

M60/M62/M66 Simister Island Interchange

TR010064

ENVIRONMENTAL STATEMENT APPENDICES

APPENDIX 11.1 INTRODUCTION TO ACOUSTICS

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed
Forms and Procedure) Regulations 2009

Infrastructure Planning

Planning Act 2008

**The Infrastructure Planning
(Applications: Prescribed Forms and
Procedure) Regulations 2009**

**M60/M62/M66 Simister Island Interchange
Development Consent Order 202[]**

**ENVIRONMENTAL STATEMENT APPENDICES
APPENDIX 11.1 INTRODUCTION TO ACOUSTICS**

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Appendix 11.1 Introduction to acoustics

1.1 Introduction

1.1.1 This appendix explains some of the basics of acoustics, specifically related to the assessment of and description of impacts from road traffic noise.

1.2 Human perception

1.2.1 Noise is commonly defined as unwanted sound and is therefore subjective. The human perception of noise is influenced by physical, physiological and psychological factors. Physical factors include the sound pressure level at the position of the listener, physiological factors include the acuity of hearing, and psychological factors include acclimatisation to steady sound and the activity that an individual is undertaking while the sound is present.

1.2.2 Sound consists of vibrations transmitted to the ear as rapid variations in air pressure which can be measured accurately. The more rapid the variations in air pressure the higher the frequency of the sound. Frequency is defined as the number of pressure fluctuations per second and is expressed in hertz (Hz).

1.2.3 The ear can detect both loudness and frequency of sound. However, the sensitivity of the human ear varies with frequency, and therefore noise is commonly measured using the A-weighted filter network which mimics the frequency response characteristics of the human ear. The 'A' notation is used to indicate when noise levels have been filtered using the A-weighting network.

1.2.4 Noise levels range from the threshold of hearing at 0 decibel (dB) (A) to levels of over 130dB(A) at which point the noise becomes painful. Noise levels over 80dB(A) are considered potentially damaging to hearing. Table 1.1 presents guide to the A-weighted sound pressure levels in common areas and activities.

Table 1.1 Common noise levels

Source	Sound pressure level, dB(A)
Threshold of hearing – silent	0
Quiet bedroom	25-35
Quiet rural area	45-50
Suburban areas away from main traffic routes	50-60
Conversational speech at 1m distance	60-70
Busy urban street corner	70-80
Passenger car at 60 km/h and 10m distance	70
Health & Safety 'lower exposure action value' to prevent damage to hearing	80
Heavy diesel lorry at 40 km/h and 10m distance	80

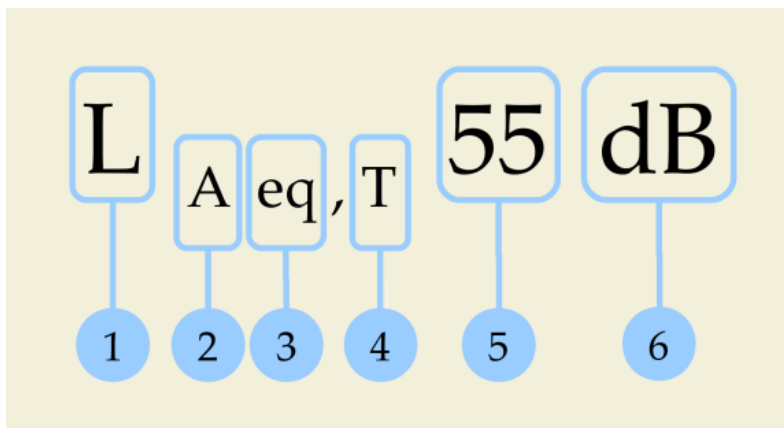
Source	Sound pressure level, dB(A)
Pneumatic drill (un-silenced) at 7m distance	95
Threshold of pain	130

1.3 Acoustic descriptors

1.3.1 Outdoor noise levels may fluctuate rapidly over time, and therefore to describe the acoustic environment it is necessary to collect statistical data on the distribution of noise levels during the period of interest.

1.3.2 The nomenclature used to represent acoustic quantities can appear complicated, however once understood it becomes a logical and efficient way of qualifying noise levels. As an example, the upper guideline level recommended by BS 8233:2014 (British Standards Institution, 2014) for noise levels in gardens is $L_{Aeq,T} 55\text{dB}$, as shown in Plate 1.1.

Plate 1.1 Example of an acoustic descriptor



1.3.3 The above descriptor is comprised as follows:

- The first grouping ('L') indicates that the quantity is a sound pressure level. Other common quantities are sound intensity level (LI) and sound power level (LW).
- The second grouping ('A') denotes that the sound pressure level is evaluated using the A-weighted filter network.
- The third grouping of characters identify the statistical index. In this example, the letters indicate that the quantity is in terms of the equivalent continuous noise level (eq), which has some similarities with the concept of an average noise level. Numerical values can also be used, and these indicate the level exceeded for n per cent of the measurement (e.g. a value of $L_{A90,T} 45\text{dB}$ indicates that the A-weighted sound pressure level exceeds 45dB for 90% of the period analysed).
- The quantity ('T') shown after the statistical descriptor is the duration over which the quantity is evaluated. This is typically represented in minutes or hours, e.g. 15min, 16h.

- The fifth term of the statistical descriptor identifies its numeric value. This value is usually given as a whole number or to one decimal place.
- The sixth and final group of characters indicate that the units of the sound pressure level are decibels.

1.3.4 A variety of statistical indices are used to quantify noise in different situations. The most common are described in the next Section.

1.4 Acoustic parameters

Ambient noise level

1.4.1 General environmental noise from transport, commercial, construction, industrial or unidentified sources is often expressed in terms of the equivalent continuous sound pressure level over the time period of interest ($L_{Aeq,T}$). This is the notional continuous constant noise that contains the same sound energy over the period of interest as the actual fluctuating noise. This is not an 'average' sound level over a period, but the concept has some similarities and provides a single figure quantity that can be used to compare noise levels which fluctuate with time.

1.4.2 The L_{den} is a noise index that is mainly used by the World Health Organisation and health professionals. It provides a single weight noise level taking into account the commonly used three periods of day (07:00 to 19:00), evening (19:00 to 23:00) and night (23:00 to 07:00). Before the $L_{Aeq,T}$ noise levels from these three periods are added together the evening period has a +5 dB(A) correction applied and the night period a +10 dB(A) correction applied.

Road traffic noise

1.4.3 The index adopted by the UK Government to quantify road traffic noise is the $LA_{10,18h}$, which is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the 18 one-hour periods between 6am and midnight.

1.4.4 The $LA_{10,18h}$ index has been shown to have a good relationship with annoyance caused by road traffic noise, which has a strong low frequency content.

1.4.5 The L_{night} is the equivalent continuous sound pressure level when the reference time interval is the night. In the assessment of road traffic noise the night-time period is considered to be 23:00-07:00.

Background noise level

1.4.6 The $LA_{90,T}$ index identifies the noise level exceeded for 90% of the period of interest, and provides a good indication of the background noise level that remains in a location in the absence of any easily identifiable sources.

Maximum sound level

- 1.4.7 The maximum sound level (L_{Amax}) is the highest time-weighted sound level measured during a period. The time constant of the measure may either be Fast (125ms), Slow (1s) or Impulsive (35ms), and it is usual to identify the time constant in the notation – e.g. L_{AFmax} indicates that the maximum sound level was measured with the fast time-weighting. The longer the time constant over which the measurement is integrated, the greater the smoothing effect of the time-weighting, which may result in a lower numeric value of the measurement. If it is not clear which time weighting has been used for a measurement, then it is generally assumed to be the fast time weighting as this is most common.

1.5 Vibration

- 1.5.1 Groundborne vibration is typically measured in terms of velocity (millimeters per second). Where sources of vibration are impulsive / intermittent it is the peak velocity or acceleration which is measured (and this will be the maximum value recorded during a specific event).
- 1.5.2 Acceptable levels for human exposure to vibration and for the evaluation of building vibration with respect to annoyance and comfort are provided in various standards and guidance documents. Based on guidance given in BS 5228-2:2009+A1:2014, Table 1.2 summarises the effects of vibration levels on buildings and humans.

Table 1.2 Guidance on the effects of vibration levels

Vibration level, PPV ¹	Effect
0.14mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.
0.3mm/s	Vibration might be just perceptible in residential environments.
1.0mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
6.0mm/s	Possible cosmetic damage to a building structure may occur from continuous works.
10mm/s	Vibration is likely to be intolerable to humans for any more than a very brief exposure to this level.
15mm/s	Damage to an unreinforced or light building structure can occur from transient works (value to be halved for continuous works).
50mm/s	Damage to a reinforced or heavy building structure can occur from transient works (value to be halved for continuous works).
¹ PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal. It is specified in mm/s. It should be noted that the PPV refers to the movement within the ground of molecular particles and not surface movement.	

Acronyms and initialisms

Acronym or initialism	Term
dB	Decibel
Hz	Hertz
Km/h	Kilometres per hour
mm/s	Millimetres per second
ms	Millisecond
PPV	Peak Particle Velocity
S	second

Glossary

Term	Definition
A-Weighting	This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
dB	Abbreviation of decibel.
dB(A)	Abbreviation of A-weighted decibel.
Decibel	The scale on which sound pressure level is expressed. In air it is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ($2 \times 10^{-5} \text{Pa}$).
Equivalent Continuous Sound Pressure Level (L_{eq})	The Equivalent Continuous Sound Pressure Level is the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.
Façade and free-field levels	Due to the effects of reflection, sound pressure levels measured close to large vertical reflecting surfaces such as building façades are higher than those that are measured away from reflective surfaces. Sound pressure levels measured 1m from a large solid, reflecting surface are termed 'façade' levels, while those measured at least 3m away from any reflective surfaces (apart from the ground) are termed 'free-field'.
L_{10} or L_{A10}	Acoustic nomenclature indicating that the value is exceeded for 10% of the period of interest. This index, evaluated over the period 06:00 to 24:00, is commonly used to describe road traffic noise.
L_{90} or L_{A90}	Acoustic nomenclature indicating that the value is exceeded for 90% of the period of interest. This index is taken to be a good indicator of the background noise level remaining at a location in the absence of any easily identifiable sources.

Term	Definition
L_{eq} or L_{Aeq}	Acoustic nomenclature indicating that a value is expressed in terms of the Equivalent Continuous Sound Pressure Level.
L_{den}	Day-evening-night weighted sound pressure level.
L_{night}	Equivalent continuous sound pressure level when the reference time interval is the night.
Peak Particle Velocity (PPV)	PPV is defined as the maximum instantaneous positive or negative peak of the vibration signal. It is specified in millimeters per second (mm/sec). It should be noted that the PPV refers to the movement within the ground of molecular particles and not surface movement.

References

British Standards Institution (2014). BS 5228-2:2009+A1:2014: Code of practice for noise and vibration control on construction and open sites. Vibration

British Standards Institution (2014). BS 8233:2014: Guidance on sound insulation and noise reduction for buildings.