

DMG-240924

26th September 2024



John Southworth

Assessment of noise at the land off
Princedom Street, Harpurhey, Manchester
for proposed residential development

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CONTENTS

1.0 SUMMARY

2.0 INTRODUCTION

3.0 ASSESSMENT STANDARDS

3.1 NPPF, NPSE and NPPG

3.2 BS8233 and WHO

3.3 Local Authority

4.0 GUIDE TO MODELLING

5.0 SURVEY DETAILS

5.1 Site Times and Personnel

5.2 Instrumentation

5.3 Measurement Positions

5.4 Survey Conditions

6.0 RESULTS AND DISCUSSIONS

6.1 Basic Results

6.2 Assessment

6.3 Mitigation

7.0 CONCLUSIONS/RECOMMENDATIONS

Appendix 1: Definition of Acoustic Terms

Appendix 2: Measurement and Calculation Details

1.0 SUMMARY

During the early night time period and the rush hour period, the general and typical noise climate was dominated by road traffic, mainly middle distance. From around 09:00 on the day of the second survey, the noise was dominated by construction noise and the use of a chainsaw on a tree stump, both very close by.

Note that the night time survey had to be aborted due to threats from locals and safety concerns. It was agreed with the Environmental Protection Officers that a short night time and daytime survey should be adequate. We can also confirm that our results for the daytime are consistent with those undertaken in 2023 by another consultancy. They did not do any night time measurements.

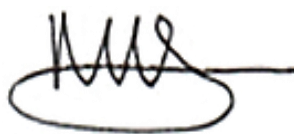
The BS 8233 criterion for *desirable* conditions should easily be met with basic 1.8 m garden fencing, even ignoring the screening effects of the proposed houses.

With open windows, the predicted internal levels meet BS 8233 criteria for *reasonable* conditions in the most exposed (outward-facing) living rooms and *desirable* conditions for the most exposed bedrooms. More sheltered rooms (rear and inner facing) will of course be far less exposed and should easily fall well within criteria for *desirable* conditions with open windows.

To be sure that the most exposed living rooms to meet the criterion for desirable conditions, windows will need to be closed. However, given that reasonable conditions should still be achieved, and the likelihood that the site itself will provide additional screening, it would seem somewhat excessive to require mechanical ventilation. This should be discussed this with planners.



A R Raymond



M A Pickering

2.0 INTRODUCTION

Eco Technology Lcz Ltd was asked to carry out an independent assessment of the above site with regards to its suitability for residential development from a noise perspective.

This report begins by summarising assessment standards and, where appropriate, discusses alternative interpretations.

After a brief statement of survey details we discuss basic results and the resulting assessment, along with any mitigation which might be implied. We sum-up and conclude at the end, along with brief recommendations.

3.0 ASSESSMENT STANDARDS

3.1 NPPE, NPSE and NPPG

The National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the National Planning Practice Guidance (NPPG) provide nothing in the way of quantitative criteria but instead provide general policy aims and statements and some guidance on how certain situations can be interpreted.

The NPPF's main statement on noise is to be found in paragraph 191:-

191. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:
- a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life⁶⁹;
 - b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and
 - c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation.

Paragraph 193 is also relevant:-

193. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

The NPPF refers to the NPSE which sets out the following aims:-

1. *avoid significant adverse impacts on health and quality of life;*
2. *mitigate and minimise adverse impacts on health and quality of life;*
- and*
3. *where possible, contribute to the improvement of health and quality of life.*

It also introduces the concepts of:

- *NOEL – No Observed Effect Level. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.*
- *LOAEL – Lowest Observed Adverse Effect Level. This is the level above which adverse effects on health and quality of life can be detected.*
- *SOAEL – Significant Observed Adverse Effect Level. This is the level above which significant adverse effects on health and quality of life occur.*

SOAEL is clearly something the policy seeks to avoid in aim 1. Aim 2 represents situations between SOAEL and LOAEL, and seeks to minimise and mitigate the effects.

The NPPG section on noise adds some further detail, much of it reproducing the NPPF and NPSE, but some useful qualitative guidance is provided Noise Exposure Hierarchy, as follows:-

Response	Examples of outcomes	Increasing effect level	Action
No Observed Effect Level			
Not present	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

It also makes the point that the subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation, including the level of the noise in absolute terms and how it might compare with the underlying background noise, the impulsiveness or intermittence pattern of the noise, its spectral content, and the time of day. It discusses in very general terms the issues to consider when introducing noise sources to existing noise sensitive area, new residential development in areas affected by existing noise sources (most of which have their own specific guidance, such as BS 4142, BS 8233, etc.) and the potential impact on wildlife.

3.2 BS8233 and WHO

BS 8233 was updated in March 2014. Quantitatively, however, the design criteria are little changed – just expressed differently to reduce ambiguity in certain situations.

The criteria in Table 4 of BS 8233 are based on WHO guidance and give the desirable criteria for indoor ambient noise levels for dwellings as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	35 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,8hour}$	30 dB $L_{Aeq,8hour}$

Note that the standard accepts the widely used rule of thumb that, for a partly open window, the levels just outside will be 15dB higher than those just inside. This brings us to an external equivalent of the above table, as follows:-

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living room	50 dB $L_{Aeq,16hour}$	-
Dining	Dining room/area	55 dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	50 dB $L_{Aeq,8hour}$	45 dB $L_{Aeq,8hour}$

It goes on to state that, where necessary, the criteria can be relaxed by up to 5 dB and still achieve reasonable conditions.

Note that this version of BS 8233 does not explicitly state criteria for bedroom noise in terms of dB L_{Amax} but the WHO Guidelines for Community Noise (or similar) are widely used with a recommendation that the noise inside bedrooms should not typically exceed 45 dB L_{Amax} , for instance no more than 10 to 15 times a night.

Garden area criteria are 50 dB L_{Aeq} and 55 dB L_{Aeq} being considered desirable and reasonable respectively.

Note that the new version of BS8233 more explicitly specifies the assessment periods as 16 hour and 8 hour for daytime and night time respectively.

3.3 Local Authority

As far as we are aware no planning conditions have been proposed.

4.0 GUIDE TO MODELLING

Full details of calculations are given in Appendix 2. The basic approach is as follows.

1. The external noise break-in is based on the level of external noise just outside the façade(s), the area of the façade(s), the sound insulation properties of the façade(s) and the internal absorption of the room.

2. The first input to the calculation process is the area of the exposed façade. Where more than one façade is exposed, then they can all be entered. The room depth is also entered so as to derive the room volume. Where the room is not a straight forward rectangular shape, an “effective depth” is sometimes entered so as to derive the approximate room volume. Judgement may occasionally be used if the room is not simple, such as a very unusual shape or a multi-use room such as a through-kitchen/dining room/living room, or studio-style area.
3. The reverberation time (RT) is entered. Usually this is a standardised 0.5 seconds and represents the absorption properties of the room.
4. Two corrections result from the above inputs. Firstly, we have the Area Correction. Put simply, the greater the exposed area, the more noise will break in. The correction is $10 \times \log(\text{Effective Area})$ and is usually a positive number. Note that the “Effective Area” takes account of the method of modelling vents – see later. The Room Correction takes account of the room absorption (more absorption reduces the noise) and the room volume (a larger volume disperses, and so reduces, the noise). The correction is $10 \times \log(\text{RT}/0.163/\text{Volume})$ and is usually a negative number.
5. These corrections, together with the sound insulation properties of the façade(s) give us the basic outside-to-inside level difference. The sound insulation properties of the façade(s), known as the Sound Reduction Index (SRI or just R) are effectively the sound insulation of 1m^2 of material (apart from vents – see later). Of course, a façade is usually made up of more than one element – windows and walls for instance. The overall SRI or R is referred to as the Composite SRI or composite R and is related to the SRI or R of the individual elements and their respective areas. SRI or R figures are usually based on laboratory tests and therefore somewhat idealised.
6. An additional complication is that performance data for vents is generally standardised to 10m^2 . The area of a vent is therefore usually entered as 10m^2 , even though its actual area will usually be nowhere near that much.
7. So, the composite SRI or R, combined with the areas and room corrections gives us the basic level difference to be expected under perfect (laboratory) conditions. However, actual site conditions are affected by workmanship, which can never be guaranteed to be perfect, and flanking paths (noise paths other than straight through the façade(s)). We add a 3 dB allowance for this.
8. Finally we have to enter any differences between the measurement position and the façade being modelled. If the measurements were made in free field conditions, then a façade effect of up to +3 dB is necessary.

9. The process is repeated in octave bands across the frequency range to derive the predicted internal levels.

5.0 SURVEY DETAILS

5.1 Site Times and Personnel

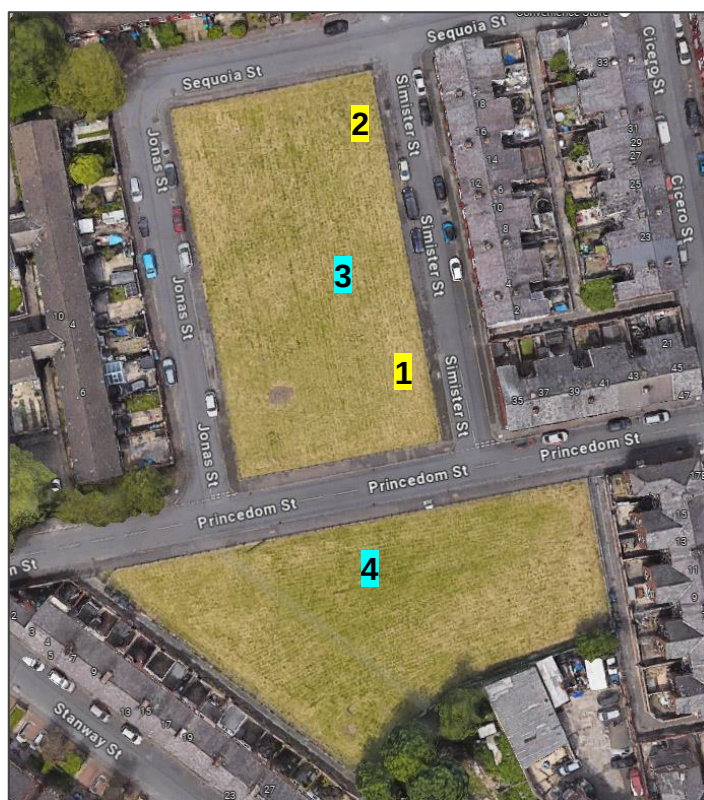
The measurements were carried out initially by Robert Smith of Eco Technology on the early hours of the 15th August 2024, with measurements made from approximately 00:15 to 01:15 before abandoning due to safety reasons. A subsequent period was carried out by Mark Pimlett of Eco Technology on 25th September 2024 from approximately 07:00 hours to 11:30 hours. These times were agreed with the Local Authority in email exchangers between Rob Smith and Environmental Protection Officer Rebecca Twigg-Purcell on 19th September 2024.

5.2 Instrumentation

Instrumentation used was a Rion NL-52 and Norsonic Class I sound level meter which holds a current calibration certificate and which was field-calibrated as necessary with no drift noted. The meter was set up to measure continuous 5 minute samples in terms of dB L_{eq}, dB L_{max} and dB L₉₀ in overall A-weighted terms, and in octave bands across the frequency range. See Definition of Acoustic Terms in Appendix 1.

5.3 Measurement Positions

The main measurement positions were as shown on the following plan with yellow numbers. The blue numbers show the short night time measurements.



The microphone was 1.3 m above ground and well away from other reflecting surfaces.

5.4 Survey Conditions

We have no reason to believe that the conditions we found on the survey were anything other than representative of normal conditions. See 6.0 below for difficulties during the night time survey.

The first survey (night time) weather conditions were as follows :-

Rain	:	none, dry roads
Cloud	:	0%
Temperature	:	16 Celsius
Wind	:	<3m/s from the south west

Second survey (daytime) weather conditions were as follows :-

Rain	:	none, damp roads
Cloud	:	70 to 100%
Temperature	:	11 Celsius
Wind	:	negligible

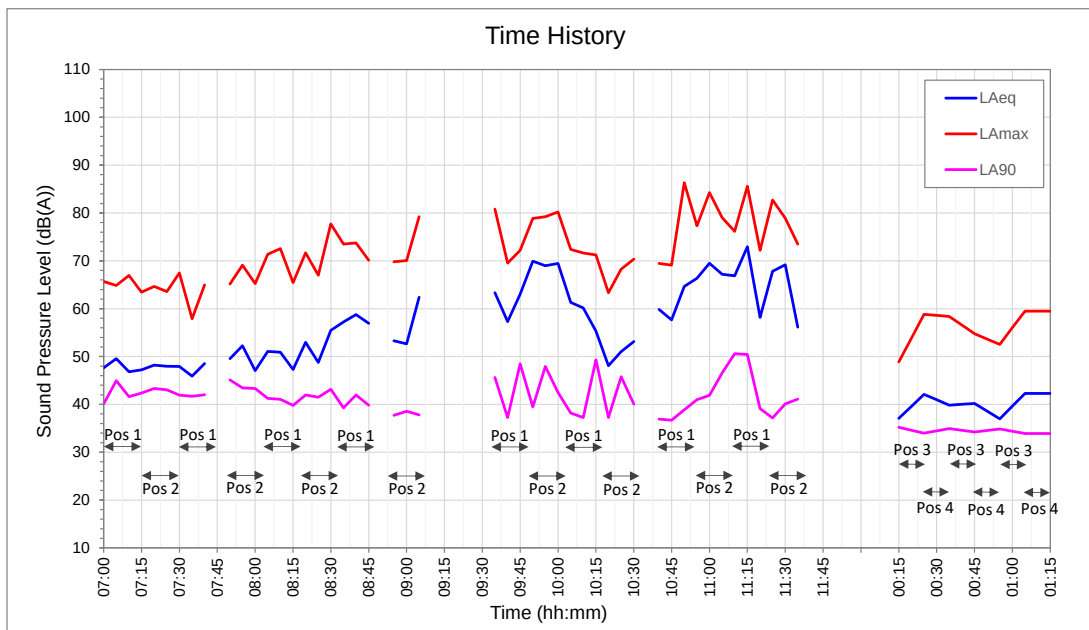
6.0 RESULTS AND DISCUSSIONS

During the first survey (night time) the background noise climate was relatively constant with distant road traffic and general city noise. There were very occasional vehicles on Simister Street and Princedom Street, as well as occasional aircraft and some noise from the surrounding houses. The survey was aborted due to safety concerns, as local residents surrounded our surveyor and issued threats.

During the first half of the second survey (daytime), up until shortly after 09:00, the primary noise source was predominantly distant and middle distance traffic. Middle distance construction noise was also audible. From 09:00, much closer construction noise became dominant, along with work with a chainsaw on a tree stump, also nearby. There was also occasional engine revving from what appeared to be a car dealers and garage to the southeast.

6.1 Basic Results

Full details are given in Appendix 2. They can be viewed graphically over time as follows:-



A summary of overall levels is as follows:-

Overall Summary	Index	dB(A)
Position 1 (Daytime)	Leq	62
	Lmax	77
	L90	44
Position 2 (Daytime)	Leq	64
	Lmax	77
	L90	43
Position 3 (Night Time)	Leq	38
	Lmax	55
	L90	35
Position 4 (Night Time)	Leq	42
	Lmax	58
	L90	34

Note that the second half of the daytime period was heavily influenced by nearby construction noise and other non-typical activities and is not representative. We can see that it is significantly higher after 09:00 when rush hour was dying down. A summary of overall levels for rush hour only is as follows:-

Rush Hour Summary	Index	dB(A)
Position 1 (Rush Hour)	Leq	53
	Lmax	70
	L90	42
Position 2 (Rush Hour)	Leq	54
	Lmax	72
	L90	42

These rush hour measurements are consistent with a survey carried out in May 2023 by Professional Consult for AEW Architects (ref. 21.158.1.R1). Extracts are reproduced as follows:-



Noise Measurement Position 1: Located 5m from the nearside kerb of Princedom Street between 10:00 – 13:00 on Wednesday 17th May 2023. Noise sources at the measurement location comprised of intermittent road traffic movements on Princedom Street.

3.1.2 Table 5 presents the measured road traffic noise levels:

Table 5. Summary of Measured Road Traffic Noise Levels

Measurement Position	Period	Measured Sound Pressure Level (dB)		
		L _{Aeq,1hr}	L _{A10,1hr}	L _{Amax,fast}
1	17/05/2023 10:00	49.6	52.1	70.6*
	17/05/2023 11:00	50.3	51.4	
	17/05/2023 12:00	52.4	53.6	
*10 th highest L _{Amax,fast}				



6.2 Assessments

The above results give the following assessments.

In terms of BS 8233/WHO, we are mainly concerned with the dB(A) L_{eq} values, or the dB L_{Aeq} levels. See definition of Acoustic terms in Appendix 1. The current version of BS8233 no longer has night time criteria in terms of dB(A) L_{max} values, or dB L_{Amax} values, but some local authorities still like to see them presented and assessed to WHO guidelines or similar.

In order to meet criteria, the measured levels appear to suggest that sound insulation will need to be designed to control external noise break-in as follows:

<i>Position</i>	<i>Environment</i>	<i>Reductions for BS8233 desirable* criteria</i>	<i>Reductions for WHO-Type Criteria</i>
1	Living Rooms	18 dB L _{Aeq}	-
	Outdoor Living Areas	3 dB L _{Aeq}	-
2	Living Rooms	19 dB L _{Aeq}	-
	Outdoor Living Areas	4 dB L _{Aeq}	-
3	Bedrooms	8 dB L _{Aeq}	10 dB L _{Amax}
4	Bedrooms	12 dB L _{Aeq}	13 dB L _{Amax}

Note that these figures do not include any façade effect which might be applicable

* BS 8233 considers a 5 dB relaxation would still provide *reasonable* conditions

Note, of course, that these assertions are based upon the assumption that night-time noise levels are represented by measurements during the early part of the night, and that daytime noise levels are represented by measurements around rush hour. In other words, they should represent a worst-case.

6.3 Mitigation

For outdoor living areas (usually rear gardens), the suggested reduction of up to 4 dB to meet the BS 8233 criterion for *desirable* conditions should easily be met with basic 1.8 m garden fencing, even ignoring the screening effects of the proposed houses. There is no need for any particular acoustic specification to the fencing as long as it is essentially closed, eg. overlapping featheredge. Even without any fencing and also ignoring the screening effect of the proposed houses, the BS 8233 criterion for *reasonable* conditions is easily met.

Moving on to break-in to habitable rooms, a partly open window can be expected to provide about 15 dB reduction. This will be sufficient to achieve BS 8233 criteria for *reasonable* conditions to the most exposed (outward-facing) living rooms and *desirable* conditions for the most exposed bedrooms. More sheltered rooms (rear and inner facing) will of course be far less exposed and should easily fall well within criteria for *desirable* conditions.

To be sure that the most exposed living rooms to meet the criterion for desirable conditions, windows will need to be closed. However, given that reasonable conditions should still be achieved, and the likelihood that the site itself will provide additional screening, it would seem somewhat excessive to require mechanical ventilation. You should discuss this with planners.

A summary of mitigation (or building elements assumed in our calculations) is as follows:-

<i>Façade</i>	<i>Room Type</i>	<i>Make-Up on Which Calculations are Based</i>
Position 1	Living Room/Kitchen	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300
Position 2	Living Room/Kitchen	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300
Position 3	3rd Bedroom	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300
Position 4	3rd Bedroom	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300

The rooms are used as worst case examples as they are exposed on two or more facades, and/or have large window areas, and/or smaller room volumes. Other rooms on the same façade with the same glazing and vent specification can be expected to perform better

Full calculation details are shown in Appendix 2 and a summary of predicted internal noise levels is as follows:-

<i>Façade</i>	<i>Room Type</i>	<i>Time</i>	<i>Index</i>	<i>dB(A)</i>
Position 1	Living Room/Kitchen	Rush	Leq	32
Position 2	Living Room/Kitchen	Rush	Leq	33
Position 3	3rd Bedroom	Early Night	Leq	20
			Lmax	35
Position 4	3rd Bedroom	Early Night	Leq	23
			Lmax	39

We can see that predicted levels are within all criteria.

Of course, these assessments are very robust as they use what are likely to be the noisier times of day and night, assume all facades have a unrestricted lines of sight to the main sources and that the development itself will not provide any screening to its own properties.

7.0 **CONCLUSIONS/RECOMMENDATIONS**

The BS 8233 criterion for *desirable* conditions should easily be met with basic 1.8 m garden fencing, even ignoring the screening effects of the proposed houses.

With open windows, the predicted internal levels meet BS 8233 criteria for *reasonable* conditions in the most exposed (outward-facing) living rooms and *desirable* conditions for the most exposed bedrooms. More sheltered rooms (rear and inner facing) will of course be far less exposed and should easily fall well within criteria for *desirable* conditions with open windows.

To be sure that the most exposed living rooms to meet the criterion for desirable conditions, windows will need to be closed. However, given that reasonable conditions should still be achieved, and the likelihood that the site itself will provide additional screening, it would seem

somewhat excessive to require mechanical ventilation. This should be discussed this with planners.

We recommend that you issue this report to planners and we would encourage officers to contact us directly with any queries.

Appendix 1

Definition of Acoustic Terms

The Decibel

The decibel is the basic unit of noise measurement and is denoted dB. Technically, it is a means of expressing the difference in noise level between the measured noise and a standard level of noise. Most often the threshold of human hearing is used as the standard reference but it really should be stated. The threshold of human hearing is a sound pressure of $20\mu\text{Pa}$ or a sound power of 1pW .

A sound pressure level or SPL should be expressed in dB(re. $20\mu\text{Pa}$). A sound power level or SWL should be expressed in dB(re. 1pW). If the reference levels are omitted, it will often (but not always) be safe to assume that they are referenced to the threshold of human hearing.

A-Weighting and dB(A)

The human hearing system responds differently to different frequencies. The A-weighting system takes account of this by emphasising mid and high frequencies more than low frequencies to given an overall level. An A-Weighted noise level, therefore, reflects the way normal, healthy hearing would perceive the overall level of the noise. The basic unit is dB(A), although other systems of expressing an A-weighted level are discussed below.

Other weighting systems, such as C-Weighting, denoted dB(C), reflect the human hearing system's response at higher noise levels.

Equivalent Continuous Sound Level, L_{eq}

This is a kind of mean noise level.

The unit is dB L_{eq} . For A-weighted levels the unit is dB(A) L_{eq} or, in more modern units, dB L_{Aeq} . The Noise at Work Regulations use $L_{eq(s)}$ which refers to a sample level.

Maximum Level, L_{max}

This is the maximum level reached (usually for a fraction of a second) in the measurement period.

The unit is dB L_{max} . For A-weighted levels the unit is dB(A) L_{max} or, in more modern units, dB L_{Amax} .

Statistical (Percentile) Levels, L_n

During a measurement of fluctuating noise, it is often useful to establish the levels exceeded for a percentage of the time. L_n is the index representing the level exceeded for $n\%$ of the measurement period.

The unit is dB L_n . For A-weighted levels, the unit is dB(A) L_n or, in more modern units, dB L_{An} .

Common examples are as follows :-

dB L_{A90} is the A-weighted level exceeded for 90% of the time and is often used to describe the underlying background noise.

dB L_{A50} is the A-weighted level exceeded for 50% of the time. Mathematically, it is the median, another kind of average.

dB L_{A10} is the A-weighted level exceeded for 10% of the time and has traditionally been used to describe the intermittent highs in the noise climate such as passing cars or aircraft.

Frequency Analysis

Here the audible frequency range is divided up into bands and the noise level is expressed in each frequency band from low pitches to high pitches.

Octave Band analysis is where the frequency range is divided into 8 bands from 63 Hz to 8kHz, or sometimes into 10 bands from 31.5 Hz to 16kHz.

1/3 Octave Band analysis provides more detailed subdivision into 24 bands from 50 Hz to 10kHz, or sometimes into 30 bands from 20Hz to 20kHz.

Narrow Band analysis takes this further with the possibility of many thousands of bands, possibly only 1Hz wide, or even less.

In all types of frequency analysis, the level in each band can be expressed in terms of L_{eq} , L_{max} , L_n , etc. as defined above.

Appendix 2

Measurement and Calculation Details

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
07:00	Leq	48	55	50	47	41	43	42	32	31
	Lmax	66	65	59	59	56	59	63	48	53
	L90	40	51	46	40	35	37	29	18	14
07:05	Leq	50	56	51	46	45	44	43	39	35
	Lmax	65	74	59	57	57	61	58	54	48
	L90	45	53	48	43	41	40	38	33	30
07:10	Leq	47	56	51	47	42	42	39	35	27
	Lmax	67	70	60	65	65	61	60	55	48
	L90	42	53	48	42	37	38	28	20	16

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
07:15	Leq	47	55	51	47	43	43	38	32	24
	Lmax	63	62	59	58	61	59	56	50	42
	L90	42	52	47	41	38	40	30	18	14
07:20	Leq	48	57	51	47	42	45	41	34	27
	Lmax	65	76	64	62	58	61	58	52	45
	L90	43	53	48	42	39	41	31	19	14
07:25	Leq	48	57	53	51	44	43	37	30	24
	Lmax	64	68	61	66	60	57	56	53	49
	L90	43	53	48	41	39	40	31	20	14

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
07:30	Leq	48	55	51	45	42	45	40	33	26
	Lmax	67	73	68	62	61	64	61	54	45
	L90	42	51	48	42	37	39	30	21	15
07:35	Leq	46	56	52	49	43	40	33	28	25
	Lmax	58	68	63	61	57	48	46	44	45
	L90	42	52	48	42	37	39	30	21	15
07:40	Leq	49	55	51	47	44	45	40	35	28
	Lmax	65	63	61	57	61	61	59	53	47
	L90	42	52	48	42	37	39	30	20	14

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
07:50	Leq	50	60	53	48	44	46	41	35	29
	Lmax	65	78	69	63	59	62	56	51	46
	L90	45	55	48	43	39	42	37	28	19
07:55	Leq	52	58	52	49	48	49	45	40	32
	Lmax	69	79	63	65	65	65	62	57	51
	L90	43	53	48	42	39	41	32	21	15
08:00	Leq	47	57	51	46	43	44	37	32	24
	Lmax	65	66	60	70	57	60	54	54	48
	L90	43	54	47	42	39	41	32	20	14

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
08:05	Leq	51	54	49	46	45	48	45	38	29
	Lmax	71	67	65	67	66	68	65	57	51
	L90	41	51	46	41	37	38	30	20	14
08:10	Leq	51	58	52	46	44	48	45	36	27
	Lmax	73	78	67	66	68	69	67	58	50
	L90	41	52	46	41	36	38	31	21	14
08:15	Leq	47	54	49	45	42	44	40	32	23
	Lmax	65	65	63	60	59	62	59	51	40
	L90	40	51	46	40	36	36	29	19	14

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
08:20	Leq	53	57	53	49	48	49	46	40	36
	Lmax	72	71	67	64	67	68	65	61	57
	L90	42	52	47	41	38	39	31	20	15
08:25	Leq	49	63	55	48	44	43	40	38	32
	Lmax	67	80	70	64	63	62	58	57	55
	L90	41	53	47	41	38	38	30	21	15
08:30	Leq	55	61	59	54	53	51	47	42	35
	Lmax	78	76	70	73	75	75	67	62	55
	L90	43	54	50	44	39	39	31	24	17

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
08:35	Leq	57	57	51	48	51	53	50	50	40
	Lmax	74	73	67	63	66	72	63	64	54
	L90	39	50	46	40	34	35	29	21	15
08:40	Leq	59	56	52	50	53	54	52	51	41
	Lmax	74	69	62	61	71	70	64	63	55
	L90	42	51	46	40	38	37	35	28	19

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
08:55	Leq	53	59	52	49	51	49	45	41	34
	Lmax	70	80	72	64	67	65	63	58	50
	L90	38	50	43	37	33	33	30	25	17
09:00	Leq	53	65	57	52	50	47	43	40	40
	Lmax	70	82	77	72	68	63	57	55	57
	L90	39	50	43	37	34	34	31	26	18
09:05	Leq	62	56	55	48	55	57	54	57	51
	Lmax	79	76	71	64	72	75	68	74	68
	L90	38	48	44	37	32	33	30	25	18

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
09:35	Leq	63	58	63	59	55	57	56	58	49
	Lmax	81	80	74	71	77	75	76	68	60
	L90	46	49	47	46	41	39	38	38	29
09:40	Leq	57	56	55	51	49	51	50	52	43
	Lmax	70	77	69	68	61	62	62	64	56
	L90	37	50	45	39	34	31	27	19	14
09:45	Leq	63	64	60	53	53	56	56	58	49
	Lmax	72	72	67	71	68	64	62	67	59
	L90	49	55	51	46	41	42	43	40	30

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
09:50	Leq	70	56	59	54	62	64	62	65	58
	Lmax	79	68	70	68	72	75	68	73	69
	L90	39	49	42	37	35	36	31	22	15
09:55	Leq	69	62	60	55	60	64	61	64	58
	Lmax	79	74	69	70	68	76	68	73	69
	L90	48	56	55	45	40	41	42	39	26
10:00	Leq	69	61	59	54	61	63	61	65	59
	Lmax	80	79	70	73	71	78	68	73	68
	L90	42	54	46	40	39	38	34	28	19

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
10:05	Leq	61	66	54	49	49	56	54	56	47
	Lmax	72	77	67	64	64	69	64	64	56
	L90	38	55	44	39	32	33	29	26	15
10:10	Leq	60	63	57	51	49	54	53	55	45
	Lmax	72	79	69	69	64	66	64	66	57
	L90	37	53	44	38	31	32	29	23	15
10:15	Leq	55	64	60	54	48	49	49	47	38
	Lmax	71	78	71	70	65	68	63	59	60
	L90	49	60	57	48	40	42	43	41	31

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
10:20	Leq	48	57	52	51	42	41	40	38	29
	Lmax	63	70	62	67	59	55	54	53	50
	L90	37	50	43	37	34	32	28	21	14
10:25	Leq	51	60	56	49	45	45	44	42	33
	Lmax	68	70	62	58	65	65	60	52	49
	L90	46	55	53	44	39	40	39	36	25
10:30	Leq	53	61	55	49	47	49	47	42	35
	Lmax	70	78	73	66	65	64	64	61	61
	L90	40	50	45	40	36	36	31	26	18

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
10:40	Leq	60	52	50	52	50	53	52	56	45
	Lmax	69	62	60	62	61	64	59	65	56
	L90	37	48	42	36	31	33	29	21	14
10:45	Leq	58	51	49	49	46	52	50	53	41
	Lmax	69	61	58	62	58	66	60	63	51
	L90	37	48	43	38	32	32	27	20	14
10:50	Leq	65	53	53	50	54	62	58	55	43
	Lmax	86	76	67	65	74	83	81	76	66
	L90	39	48	43	38	35	35	31	24	15

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
10:55	Leq	66	62	60	55	59	62	58	60	53
	Lmax	77	84	80	72	70	74	67	70	64
	L90	41	51	44	40	39	36	31	25	16
11:00	Leq	69	61	63	62	64	66	61	61	54
	Lmax	84	82	85	80	78	81	74	76	68
	L90	42	51	46	42	40	37	33	27	18
11:05	Leq	67	60	58	63	61	63	59	60	53
	Lmax	79	80	79	76	72	77	67	69	64
	L90	47	53	51	49	44	40	38	32	22

<i>Position 1</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
11:10	Leq	67	61	60	64	60	63	60	58	49
	Lmax	76	78	75	74	70	73	67	66	58
	L90	51	54	53	52	46	45	43	38	27
11:15	Leq	73	67	65	69	65	68	67	65	53
	Lmax	86	89	82	82	81	81	79	76	69
	L90	50	52	49	51	42	45	45	42	28
11:20	Leq	58	60	55	54	49	54	51	51	40
	Lmax	72	80	77	76	65	65	62	64	55
	L90	39	49	44	41	34	33	32	25	17

<i>Position 2</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
11:25	Leq	68	54	54	51	60	64	58	61	54
	Lmax	83	68	68	64	71	82	72	71	65
	L90	37	47	42	36	33	32	29	23	16
11:30	Leq	69	58	56	55	61	65	60	64	57
	Lmax	79	72	68	66	71	76	67	72	66
	L90	40	50	46	44	37	32	28	21	15
11:35	Leq	56	59	58	56	50	49	49	49	36
	Lmax	74	76	76	72	72	66	64	66	55
	L90	41	52	47	44	39	33	31	25	16

<i>Position 3</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
00:15	Leq	37	49	40	35	35	33	26	20	16
	Lmax	49	60	50	45	48	41	40	39	36
	L90	35	46	38	34	33	32	24	16	12

<i>Position 4</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
00:25	Leq	42	50	43	38	37	39	35	29	23
	Lmax	59	66	56	57	54	55	51	47	43
	L90	34	45	39	32	32	30	22	15	13

<i>Position 3</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
00:35	Leq	40	50	42	36	35	36	33	24	17
	Lmax	58	64	59	50	49	54	54	46	35
	L90	35	46	39	34	33	31	22	13	14

<i>Position 4</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
00:45	Leq	40	49	42	38	36	37	32	27	22
	Lmax	55	63	52	55	51	50	45	45	43
	L90	34	45	39	32	32	30	22	16	13

<i>Position 3</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
00:55	Leq	37	50	42	35	35	32	25	20	18
	Lmax	53	59	49	43	43	43	48	45	44
	L90	35	48	40	34	34	30	21	14	12

<i>Position 4</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
01:05	Leq	42	49	42	38	37	39	35	31	26
	Lmax	59	64	53	56	53	55	52	51	46
	L90	34	46	39	32	32	30	22	16	13

<i>Overall Summary</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
Position 1 (Daytime)	Leq	62	60	57	57	54	57	56	55	44
	Lmax	77	78	72	71	71	73	70	67	59
	L90	44	53	48	44	38	39	37	34	24
Position 2 (Daytime)	Leq	64	60	57	55	57	60	56	59	52
	Lmax	77	78	75	71	70	74	66	69	63
	L90	43	52	48	42	38	38	34	29	19
Position 3 (Night Time)	Leq	38	50	42	35	35	34	29	22	17
	Lmax	55	61	55	47	47	50	50	44	40
	L90	35	47	39	34	33	31	22	14	13
Position 4 (Night Time)	Leq	42	49	42	38	37	38	34	29	24
	Lmax	58	64	54	56	53	54	50	48	44
	L90	34	45	39	32	32	30	22	16	13

<i>Rush Hour Summary</i>	<i>Index</i>	<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
Position 1 (Rush Hour)	Leq	53	56	51	47	47	48	46	45	35
	Lmax	70	72	65	63	66	66	62	58	51
	L90	42	52	47	41	37	38	32	26	20
Position 2 (Rush Hour)	Leq	54	60	54	50	49	50	46	47	41
	Lmax	72	77	70	67	68	68	63	64	59
	L90	42	53	47	41	38	39	32	23	16

Measurement Summary

Position	Time	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
1	Rush Hour	Leq	53	56	51	47	47	48	46	45	35
		Lmax	70	72	65	63	66	66	62	58	51
		L90	42	52	47	41	37	38	32	26	20
2	Rush Hour	Leq	54	60	54	50	49	50	46	47	41
		Lmax	72	77	70	67	68	68	63	64	59
		L90	42	53	47	41	38	39	32	23	16
3	Early Night	Leq	38	50	42	35	35	34	29	22	17
		Lmax	55	61	55	47	47	50	50	44	40
		L90	35	47	39	34	33	31	22	14	13
4	Early Night	Leq	42	49	42	38	37	38	34	29	24
		Lmax	58	64	54	56	53	54	50	48	44
		L90	34	45	39	32	32	30	22	16	13

Required Reductions

Position	Environment	Reductions for BS8233 desirable* criteria	Reductions for WHO-Type Criteria
1	Living Rooms	18 dB L _{Aeq}	-
	Outdoor Living Areas	3 dB L _{Aeq}	-
2	Living Rooms	19 dB L _{Aeq}	-
	Outdoor Living Areas	4 dB L _{Aeq}	-
3	Bedrooms	8 dB L _{Aeq}	10 dB L _{Amax}
4	Bedrooms	12 dB L _{Aeq}	13 dB L _{Amax}

Note that these figures do not include any façade effect which might be applicable

* BS 8233 considers a 5 dB relaxation would still provide *reasonable* conditions

Mitigation Summary

Façade	Room Type	Make-Up on Which Calculations are Based
Position 1	Living Room/Kitchen	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300
Position 2	Living Room/Kitchen	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300
Position 3	3rd Bedroom	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300
Position 4	3rd Bedroom	Walls: Traditional Masonry Glazing: Basic thermal eg. 4+20+4 Vents: Non-acoustic eg. Simon Airstrip 300

Predicted Summary

Façade	Room Type	Time	Index	dB(A)	63	125	250	500	1k	2k	4k	8k
Position 1	Living Room/Kitchen	Rush	Leq	32	44	33	31	28	26	24	23	7
Position 2	Living Room/Kitchen	Rush	Leq	33	48	36	33	30	27	24	24	13
Position 3	3rd Bedroom	Early Night	Leq	20	39	25	20	18	13	8	1	-10
			Lmax	35	51	39	32	30	29	29	23	13
Position 4	3rd Bedroom	Early Night	Leq	23	39	25	23	19	17	13	8	-3
			Lmax	39	54	37	40	35	33	29	27	17

Living Room Break-in

Position 1			<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
<i>Living Room/Kitchen</i>											
Width of Exposed Façade 1	4.20 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 2	9.00 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 3	3.00 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 4	0.00 m		-	-	-	-	-	-	-	-	-
Total Exposed Façade Width	16.20 m		-	-	-	-	-	-	-	-	-
Element Height	2.50 m		-	-	-	-	-	-	-	-	-
Effective Room Depth (re. Exposed façade 1)	7.98 m		-	-	-	-	-	-	-	-	-
Element Area	40.50 m2		-	-	-	-	-	-	-	-	-
Effective Area (ie. with vents)	70.50 m2		-	-	-	-	-	-	-	-	-
Room Volume	83.75 m3		-	-	-	-	-	-	-	-	-
Assumed RT	0.50 s		-	-	-	-	-	-	-	-	-
Element Area Correction			-	18	18	18	18	18	18	18	18
Room Correction 10 x Log (RT/0.163/V)			-	-14	-14	-14	-14	-14	-14	-14	-14
Walls: Traditional Masonry	36.50 m2		-	23	32	41	47	49	53	58	55
Glazing: Basic thermal eg. 4+20+4	4.00 m2		-	15	21	17	25	35	37	31	31
Vents: Non-acoustic eg. Simon Airstrip 300	30.00 m2		-	23	28	26	26	29	29	29	36
Composite SRI	70.50 m2		-	22	28	26	29	33	33	32	38
Level Difference (Reverberant only)			-	-18	-24	-22	-25	-28	-28	-28	-34
Allowance for flanking/workmanship	3 dB		-	3	3	3	3	3	3	3	3
Façade relative to Measurement Position	3 dB		-	3	3	3	3	3	3	3	3
Predicted Internal Levels	Rush	Leq	32	44	33	31	28	26	24	23	7

Position 2			<i>dB(A)</i>	63	125	250	500	1k	2k	4k	8k
<i>Living Room/Kitchen</i>											
Width of Exposed Façade 1	4.20 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 2	9.00 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 3	3.00 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 4	0.00 m		-	-	-	-	-	-	-	-	-
Total Exposed Façade Width	16.20 m		-	-	-	-	-	-	-	-	-
Element Height	2.50 m		-	-	-	-	-	-	-	-	-
Effective Room Depth (re. Exposed façade 1)	7.98 m		-	-	-	-	-	-	-	-	-
Element Area	40.50 m2		-	-	-	-	-	-	-	-	-
Effective Area (ie. with vents)	70.50 m2		-	-	-	-	-	-	-	-	-
Room Volume	83.75 m3		-	-	-	-	-	-	-	-	-
Assumed RT	0.50 s		-	-	-	-	-	-	-	-	-
Element Area Correction			-	18	18	18	18	18	18	18	18
Room Correction 10 x Log (RT/0.163/V)			-	-14	-14	-14	-14	-14	-14	-14	-14
Walls: Traditional Masonry	36.50 m2		-	23	32	41	47	49	53	58	55
Glazing: Basic thermal eg. 4+20+4	4.00 m2		-	15	21	17	25	35	37	31	31
Vents: Non-acoustic eg. Simon Airstrip 300	30.00 m2		-	23	28	26	26	29	29	29	36
Composite SRI	70.50 m2		-	22	28	26	29	33	33	32	38
Level Difference (Reverberant only)			-	-18	-24	-22	-25	-28	-28	-28	-34
Allowance for flanking/workmanship	3 dB		-	3	3	3	3	3	3	3	3
Façade relative to Measurement Position	3 dB		-	3	3	3	3	3	3	3	3
Predicted Internal Levels	Rush	Leq	33	48	36	33	30	27	24	24	13

Bedroom Break-in

Position 3 3rd Bedroom			dB(A)	63	125	250	500	1k	2k	4k	8k
Width of Exposed Façade 1	2.10 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 2	3.90 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 3	0.00 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 4	0.00 m		-	-	-	-	-	-	-	-	-
Total Exposed Façade Width	6.00 m		-	-	-	-	-	-	-	-	-
Element Height	2.50 m		-	-	-	-	-	-	-	-	-
Effective Room Depth (re. Exposed façade 1)	3.76 m		-	-	-	-	-	-	-	-	-
Element Area	15.00 m2		-	-	-	-	-	-	-	-	-
Effective Area (ie. with vents)	25.00 m2		-	-	-	-	-	-	-	-	-
Room Volume	19.75 m3		-	-	-	-	-	-	-	-	-
Assumed RT	0.50 s		-	-	-	-	-	-	-	-	-
Element Area Correction			-	14	14	14	14	14	14	14	14
Room Correction 10 x Log (RT/0.163/V)			-	-8	-8	-8	-8	-8	-8	-8	-8
Walls: Traditional Masonry	14.00 m2		-	23	32	41	47	49	53	58	55
Glazing: Basic thermal eg. 4+20+4	1.00 m2		-	15	21	17	25	35	37	31	31
Vents: Non-acoustic eg. Simon Airstrip 300	10.00 m2		-	23	28	26	26	29	29	29	36
Composite SRI	25.00 m2		-	22	29	27	29	33	33	33	39
Level Difference (Reverberant only)			-	-16	-23	-21	-24	-27	-27	-27	-33
Allowance for flanking/workmanship			3 dB	-	3	3	3	3	3	3	3
Façade relative to Measurement Position			3 dB	-	3	3	3	3	3	3	3
Predicted Internal Levels	Early Night	Leq	20	39	25	20	18	13	8	1	-10
		Lmax	35	51	39	32	30	29	29	23	13

Position 4 3rd Bedroom			dB(A)	63	125	250	500	1k	2k	4k	8k
Width of Exposed Façade 1	2.10 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 2	3.90 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 3	0.00 m		-	-	-	-	-	-	-	-	-
Width of Exposed Façade 4	0.00 m		-	-	-	-	-	-	-	-	-
Total Exposed Façade Width	6.00 m		-	-	-	-	-	-	-	-	-
Element Height	2.50 m		-	-	-	-	-	-	-	-	-
Effective Room Depth (re. Exposed façade 1)	3.76 CHECK		-	-	-	-	-	-	-	-	-
Element Area	15.00 m2		-	-	-	-	-	-	-	-	-
Effective Area (ie. with vents)	25.00 m2		-	-	-	-	-	-	-	-	-
Room Volume	19.75 m3		-	-	-	-	-	-	-	-	-
Assumed RT	0.50 s		-	-	-	-	-	-	-	-	-
Element Area Correction			-	14	14	14	14	14	14	14	14
Room Correction 10 x Log (RT/0.163/V)			-	-8	-8	-8	-8	-8	-8	-8	-8
Walls: Traditional Masonry	14.00 m2		-	23	32	41	47	49	53	58	55
Glazing: Basic thermal eg. 4+20+4	1.00 m2		-	15	21	17	25	35	37	31	31
Vents: Non-acoustic eg. Simon Airstrip 300	10.00 m2		-	23	28	26	26	29	29	29	36
Composite SRI	25.00 m2		-	22	29	27	29	33	33	33	39
Level Difference (Reverberant only)			-	-16	-23	-21	-24	-27	-27	-27	-33
Allowance for flanking/workmanship			3 dB	-	3	3	3	3	3	3	3
Façade relative to Measurement Position			3 dB	-	3	3	3	3	3	3	3
Predicted Internal Levels	Early Night	Leq	23	39	25	23	19	17	13	8	-3
		Lmax	39	54	37	40	35	33	29	27	17