. This approach would give rise to a higher source noise level than has been assumed in the construction noise assessment. It would also be considered appropriate to predict construction noise levels in terms of $L_{Aeq, 1hr}$.

- 3.4 No comment has been made in relation to potential vibration from the construction works and whether or not there are likely to be significant sources of vibration from the construction works.

Road Traffic Noise

- 3.5 The road traffic noise calculations in the Environmental Statement use the methodology contained in the Department of Transport/Welsh office ‘Calculation of Road Traffic Noise’ (CRTN) publication. This is the correct prediction methodology to use.
- 3.6 No information is provided within the Environmental Statement on how the road traffic predictions have been implemented and whether the calculations have used a computerised method to calculate road traffic levels. The predictions in Tables 9.10 and 9.27 are free field noise levels at a notional distance from the roads chosen to represent the typical distance of residential properties from that road.
- 3.7 The CRTN prediction methodology produces noise levels in dB $L_{A10,18hr}$ noise units. The Environmental Statement converts these predicted noise levels in to dB $L_{Aeq,16hr}$ noise units. Whilst the technical methodology used for making this conversion is correct, comments will be made later regarding the presentation and assessment of road traffic noise data.

Aircraft Noise – Ground Noise

- 3.8 There is no government produced or British Standard calculation methodology for predicting ground noise in the UK. The general approach to predicting ground noise in the UK is to use measured data for the different types of operation covered and use this information together with event duration information in noise prediction software to calculate noise levels from the operations proposed at the airport. This is the approach used in the Environmental Statement, with the commonly used CADNA software being used to carry out the predictions.

- 3.9 It is not specified in the Environmental Statement, but it is assumed that the prediction methodology used in the CADNA software is ISO 9613 – ‘Attenuation of sound during propagation outdoors’. This should be confirmed.
- 3.10 It is not clear whether all of the ground noise predictions provided within the Environmental Statement are carried out on a consistent basis. Tables 9.13 and 9.26 show predicted noise levels in dB $L_{Aeq,16hr}$. However, Figures 9.3, 9.12 and 9.13 are labelled ‘sound exposure level in dB(A)’. The Figures (and the tables) show very small differences in noise levels between the 2008 current situation and the ‘2020 baseline’ or ‘2020 with development’ situations. Whilst this may be true if looking at sound exposure level which is the noise produced by an individual noise event, it is unlikely that this is true of the difference in dB $L_{Aeq,16hr}$ between 2008 and 2020 around the new terminal because of the large increase of passenger jet movements in this area.
- 3.11 Predictions of ground running noise are provided in a separate prediction contained in Appendix F to the Environmental Statement. It is not clear why these predictions have not been included within the overall ground noise assessment.

Aircraft Noise – Airborne Noise

- 3.12 The Environmental Statement uses the Integrated Noise Model (INM) software package to carry out predictions of aircraft noise from start of take off to end of landing roll on the runway (airborne noise). The software has been developed by the US Federal Aviation Authority to predict aircraft noise and includes source data from measurements of a wide range of aircraft. It is an accepted prediction methodology used at many UK and worldwide airports and is considered appropriate for use with this application.
- 3.13 The INM methodology has been verified by measurements at a number of airports and is considered to generally show good correlation between measurements and predictions for specific operations at airports, although sometimes refinements need to be made to the model if the source data for a particular aircraft model is not contained within the INM database.

However, like all noise prediction programmes, the accuracy of the predictions are dependant on the accuracy of input data. With INM, when calculating the highest noise levels close to the airport, the accuracy of the future fleet mix assumed (the aircraft types that will carry out the various flights from the airport) is generally the most important factor. Similar sized aircraft can have significantly different noise characteristics, and therefore the fleet mix assumptions can have a significant impact on the predicted noise levels.

- 3.14 The Avia Traffic forecast Report submitted with the planning application states in section 3 that the runway extension will facilitate a wider range of commercial services and should make the airport viable to support LCC (Low-cost Carrier) airlines using aircraft of dimensions up to and including the Airbus 319 and the Boeing 737-300 or Boeing 737-700. The noise contours have been based on the assumption (from the Southend Airport Aircraft Flows document) that the LCC jet movements will all be undertaken by Airbus 319 aircraft whereas the Boeing 737-300 is significantly noisier (about 6 dB) than the Airbus 319 on approach. It is understood that within the UK, the Boeing 737-300 is used by Jet2 and BMI Baby Low-cost Carriers.
- 3.15 It is therefore considered that the aircraft noise contours shown in the Figure 9.6 for ‘2020 with development’ do not necessarily show the worst case because they are based on the Airbus 319 which is significantly quieter on approach than the Boeing 737-300.
- 3.16 The night-time noise impact of future operations is assessed on the assumption that the Airbus 319 will be used in future rather than the Boeing 737-300. This therefore affects the numbers shown in Table 9.23 and the contours shown in Figure 9.11.

4.0 ASSESSMENT METHODOLOGY

Construction Noise

- 4.1 The Environmental Statement has used BS 5228 to provide a prediction methodology for construction noise, but in section 9.2.6 when considering an assessment methodology for construction noise, no mention is made of the guidance provided in BS 5228. The Environmental Statement uses a range of 55-75 dB $L_{Aeq,16hr}$ for daytime construction noise and 45-60 dB $L_{Aeq,8hr}$ for night time construction noise.
- 4.2 British Standard 5228-1:2009 contains Annex E which discusses the Significance of Noise Effects. This Annex discusses two general approaches to construction noise criteria, absolute fixed noise limits and noise change criteria. The absolute fixed noise criteria mentioned are up to 75 dB(A) for daytime criteria in urban areas near main roads. These fixed noise criteria originated in the Wilson Report on Noise produced for parliament in 1963.
- 4.3 The Annex then discusses assessment methods based on noise change which it notes reflects more conventional methodologies used for noise impact. This is an approach that Hepworth Acoustics has used recently in noise sections of Environmental Statements. Annex E.3 contains an ABC method that divides noise criteria in to 3 levels depending on pre-construction ambient noise levels. The method recommends construction noise limits of between 65-75 dB L_{Aeq} during daytime, 55-65 dB L_{Aeq} during evenings and weekends, and 45-55 dB L_{Aeq} at night. It is not possible to accurately assess what construction noise levels would be permitted for all time periods, because ambient noise levels were not taken in the evenings, night or weekend periods, but it is likely that construction noise limits would generally be within the lower half of the limits outlined above.
- 4.4 The predictions produced in Table 9.17 of the Environmental Statement show that noise levels at Nos. 13 and 14 Smallholdings may exceed the noise limits derived from the assessment methodology discussed in 4.3 above.

- 4.5 It is also considered that construction noise should be assessed in terms of $L_{Aeq,1hr}$ noise limits.

Road Traffic Noise

- 4.6 The road traffic noise assessment in the Environmental Statement uses the $L_{Aeq,16hr}$ noise unit. Whilst this facilitates comparison with the aircraft noise predictions, it is not the noise unit that is specified for assessment of the noise impact of road schemes in the UK.

- 4.7 The noise and vibration impact of new road schemes in the UK is assessed using the Design Manual for Roads and Bridges Volume 11 Section 3 Part 7 – Noise and Vibration (HA 205/08). Section 1.1 of this guidance note provides the following introduction:

This Advice Note provides guidance on the appropriate level of assessment to be used when assessing the noise and vibration impacts arising from all road projects, including new construction, improvements and maintenance.

- 4.8 Further on in 1.4 of the introduction, it is stated that:

The impact of a project at any location can be reported in terms of changes in absolute noise level. In the UK the standard index used for traffic noise is the $L_{A10,18h}$ level, which is quoted in decibels.

- 4.9 The methodology contained within HA 205/08 (the DMRB methodology) is a detailed approach explaining the level of work required at various assessment stages from initial route selection stage through to a detailed assessment suitable for an Environmental Statement. From the information provided in section 9.4.2 of the ES it would appear that the road scheme meets the criteria for a detailed assessment.

- 4.10 A detailed assessment would require the assessment of traffic noise levels at dwellings within 600m of the scheme. Calculations should be carried out for the Do-Minimum and Do-Something situations for the baseline year (opening year for the road) and the future assessment year (maximum impact year within 15 years of road opening). The results of the noise predictions are also used to assess change in noise nuisance.

- 4.11 The detailed assessment also requires an evaluation of the need for any requirements under the Noise Insulation Regulations 1975 (as amended). The methodology in HA 205/08 provides detailed recommendations on how to tabulate the results of the noise and nuisance assessments. These tables present the noise and nuisance level changes in a number of change bands cross correlated to bands of absolute noise levels.
- 4.12 The Environmental Statement (page 9-18) makes reference to a scale of significance for road traffic noise derived from ‘an interpretation of change criteria from DMRB’. This section also includes information relating to impact of road traffic noise related to absolute noise level.
- 4.13 It is considered that the road traffic noise assessment does not meet the requirements contained in HA 205/08 in a number of ways, and therefore does not allow the impact of the road works to be assessed in the same way that all other similar road schemes would be assessed.

Aircraft Noise – Ground Noise

- 4.14 The ground noise assessment shown in Table 9.26 shows changes in dB $L_{Aeq,16h}$ noise levels between 2008 and ‘2020 with development’ as well as ‘2020 without development’ compared with ‘2020 with development’. As stated previously, there are some concerns about whether all of the data presented is in dB $L_{Aeq,16h}$ format, as illustrations on the Figures indicate otherwise. The figures in Table 9.26 do not appear to tie in with the change in the number of commercial flights that are predicted to use the airport. In 2008 there were just two commercial passenger routes using the airport which together accounted for under 800 movements during the year. The Southend Airport Aircraft Flows document shows over 13,000 commercial passenger movements in ‘2020 without development’ and over 24,000 commercial passenger movements with development. This level of change would be expected to show much bigger increases in ground noise contours near to the terminal between 2008 and 2020.

- 4.15 Whilst the concept of comparing the existing 2008 $L_{Aeq,16h}$ ground noise values with 2020 $L_{Aeq,16h}$ ground noise values is accepted, it is not possible to comment further on the acceptability of the levels because of the queries about the methodology used.

Aircraft Noise – Airborne Noise

- 4.16 It has been mentioned in Section 3 that it is considered that the airborne noise predictions do not consider the worst case scenario with the development because the Airbus 319 aircraft has been used in the predictions rather than the Boeing 737-300 which is around 6 dB(A) noisier on landing. It is not known precisely what impact this would have on the size of the noise contours because the aircraft produce similar noise levels on departure. However, it is considered that the noise contours should be recalculated using the Boeing 737-300 to assess this option, because I am not aware of any proposed restrictions that would allow the Airbus 319 to operate but not the Boeing 737-300.
- 4.17 The effect of the fleet mix on the noise contours is shown by comparing the noise contours shown in the ES with those produced in the Bickerdike Allen Partners report no. A7937-R01A-DC 'London Southend Airport Noise Implications of Runway Extension' produced in October 2008. This report used previous fleet mix predictions for 2020. These figures indicated a figure of 23,633 movements for the 92 day summer period in 2020 with runway extension, compared with a figure of 13,914 indicated in the Southend Airport Aircraft Flows document used as the basis of the ES contour predictions. The noise contours produced in the 2008 report were significantly larger in area than those produced in the ES. The noise levels for 2020 with the runway extension are about 7 dB $L_{Aeq,16h}$ higher in the 2008 report than in the ES for any given location close to the airport. At the very least, further information is required on the reason for such significant changes in the fleet mix and the noise contours.
- 4.18 It is noted that the presentation of information in Table 9.21 is inconsistent with the information presented in Table 9.26 relating to Ground Noise. Whilst both tables present noise levels for 2008 and 2020 with and without development, the Air Noise table only shows the change between 2020 with development and 2020 without development. The Ground Noise

table shows two change figures, the difference between 2020 with and without development but also the difference between 2020 with development and 2008. It is considered that the Air Noise table should also show the change between 2008 and 2020 with development.

5.0 NOISE MITIGATION MEASURES

Construction Noise

- 5.1 In relation to noise mitigation measures for construction, the ES does not consider construction noise to be a significant impact and only recommends that attention should be given to minimising construction noise impacting on Nos.13 and 14 Smallholdings where practicable. This is influenced by the choice of assessment criterion for construction noise and also by the prediction methodology used. It is also commented that existing noise levels are high at these properties because of road traffic on Eastwoodbury Lane. However, it should be considered that when the runway extension works are being carried out that Eastwoodbury Lane will be closed adjacent to these properties, and therefore ambient noise levels will be much lower than they currently are. It is also possible that runway extension works may be carried out at night-time.
- 5.2 It is therefore recommended that a more detailed assessment of construction noise levels is carried out that produces worst case one hour noise levels for construction noise during the day, evening and night. Construction noise criteria should be set using the ‘ABC method’ contained in Annex E.3 of BS 5228-1:2009. These criteria should take in to account the fact that some of the construction works will take place after Eastwoodbury Lane is closed. The results of this assessment should then be used to assess whether additional noise mitigation measures such as screening are required to meet the relevant criteria.

Road Traffic Noise

- 5.3 It is not possible to assess whether any noise mitigation measures are required against road traffic noise because the assessment has not been carried out in the format required by the Design Manual for Roads and Bridges, the relevant guidance for assessing the noise and vibration impact of new roads. The assessment should therefore be carried out using the appropriate noise index ($L_{A10,18h}$) with the appropriate assessment years. This assessment would then inform on whether there is a requirement under the Noise Insulation Regulations

1975 (as amended) for noise insulation because of the use of the new road, and also whether any noise mitigation measures such as screening need to be built in to the road scheme design to limit the changes in noise levels resulting from the use of the new road.

Aircraft Noise – Ground Noise

- 5.4 The assessment of the Ground Noise section in the ES has identified some fundamental queries about the noise calculations presented and whether the results used are $L_{Aeq,16h}$ values. This should be clarified with the applicant and information provided on the source data used for the calculations to enable the predictions to be verified. It is also considered that ground running/testing of engines should be included within the overall CADNA model of ground noise.
- 5.5 The approach of considering changes in L_{Aeq} is considered to be a valid method of comparing the impact of this noise, however, at present it is not considered that the impact of this source can be assessed on the information presented in the ES and it is therefore not possible to assess whether any further mitigation measures are required.

Aircraft Noise – Airborne Noise

- 5.6 The review of the Airborne Noise assessment methodology has identified factors in the data used for the predictions that means that it is not considered that a worst case scenario has been assessed. It is considered that further information should be obtained from the applicants to explain the differences between the data submitted in the 2008 Bickerdike Allen Partners noise report for the runway extension and the data in the ES. It is considered that the noise contours should be recalculated for a worst case scenario for the extended runway.
- 5.7 It is understood that the applicant has offered to provide sound insulation to residential properties as part of a Section 106 agreement. The proposal is to offer sound insulation to properties that fall within the 63 dB $L_{Aeq,16h}$ contour and which experience an increase in noise of 3 dB L_{Aeq} or more. In relation to the trigger limit for the sound insulation scheme, many of

the larger airports have sound insulation schemes with a trigger limit around 63 dB $L_{Aeq,16h}$. This trigger limit is lower than that contained in the Noise Insulation Regulations for Railways published in 1996 which use a trigger value of 68 dB $L_{Aeq,18h}$. There are a couple of instances of airport noise insulation schemes in the UK using lower trigger limits, but it is considered that the 63 dB $L_{Aeq,16h}$ level would be an appropriate trigger level. However, it is considered that the requirement for a 3 dB L_{Aeq} increase should be deleted. The application is for a scheme that will enable growth of commercial flights from the airport. It is considered that eligibility for the sound insulation package should be solely determined by whether the property is within the 63 dB $L_{Aeq,16h}$ contour.

- 5.8 The current proposal also only relates to residential premises. It is considered that the scheme should be extended to cover health care or education premises.
- 5.9 It is understood that the applicant has offered to acquire residential properties as part of a Section 106 agreement. The proposal is to acquire properties that fall within the 69 dB $L_{Aeq,16h}$ contour and which experience an increase in noise of 3 dB L_{Aeq} or more. It is considered that the 69 dB $L_{Aeq,16h}$ level would be an appropriate trigger level but that the requirement for a 3 dB L_{Aeq} increase should be deleted.
- 5.10 The proposed scheme would provide secondary glazing, powered mechanical ventilation, loft insulation and blinds for windows facing south. As an alternative a 50% contribution would be made to the cost of replacement double glazing if the owner preferred this to secondary glazing. This proposed level of works is similar to that offered by other airport authorities and is more flexible than the government sound insulation schemes for roads and railways. It is considered that it provides the basis of a suitable sound insulation scheme. It is not recommended that a precise acoustic specification is provided to be met by the insulation measures as often construction details in properties provide some limitations to what can be achieved. It is therefore recommended that the scheme specification as detailed in the Section 106 agreement is accepted.

- 5.11 Some details are provided of the proposed noise monitoring equipment in the Section 106 agreement. It is considered that two fixed noise monitors and one mobile monitor provide the basis for a suitable system. A fixed noise monitor should be located along the extended centreline at each end of the runway. The location should ideally be representative of noise sensitive properties, although it is necessary to obtain a suitable location for the monitors so that they are not unduly affected by extraneous noise. The mobile monitor provides the facility to investigate noise complaints and to carry out additional noise monitoring at other locations around the airport.
- 5.12 The two fixed monitors should be set up to continuously monitor all aircraft movements at the airport. The monitors should be capable of providing A-weighted and EPN measurements. The monitors should be Type 1 and able to provide L_{eq} and L_{90} measurements for all time periods and be able to measure L_{max} , L_{eq} and SEL measurements for all aircraft events. The noise monitoring system should be able to be correlated with aircraft movement data from Air Traffic control so that it is possible to identify specific aircraft movements and correlate with the noise level data. This also provides a method of checking that the system is measuring all relevant aircraft movements. There are a number of acoustic hardware companies that provide various levels of sophisticated airport noise monitoring systems that have the ability to integrate other sources of information. Manufacturers include B&K/Lochard, Cirrus Environmental, and Topsonic. The draft Section 106 agreement provides for the local authorities to be provided with the outputs of the noise monitors every 6 months together with information on flight details for correlation. It is suggested that the Council are also provided with a summary report every 6 months detailing overall noise parameters for the period.

6.0 SUMMARY AND CONCLUSIONS

- 6.1 Hepworth Acoustics was commissioned by Southend-on-Sea Council to provide an assessment of the noise aspects of the information submitted in the Environmental Statement and associated documents with the planning application for an extension of the runway and associated works at Southend Airport.
- 6.2 The assessment has considered construction noise; road traffic noise; ground noise from aircraft; and airborne noise from aircraft.
- 6.3 The prediction methodologies, assessment methodologies and mitigation measures proposed have been assessed. Comments have been made on requirements for additional work or clarification on all four issues considered. It is currently not possible to definitively judge the overall noise impact of the proposed works because of the requirement for additional work or clarification. However, where possible, comments have been made on the proposed assessment criteria and noise mitigation measures.
- 6.4 Whilst a number of requests for additional information are made, it is not considered at this stage that there are insurmountable noise issues arising from the proposed development. The additional information is required to determine whether there is a need for additional noise mitigation measures over and above those already proposed.

Appendix I – Noise Units and Indices

a) Sound Pressure Level and the decibel (dB)

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120 dB (threshold of pain).

b) Frequency and hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kilohertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20,000 Hz. However, the upper frequency limit gradually reduces as a person gets older.

c) Glossary of Terms

When a noise level is constant and does not fluctuate over time, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise

where the level is continuously varying, a number of other indices, are used. The indices used in this report are described below.

L_{Aeq} This is the A-weighted ‘equivalent continuous noise level’ which is an average of the total sound energy measured over a specified time period. In other words, L_{Aeq} is the level of a continuous noise which has the same total (A-weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

SEL Referred to as the Sound Exposure Level (dB) this is the total A-weighted sound energy produced by an event and is effectively the L_{Aeq} of an event normalised to a duration of 1 second in length. SEL’s can be scaled according to the number of events and can be further manipulated to provide an average noise level $L_{Aeq,T}$.

EPNdB Referred to as the Effective Perceived Noise Level. This is a measure of the noise from an aircraft movement, weighted to reflect subjective responses to aircraft noisiness.