

Oakdene
Windmill Lane
Burseldon
Hampshire
SO31 8BG

Sound Level Assessment



July 2018

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1 Introduction and assessment brief

1.1 Introduction

Apple Environmental Limited has been commissioned to undertake a sound level assessment on land at the rear of the existing dwellings in Windmill Lane, Burseldon, in support of a proposed planning application for the construction of six new park home dwellings with associated gardens. The assessment was performed by Dr. Adrian Whittle Tech.ioA.

This work has been requested due to the close proximity of the M27 motorway, which runs in a northwest-southeast direction very close to the site, and the high volume of traffic using this road on a daily basis.

In addition to this, the A3024 also runs in a southwest-northeast direction approximately 220m to the northwest of the site, and the A27 runs in a northwest-southeast direction approximately 420m to the southwest of the site. Neither of these trunk roads is expected to have a significant impact on the new dwellings.

1.2 Aims and objectives

In order to address any noise concerns an assessment has been carried out in accordance with the Department for Communities and Local Government National Planning Policy Framework, and with reference to other guideline documents as detailed below in Section 2 and Section 6. The overall aim of this work therefore is to determine the extent to which the proposed development may be affected by the general ambient sounds in this area. The objectives are as follows:

- to identify all dominating sound source(s) at the site;
- to undertake continuous 24-hour monitoring for the determining of both day-time and night-time sound levels;
- to undertake a 1/3 octave analysis to ascertain the dominant sound frequencies and other characteristics such as tonality;
- to determine the impact from any identified sound sources on the proposed residential development; and
- to make recommendations accordingly.

2 Relevant guidance

2.1 Introduction

Since the revocation of Planning Policy Guidance 24 (PPG24), the National Planning Policy Framework (NPPF) has been introduced. This document provides some general guidance to local authorities on considering the impact of noise in planning and policy decisions. This includes guidance for local authorities, in which they should ‘...aim to avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development’.

No specific guidance is provided in the NPPF on acoustic criteria, therefore the British Standard 7445-1:2003 ‘Description and measurement of environmental noise – Part 1: Guide to quantities and procedures’ has been consulted for guidance on the noise measurement parameters required to undertake a suitable assessment.

In addition to this, the British Standard 8233:2014 ‘Guidance on sound insulation and noise reduction for buildings’ has been used to determine acceptable noise criteria within dwellings. The World Health Organisation Night Noise Guidelines for Europe, 2009, Guidelines for Community Noise, 1999, and The Calculation of Road Traffic Noise 1988 (CRTN) have also been referred to. Where relevant, elements of each have been discussed below.

2.2 British Standard 7445-1:2003

Part 1 of the British Standard 7445-1:2003 defines the basic quantities required for the description of noise in community environments and describes basic procedures for the determination of these quantities. It provides guidance on the positioning of instrumentation including the distance from the exposed building and the preferred height of the microphone as well as detailing measurements to be taken during preferable meteorological conditions.

2.3 British Standard 8233:2014

British Standard 8233:2014 has reviewed and amended the former 1999 standard. As before, it sets out guidance on desirable internal ambient noise levels for dwellings. Table 1 below summarises the recommended acoustic design criteria for a dwelling.

Table 1 BS 8233:2014 desirable acoustic design criteria for good standard

Location	Internal noise level	
	Daytime	Night time
Living room	35dB $L_{Aeq, (16hr)}$	-
Dining room	40dB $L_{Aeq, (16hr)}$	-
Bedroom	35dB $L_{Aeq, (16hr)}$	30dB $L_{Aeq, (8hr)}$

It is therefore recommended that for a dwelling, acceptable internal noise levels during the daytime should not exceed 35dB $L_{Aeq, 16hr}$, and during the night time, noise levels of 30dB $L_{Aeq, 8hr}$.

In addition to the above, BS8233 also states that where development is considered desirable or necessary then despite external noise levels exceeding these guidelines, the internal target may be relaxed by up to 5dB and reasonable conditions can still be achieved.

The standard also reiterates the fact that it is desirable that noise levels in outdoor amenity areas such as gardens and balconies do not exceed 50dB $L_{Aeq, T}$ and that 55dB $L_{Aeq, T}$ should be regarded as the upper limit. However it also states that this may not be achievable in some areas, such as city centres, and that a compromise between noise and the convenience of living in these areas can be met.

2.4 WHO Night Noise Guidelines for Europe, 2009

The WHO Night Noise Guidelines for Europe have published guidelines for night time noise based upon exposure effects relationships which take into account the effects of noise on public health and wellbeing when sleeping. The night noise guideline values are recommended for the protection of public health from night noise and are shown below in Table 2.

Table 2 WHO recommended night noise guidelines for Europe

Guideline	Noise level
Night noise guideline (NNG)	$L_{\text{night, outside}}$ 40dB(A)
Interim Target (IT)	$L_{\text{night, outside}}$ 55dB(A)

For the primary prevention of subclinical adverse health effects related to night noise in the population, it is recommended that the population should not be exposed to night noise levels greater than 40dB(A) of $L_{\text{night, outside}}$ during the part of the night when most people are in bed.

The lowest observed adverse effect level (LOAEL) of night noise, 40dB(A) $L_{\text{night, outside}}$, can be considered a health based limit value of the night noise guidelines (NNG) necessary to protect the public, including most of the vulnerable groups such as children, the chronically ill and the elderly, from the adverse health effects of night noise.

An interim target (IT) of 55dB(A) $L_{\text{night, outside}}$ is recommended in the situations where the achievement of NNG is not feasible in the short term for various reasons. It should be noted that the interim target is not a health-based limit value by itself. Vulnerable groups cannot be protected at this level. Therefore, the interim target should be considered only as a feasibility-based intermediate target which can be temporarily considered by policy-makers for exceptional local situations.

2.5 WHO Guidelines for Community Noise, 1999

The WHO Guidelines for Community Noise also consider the impact of night-time exposure to noise and sleep disturbance, such that if negative effects on sleep are to be avoided, the equivalent sound pressure level ($L_{\text{Aeq, 8hr}}$) should not exceed 30dB indoors for continuous noise.

If the noise is not continuous, sleep disturbance correlates best with L_{Amax} and effects have been observed at 45dB or less. These guidelines state that this is particularly true if the background level is low. Noise events exceeding 45dB(A) should therefore be limited if possible.

The document also states that 10 to 15 occurrences per night that exceed the limiting L_{Amax} external noise level of 45dB may be considered acceptable.

For sensitive groups, an even lower limit would be preferred but this value is not specified. It also declares that it should be possible to sleep with a bedroom window slightly open (resulting in a reduction of 15dB(A) from outside to inside). To prevent sleep disturbances, the equivalent sound pressure level and the number and level of sound events should be considered.

Mitigation targeted to the first part of the night is believed to be effective for the ability to fall asleep.

The WHO Guidelines for Community Noise are considered to be complimentary to the WHO Night Noise Guidelines for Europe.

2.6 The Calculation of Road Traffic Noise 1988 (CRTN)

CRTN provides general guidance on the direct measurement of road traffic noise in which $L_{A10,18hr}$ values are generally referred to. In situations where road traffic noise is clearly dominant and relatively consistent the guidance allows for a shortened assessment to be undertaken, in which arithmetic average values are obtained over three consecutive 1 hour periods.

In this specific instance, this means of assessment may not be the most appropriate for the determining of risk to occupiers of the new dwellings, due to the fact that it is clearly evident that the noise from the motorway will impact the site, and therefore it may be helpful to obtain as much information as possible, covering a full 24 hour period at least.

3 Site description

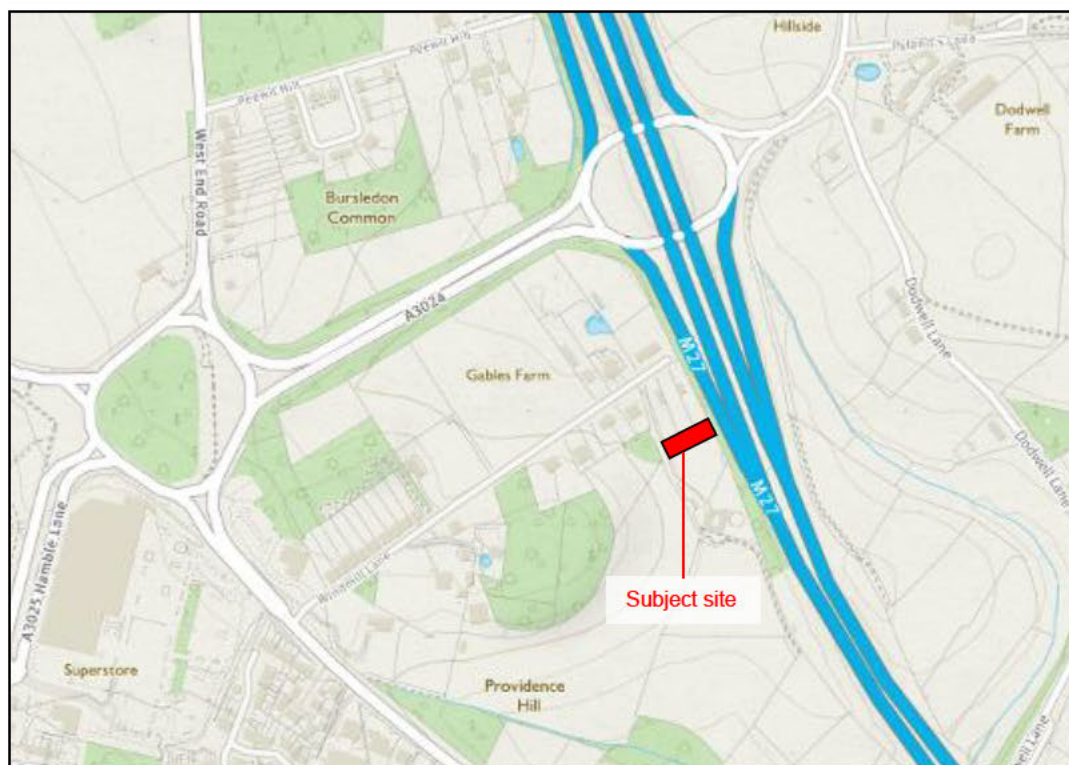
The site to which this assessment relates currently exists as the rear garden areas associated with three existing park home dwellings. These are located at the northeastern-most end of Windmill Lane, which is a no-through road ending at the M27 motorway embankment.

The subject site lies around 1m lower than the motorway, and the closest of the six proposed dwellings is expected to be around 15m from the slip-road carriageway edge, to the northeast.

To the immediate northwest of the subject site there are stables, beyond which are the aforementioned existing park homes. On the northwestern side of Windmill Lane there are more dwellings, in addition to which there are dwellings aligning the southeastern side of Windmill Lane out to an approximate distance of 200m from the motorway. The land beyond these dwellings is largely undeveloped

At the time of undertaking sound level monitoring for this assessment in March there were barely any leaves on the trees aligning the motorway, hence this would have offered very little noise absorption or reflection. The site and its close proximity to the B198 are shown below in Figure 1.

Figure 1 The location of the proposed development site



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Some of the features described above have been shown in Photographs 1 and 2 below.

Photograph 1 Looking northeastwards towards the M27 from the end of Windmill Lane



Photograph 2 Looking towards the subject site between two of the existing dwellings



4 Survey methodology

This report aims to determine the expected impact of traffic sound, impacting the proposal site from the adjacent M27 motorway, in accordance with the National Planning Policy Framework, and using guidance from BS7445-1:2003 and BS8233:2014.

The assessment has been performed over a continuous 46-hour period, running from 16:00H on Tuesday the 20th March 2018 through to 14:00H on Thursday the 22nd March. In doing so, L_{Aeq} , L_{Amax} , and a selection of percentile values have been obtained from one-second readings.

Through consideration of the road characteristics, such as this being a straight stretch of road continually past the site, with no pedestrian crossing points, it was deemed acceptable to select just one measurement location. The road surface was dry throughout the exercise although it is possible for there to have been some over-night moisture which may have dampened the road during the early morning period.

For the purposes of this assessment, A-weighted noise readings were taken throughout by means of a Cirrus Optimus CR171B Class I integrating sound pressure level meter. This was calibrated prior to and following use at 94dB using a CR151 Cirrus Acoustic Calibrator. The instrumentation details and serial numbers are as shown below in Table 3. Calibration documentation for the sound level meter and acoustic calibrator has been appended to this report.

Table 3 Sound level instrumentation used

Equipment	Description	Serial No.
Cirrus Optimus CR:171B	Class 1 sound level meter with 1/3 octave frequency analyser	G068532
Cirrus Acoustic Calibrator CR:151	IEC 60942.2003 Class 1 calibrator	70846

The sound levels were measured at a distance of approximately 45m from the carriageway edge, and at a height of around 1.5m above ground level. The microphone diaphragm remained vertical throughout the measurement period.

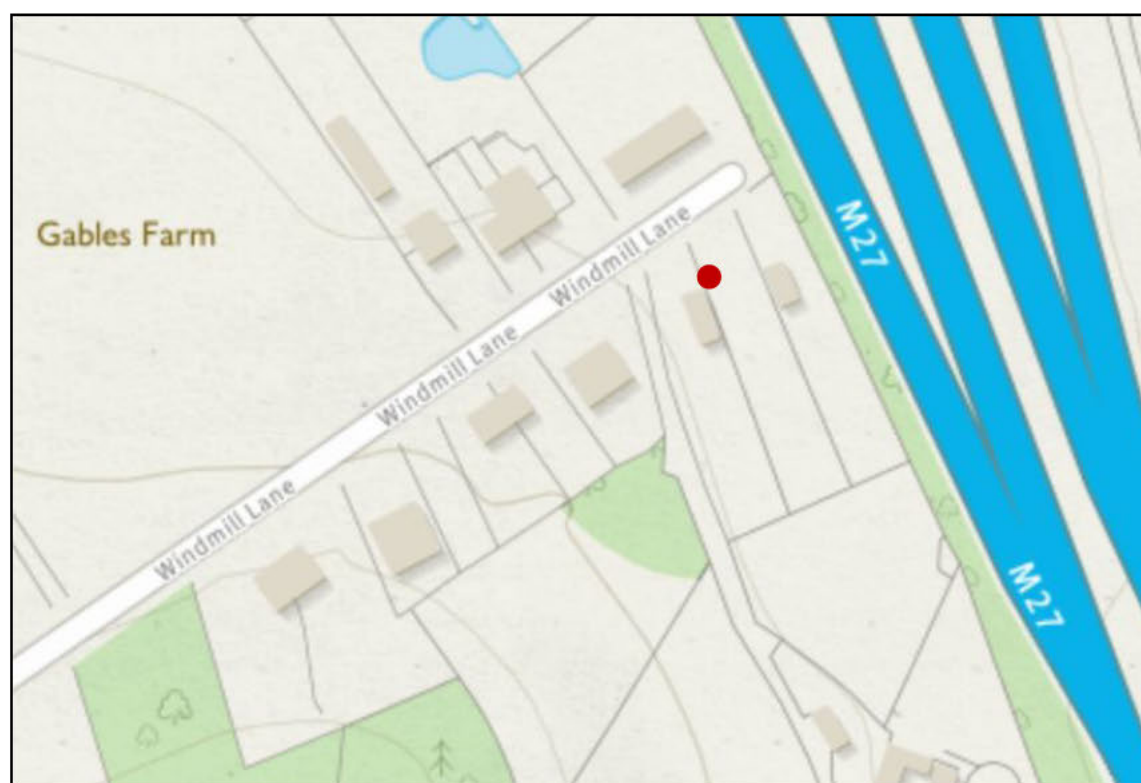
More specifically the microphone was attached via an extension lead to the top of a hanging basket bracket, positioned approximately 500mm from the boundary fence within the front garden of Unit 2 Oakdene. There was a direct line of sight between the microphone and the motorway embankment. It is expected that the microphone would have picked up a reflective contribution from the fence behind; hence the findings have been adjusted accordingly (Section 5).

The approximate measurement location has been shown below on the proposed site plan, Figure 2, and in Photograph 3.

The mean weather conditions throughout the monitoring period have also been recorded, and detailed below in Section 5.

The nature of the ground surface between the measurement position and the motorway was variable, consisting of scrubby vegetation in the vicinity of the embankment, beyond which were the tarmac surfaced front gardens.

Figure 2 The location of the sound level monitoring at the site



● Position of sound level meter

Photograph 3 The location of the sound level instrument



5 Monitoring results

The assessment was undertaken over a continuous 46-hour period, running from 16:00H on Tuesday the 20th March 2018 through to 14:00H on Thursday the 22nd March, thereby providing two night-time 8-hour assessment periods from 23.00H to 07.00H and one day-time assessment period from 07.00H through to 23.00H.

The measurement parameters obtained are reproduced below in Table 4. These have been shown as a night-time period of 8 hours from 23.00H through to 07.00H (Tuesday the 20th March - 21st March) from 23.00H through to 07.00H, a night-time period of 10 hours from 23.00H on Day 1 through to 07.00 on Day 2, and a day-time period of 6 hours on Day 2 from 07.00H through to 13.00H.

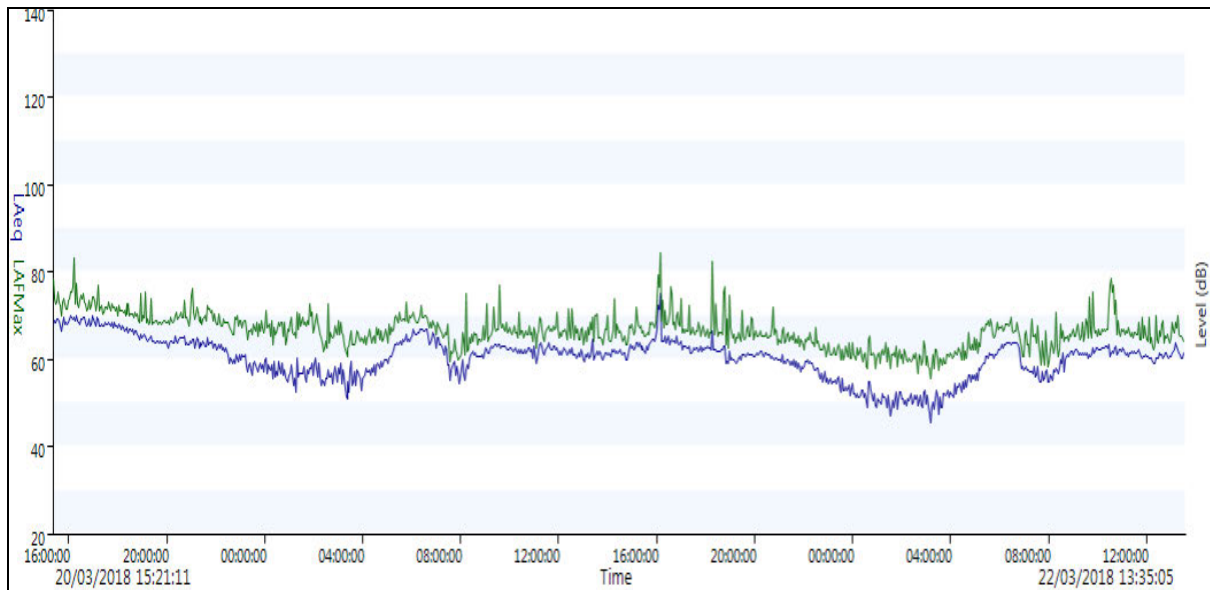
A plotted profile showing the L_{Aeq} trend throughout the entire continuous monitoring period has been reproduced below in Graph 1. Additionally one-third octave band analyses were also obtained from the overall monitoring period, the results from which are reproduced below in Graph 2.

It is generally accepted that each reflective surface can accentuate the recorded sound levels by a factor of 3dB. In this specific instance, the microphone was positioned in front of a timber fence, which is believed to have exerted a reflective effect in at least one plane. Consequently the results discussed have been adjusted by means of subtracting 3dB.

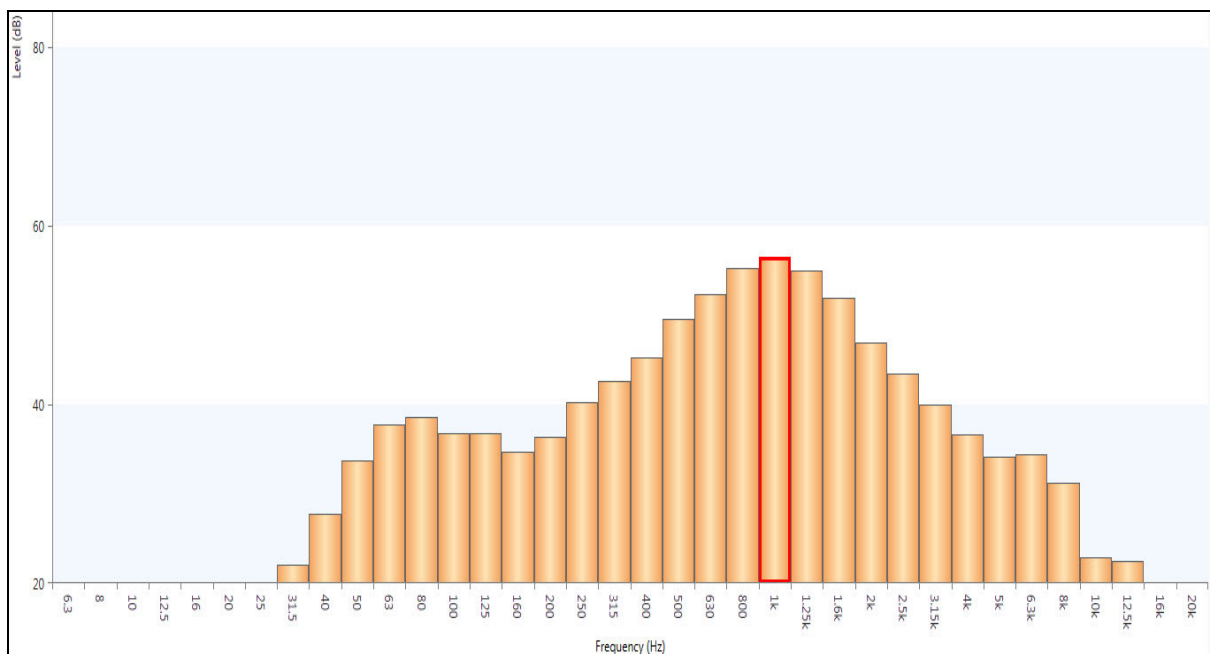
Table 4 Adjusted sound level readings

Parameter	Night-time 1	Day-time	Night-time 2
	23.00H - 07.00H /dB	07.00H - 23.00H /dB	23.00H - 07.00H /dB
L_{Aeq}	57.7	59.1	54.0
L_{Amax}	69.9	81.2	66.4
L_{A1}	65.4	65.1	62.8
L_{A5}	64.2	62.5	61.4
L_{A10}	63.2	61.7	60.2
L_{A50}	55.7	59.0	50.6
L_{A90}	45.4	55.1	38.5
L_{A95}	42.5	53.6	36.7
L_{A99}	27.2	50.5	34.0

Graph 1 L_{Aeq} measurement profile over the complete measurement period (unadjusted)



Graph 2 A-weighted 1/3 octave band profile for the complete measurement period



The weather data obtained throughout the measurement period has been reproduced below in Table 5.

Table 5 Weather conditions throughout the measurement period

Date and Time	Mean temperature	Rainfall total	Mean wind direction	Mean wind speed
Wednesday 23.03.2018 00.00 - 06.00H	4°C	<0.1mm	NNW	0.5m/s
Wednesday 23.03.2018 06.00 - 12.00H	9°C	<0.1mm	N	1m/s
Wednesday 23.03.2018 12.00 - 18.00H	11°C	<0.1mm	SW	3.5m/s
Wednesday 23.03.2018 18.00 - 00.00H	7°C	<0.1mm	N	0.8m/s
Thursday 23.03.2018 00.00 - 06.00H	6°C	<0.1mm	SSE	3m/s

As shown, the conditions were fairly stable throughout the measurement period although the wind direction was changeable.

The winds were generally light at less than 3.5m/s, with the direction swinging round from north to south. As such, on some occasions this would have had the potential to take the road noise away from the receiver; however considering the close proximity of the motorway, it is doubtful that the wind direction was particularly significant in this instance.

6 Interpretation of monitoring data

Through reference to Graph 1 above, it can be seen that the traffic noise in this location followed the expected diurnal variation, and was generally consistent, with the day-time L_{Aeq} only occasionally above 65dB and rarely falling below 52dB. This suggests that there is little else other than road traffic responsible for the noise in the area.

With regards to the night-time period, it can be seen that traffic movement continued throughout the night-time period, although noticeably tailing off between midnight and 5.00H, before continuing at a similar level to that reported on the previous morning.

Through reference to Graph 2 above showing the frequency profile at the measurement position, again this is typical of that associated with road traffic, i.e. a predominance of middle frequency noise, elevated low high frequency noise (presumably) from heavy vehicles passing by, and little evidence of tonality.

For the purposes of determining sound pressure levels for a uniform line source with distance from the source, the following equation has been used:

$$L_2 = L_1 - (10\log(r_2/r_1))\text{dB}$$

Where: L_1 is the measured $L_{Aeq(\text{day/night})}$ value, r_1 is the distance from the source to the measurement position, and r_2 is the distance from the source to the receptor.

With regards to the day-time and night-time sound levels, the potential impact at each of the proposed dwellings has been calculated and reproduced below in Table 6, using the sound level measurement obtained at a distance of 45m from the source in conjunction with the above equation.

In each instance this has been shown as the theoretical value at the closest façade to the nearest M27 carriageway edge, using the estimated distances shown below in Figure 3.

For the day-time period the measured L_{eq} of **59dB(A)** has been used, whereas for the night-time calculation a **56dB(A)** mean L_{eq} value has been used, from the two night-time period values of 57.7 and 54.0dB.

Figure 3 The location of each of the six proposed dwellings and the estimated distance from the closest façade to the M27 carriageway edge



For the proposed dwelling - **Unit 1:**

Estimated distance of the closest façade to the M27 carriageway edge = 55m

$$\text{Day-time } L_2 = 59 - (10\log(1.22))\text{dB} = \underline{58\text{dB}}$$

$$\text{Night-time } L_2 = 56 - (10\log(1.22))\text{dB} = \underline{55\text{dB}}$$

For the proposed dwelling - **Unit 2:**

Estimated distance of the closest façade to the M27 carriageway edge = 56m

$$\text{Day-time } L_2 = 59 - (10\log(1.24))\text{dB} = \underline{58\text{dB}}$$

$$\text{Night-time } L_2 = 56 - (10\log(1.24))\text{dB} = \underline{55\text{dB}}$$

For the proposed dwelling - **Unit 3:**

Estimated distance of the closest façade to the M27 carriageway edge = 39m

$$\text{Day-time } L_2 = 59 - (10\log(0.87))\text{dB} = \underline{60\text{dB}}$$

$$\text{Night-time } L_2 = 56 - (10\log(0.87))\text{dB} = \underline{57\text{dB}}$$

For the proposed dwelling - **Unit 4:**

Estimated distance of the closest façade to the M27 carriageway edge = 32m

$$\text{Day-time } L_2 = 59 - (10\log(0.71))\text{dB} = \underline{61\text{dB}}$$

$$\text{Night-time } L_2 = 56 - (10\log(0.71))\text{dB} = \underline{57\text{dB}}$$

For the proposed dwelling - **Unit 5:**

Estimated distance of the closest façade to the M27 carriageway edge = 24m

$$\text{Day-time } L_2 = 59 - (10\log(0.53))\text{dB} = \underline{62\text{dB}}$$

$$\text{Night-time } L_2 = 56 - (10\log(0.53))\text{dB} = \underline{59\text{dB}}$$

For the proposed dwelling - **Unit 6**:

Estimated distance of the closest façade to the M27 carriageway edge = 15m

Day-time $L_2 = 59 - (10\log(0.33))\text{dB} = \underline{64\text{dB}}$

Night-time $L_2 = 56 - (10\log(0.33))\text{dB} = \underline{61\text{dB}}$

Table 6 below summarises the calculated external sound level at the closest façade of each proposed unit to the nearest motorway carriageway edge.

Table 6 Predicted impact of traffic noise at the closest façade of each proposed unit

Unit No.	Approximate distance from carriageway edge / metres	Predicted L_{Aeq} /dB	Predicted L_{Aeq} /dB
		Day-time	Night-time
Measurement position	45	59	56
1	55	58	55
2	56	58	55
3	39	60	57
4	32	61	57
5	24	62	59
6	15	64	61

7 Assessment evaluation

7.1 General overview

This assessment has taken the view that the dominant sound source at the proposed development site is traffic-related, emanating from vehicles using the M27 motorway to the immediate northeast. The proposal at the site is to construct six new park home dwellings in the rear garden areas associated with the existing three park home dwellings here.

Using the measured sound level data obtained on the boundary fence between the existing Units 1 and 2, the day-time and night-time L_{Aeq} at the northeastern facade of each proposed unit has been predicted by means of theoretical calculation.

In calculating these façade sound exposure levels a number of presumptions have been made namely; (i) that the sound levels reported herein are typical of the sound levels at this measurement location, (ii) that the propagation of sound will behave in an ideal manner that reflects the theory applied, (iii) that none of the buildings will affect the propagation of sound (through means of reflection or adsorption), and (iv) that all of the proposed dwellings will be positioned at the same approximate height as the measurement location.

It has been concluded therefore that the uninfluenced day-time external sound level at each of these positions (expressed as the L_{eq}) will range from 58dB(A) to 64dB(A) depending upon distance from the motorway, and the night-time external sound exposure levels (again expressed as the L_{eq}) will range from 55dB(A) to 61dB(A).

7.2 Perimeter barrier height calculation

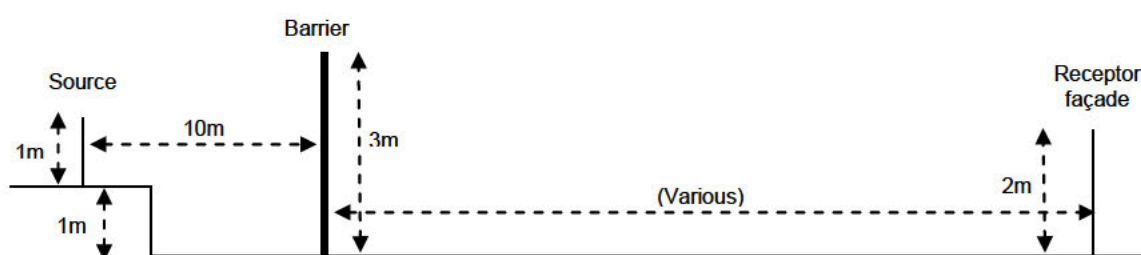
It is apparent from the above data that the site will be affected to varying degrees by noise coming from the adjacent motorway. It is therefore understood that a 3m high robust close-boarded timber fence will be installed along the northeastern and southeastern site boundaries. The section of the report calculates the beneficial effect that such may have on the sound pressure levels at the façade of each building. In doing so this has been performed for a ground floor external and internal receptor position as the proposed dwellings would be single storey structures.

The parameters used for the barrier height calculations are as follows:

- a source sound height of 1m (traffic) on a 1m embankment (total height 2m);
- a distance of 10m from the source to the barrier fence;
- a barrier fence height of 3m; and
- a receptor height of 2m*.

* Note that despite using a receptor window height of 2m above ground level, the fact that the road lies around 1m above the current site ground height, means that in actuality this window position is expected to be around 1m above the road surface level, as indicated in Figure 4 below.

Figure 4 Schematic representation of the barrier



The sound pressure level unweighted frequency breakdown has been shown below in Table 7.

Table 7 Measured SPLs for each frequency (day-time and night-time)

Frequency / Hz	Approximate distance from measurement position to source / metres	Sound pressure level /dB	Sound pressure level /dB
		Day-time	Night-time
63	45	66.5	61.2
125	45	56.9	50.8
250	45	51.9	45.8
500	45	54.9	50.1
1000	45	57.4	52.1
2000	45	49.6	44.8
4000	45	40.1	36.1

In order to perform this assessment it has been calculated that a 3m high barrier, 10m from the source should have an angle from the source to barrier top of 5.7° and an angle of source to receiver of less than 0.1° . The corresponding path difference at a distance of 45m has therefore been calculated as 0.061.

The effect that the barrier should have at this point has been shown below in Tables 8 and 9 for the day-time and night-time periods respectively. This is based upon a path difference of 0.1, which is deemed appropriate considering the fact that most of the proposed dwelling units will be closer to the source than the measurement position; hence with a path difference greater than 0.061.

Table 8 Calculating the day-time barrier effect at 45m from the source

Frequency	63	125	250	500	1000	2000	4000
Octave band level (dB)	66.5	56.9	51.9	54.9	57.4	49.6	40.1
A-weightings (dB)	-26	-16	-9	-3	0	+1	+1
A-weighted levels (dB)	40.5	40.9	42.9	51.9	57.4	50.6	41.1
A-weighted level at the measurement position without a barrier = 60dB							
Barrier attenuation (dB)	-7	-8	-9	-10	-11	-14	-16
A-weighted levels (dB)	33.5	32.9	33.9	41.9	46.4	36.6	25.1
A-weighted level at the measurement position with a barrier = 49dB							
Expected barrier reduction = 11dB							

Table 9 Calculating the night-time barrier effect at 45m from the source

Frequency	63	125	250	500	1000	2000	4000
Octave band level (dB)	61.2	50.8	45.8	50.1	52.1	44.8	36.1
A-weightings (dB)	-26	-16	-9	-3	0	+1	+1
A-weighted levels (dB)	35.2	34.8	36.8	47.1	52.1	45.8	37.1
A-weighted level at the measurement position without a barrier = 55dB							
Barrier attenuation (dB)	-7	-8	-9	-10	-11	-14	-16
A-weighted levels (dB)	28.2	26.8	27.8	37.1	41.1	31.8	21.1
A-weighted level at the measurement position with a barrier = 44dB							
Expected barrier reduction = 11dB							

Hence the expected barrier reduction at this point has been calculated to be 11dB.

Using the above sound level values, the sound reduction that a barrier of height 3m, positioned 10m from the motorway carriageway could have for each of the proposed units can be calculated, again using the following equation:

$$L_2 = L_1 - (10\log(r_2/r_1))\text{dB}$$

Where: L_1 is the calculated sound level for either the day or night, r_1 is the distance from the source to the reference position (i.e. 45m from the carriageway), and r_2 is the distance from the source to the receptor.

In doing so, the following additional criteria have been used:

- an air temperature of 20°C for day-time readings and 10°C for night-time readings, a humidity level of 70% and no other influential weather factors;
- free-field conditions;
- sound propagation across a soft level surface; and
- no transmission of sound through the barrier, around the barrier, or no reflection of sound towards the receptor.

For the proposed dwelling - **Unit 1**:

Estimated distance of the closest façade to the M27 carriageway edge = 55m

Day-time $L_2 = 49 - (10\log(1.22))\text{dB} = \underline{48\text{dB}}$

Night-time $L_2 = 44 - (10\log(1.22))\text{dB} = \underline{43\text{dB}}$

For the proposed dwelling - **Unit 2**:

Estimated distance of the closest façade to the M27 carriageway edge = 56m

Day-time $L_2 = 49 - (10\log(1.24))\text{dB} = \underline{48\text{dB}}$

Night-time $L_2 = 44 - (10\log(1.24))\text{dB} = \underline{43\text{dB}}$

For the proposed dwelling - **Unit 3:**

Estimated distance of the closest façade to the M27 carriageway edge = 39m

$$\text{Day-time } L_2 = 49 - (10\log(0.87))\text{dB} = \underline{49\text{dB}}$$

$$\text{Night-time } L_2 = 44 - (10\log(0.87))\text{dB} = \underline{45\text{dB}}$$

For the proposed dwelling - **Unit 4:**

Estimated distance of the closest façade to the M27 carriageway edge = 32m

$$\text{Day-time } L_2 = 49 - (10\log(0.71))\text{dB} = \underline{50\text{dB}}$$

$$\text{Night-time } L_2 = 44 - (10\log(0.71))\text{dB} = \underline{45\text{dB}}$$

For the proposed dwelling - **Unit 5:**

Estimated distance of the closest façade to the M27 carriageway edge = 24m

$$\text{Day-time } L_2 = 49 - (10\log(0.53))\text{dB} = \underline{52\text{dB}}$$

$$\text{Night-time } L_2 = 44 - (10\log(0.53))\text{dB} = \underline{47\text{dB}}$$

For the proposed dwelling - **Unit 6:**

Estimated distance of the closest façade to the M27 carriageway edge = 15m

$$\text{Day-time } L_2 = 49 - (10\log(0.33))\text{dB} = \underline{54\text{dB}}$$

$$\text{Night-time } L_2 = 44 - (10\log(0.33))\text{dB} = \underline{49\text{dB}}$$

Through reference to the above calculations, the barrier should result in the theoretical day-time and night-time sound levels shown below in Table 10. In doing so, note the following:

- the external sound level relates to the façade facing the motorway, and therefore considers a potentially worst-case situation;
- the internal sound levels have been shown on the presumption that each dwelling unit should be capable of attenuating motorway noise by at least 25dB; and
- in considering a partially open window scenario this report has made the presumption that the external façade sound level could be reduced by 12dB internally.

Table 10 Theoretical broadband noise exposure levels expressed as the Leq - dB(A) with the use of a barrier fence

Unit	Day-time			Night-time		
	External	Internal with windows closed	Internal with window partially open	External	Internal with windows closed	Internal with window partially open
1	48	<23	<36	43	<18	<31
2	48	<23	<36	43	<18	<31
3	49	<24	<37	45	<20	<33
4	50	<25	<38	45	<20	<33
5	52	<27	<40	47	<23	<35
6	54	<29	<42	49	<24	<37

7.3 Evaluation against guideline criteria

As shown above in Table 10, through the emplacement of a continuous close-boarded timber barrier along the northeastern and southeaster boundaries, it has been suggested that the external northeastern façade day-time sound levels could range between 48 and 54dB(A), and the night-time levels between 43 and 49dB(A); depending upon distance from the motorway.

The internal sound levels during both the day-time and night-time with windows closed, are all expected to be below 30dB(A), whereas with a partially open window the day-time sound levels could range between <36 and 42dB(A), and the night-time levels between <31 and 37dB(A).

Through reference to the noise exposure guidelines for dwellings as detailed within BS8233:2014, it is generally accepted that the external sound level should ideally not exceed 50dB during the day-time, whereas the internal day-time level should not exceed 35dB and the internal night-time level should not exceed 30dB.

It is firstly apparent therefore that even with the acoustic barrier in place the external sound exposure level will most likely exceed the 50dB(A) guideline level at the northeastern façade of the proposed dwelling units nearest to the motorway (Units 5 and 6), with the likely possibility also that this could be frequently exceeded on occasions at the northeastern façade of the remaining proposed dwelling units.

More specifically, Units 5 and 6 are only expected to marginally exceed this 50dB(A) guideline level, by 2dB and 4dB respectively. However, through reference to BS8233, although it is desirable that noise levels in outdoor amenity areas such as gardens should not exceed 50dB L_{Aeq} (with an upper limit of 55dB L_{Aeq}), it also states that where this may not be achievable, consideration can be given to a compromise between noise and the convenience of living in these areas.

With regards to the internal sound exposure levels, the only potential concern arises with windows partially open. In considering this, it is apparent that the day-time guideline level of 35dB and the night-time level of 30dB could be exceeded within all proposed dwelling units.

Of these, again the greatest concern again lies with the proposed units which are to be positioned closest to the motorway (Units 5 and 6), where each of these guideline levels could be exceeded by 5dB and 7dB respectively. Conversely with regards to Units 1 and 2, which are furthest from the motorway, these guideline levels could be exceeded by just 1dB in each instance - which could be considered negligible, whereas the two units to be located centrally (Units 3 and 4) could exceed these guideline levels by just 3dB.

Through further reference to BS8233, it also states that in some circumstances the internal target may be relaxed by up to 5dB and still allow 'reasonable' conditions to be achieved. In doing so, all dwelling units other than Unit 6 could now be considered to offer 'reasonable' living conditions, whereas Unit 6 could potentially still just exceed this relaxed guideline level by just 2dB.

8 Summary and limitations

8.1 Summary

This assessment principally makes reference to the noise exposure guidelines for dwellings as detailed within BS8233:2014. As such it aims to determine whether or not the six proposed dwelling units will be exposed to noise emanating from the adjacent M27 motorway, resulting in an external day-time exposure level of greater than 50dB, along with an internal day-time exposure level of 35dB and a night-time internal level of 30dB.

In making this assessment, the report has considered a situation where a continuous 3m high barrier fence is emplaced along the northeastern and southeastern site boundaries.

The findings of this report are basically that the above guideline levels would appear to be marginally exceeded for both external exposure, and for internal exposure with windows open. However, BS8233:2014 also states that consideration can sometimes be given to a 5dB relaxation of the guideline levels in order to achieve a 'reasonable' standard of living, in which case this report has subsequently concluded that all guideline levels should be achievable other than for Unit 6 (which is closest to the motorway) where the night-time internal noise level with an open window could exceed this relaxed criteria by just 2dB.

As such it is arguable as to whether or not this could be considered a significant exceedence of guideline criteria.

8.2 Limitations

The above concluded findings are reached on the basis that firstly, incoming roadside noise will be attenuated by a perimeter fence along the northeastern and southeastern boundaries to a height of 3000mm, and secondly on the basis that all windows will contain acoustic glazing allowing a sound reduction of at least 25dB (broadband) to be achieved when closed.

In addition to the above, it is recognised that some presumptions have been made regarding the manner in which the sound levels may be influenced or behave at this location, however it is believed that these have been made with regard to reasoned scientific understanding and professional judgement.

9 References

1. The Little Red Book of Acoustics: A Practical Guide, 2nd Ed., Watson, R. and Downey, O., Blue Tree Acoustics, 2008.
2. National Planning Policy Framework, Department for Communities and Local Government, March 2012.
3. British Standard 7445-1:2003 'Description and Measurement of Environmental Noise - Guide to quantities and procedures'.
4. British Standard 8233:2014 'Guidance on Sound Insulation and Noise Reduction for buildings.'
5. Planning Policy Guidance (PPG24); HMSO, 1994.
6. World Health Organisation Night Noise Guidelines for Europe, WHO, 2009.
7. World Health Organisation Guidelines for Community Noise, WHO, 1999.
8. The Control of Road Traffic Noise (CRTN) 1988 (HMSO).
9. Department for Transport traffic counts:
<http://www.dft.gov.uk/traffic-counts/cp.php?la=Hampshire>.
10. DEFRA Noise Mapping England: <http://services.defra.gov.uk/wps/portal/noise>.
11. Noise Action Plan: Roads (Including Major Roads) Environmental Noise (England) Regulations 2006. As amended, January 2014.
12. <http://www.masenv.co.uk/noisecalculator2>
13. Noise Control in Building Services. A Fry, Sound Research laboratories, Pergamon Press 1988.

APPENDIX

Sound level instrument calibration

Certificate of Calibration



Equipment Details

Instrument Manufacturer Cirrus Research plc
Instrument Type CR:171B
Description Sound Level Meter
Serial Number G068532

Calibration Procedure

The instrument detailed above has been calibrated to the publish test and calibration data as detailed in the instrument hand book, using the techniques recommended in the latest revisions of the International Standards IEC 61672-1:2013, IEC 61672-1:2002, IEC 60651:1979, IEC 60804:2001, IEC 61260:1995, IEC 60942:2003, IEC 60942:1997, IEC 61252:1993, ANSI S1.4-1983, ANSI S1.11-1986 and ANSI S1.43-1997 where applicable.

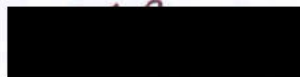
Sound Level Meters: All Calibration procedures were carried out by substituting the microphone capsule with a suitable electrical signal, apart from the final acoustic calibration.

Calibration Traceability

The equipment detailed above was calibrated against the calibration laboratory standards held by Cirrus Research plc. These are traceable to International Standards {A.0.6}. The standards are:

Microphone Type	B&K 4192	Serial Number	1920791	Calibration Ref.	S6450
Pistonphone Type	B&K 4220	Serial Number	613843	Calibration Ref.	S6388

Calibrated by



Calibration Date

22 September 2017

Calibration Certificate Number

252697

This Calibration Certificate is valid for 12 months from the date above.

Cirrus Research plc, Acoustic House, Bridlington Road, Hunmanby, North Yorkshire, YO14 0PH
Telephone: +44 (0) 1723 891655 Fax: +44 (0) 1723 891742
Email: sales@cirrusresearch.co.uk

Certificate of Calibration



Certificate Number: **114002**

Date of Issue: **22 September 2017**

Microphone Capsule

Manufacturer: **Cirrus Research plc**
Model Number: **MK:224**

Serial Number: **201385A**

Calibration Procedure

The microphone capsule detailed above has been calibrated to the published data as described in the operating manual of the associated sound level meter (where applicable).

The frequency response was measured using an electrostatic actuator in accordance with BS EN 61094-6:2005 with the free-field response derived via standard correction data traceable to the National Physical Laboratory, Middlesex, UK.

The absolute sensitivity at 1 kHz was measured using an acoustic calibrator conforming to IEC 60942:2003 Class 1.

Date of Calibration: **12 September 2017**

Open Circuit **51.6 mV/Pa**

Sensitivity at 1 kHz: **-25.7 dB rel 1 V/Pa**

Environmental Conditions

Pressure: **99.20 kPa**

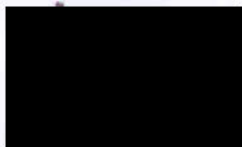
Temperature: **23.0 °C**

Humidity: **43.0 %**

Calibration Laboratory

Laboratory: Cirrus Research plc
Acoustic House, Bridlington Road, Hunmanby
North Yorkshire, YO14 0PH, United Kingdom

Test Engineer: Debra Swalwell



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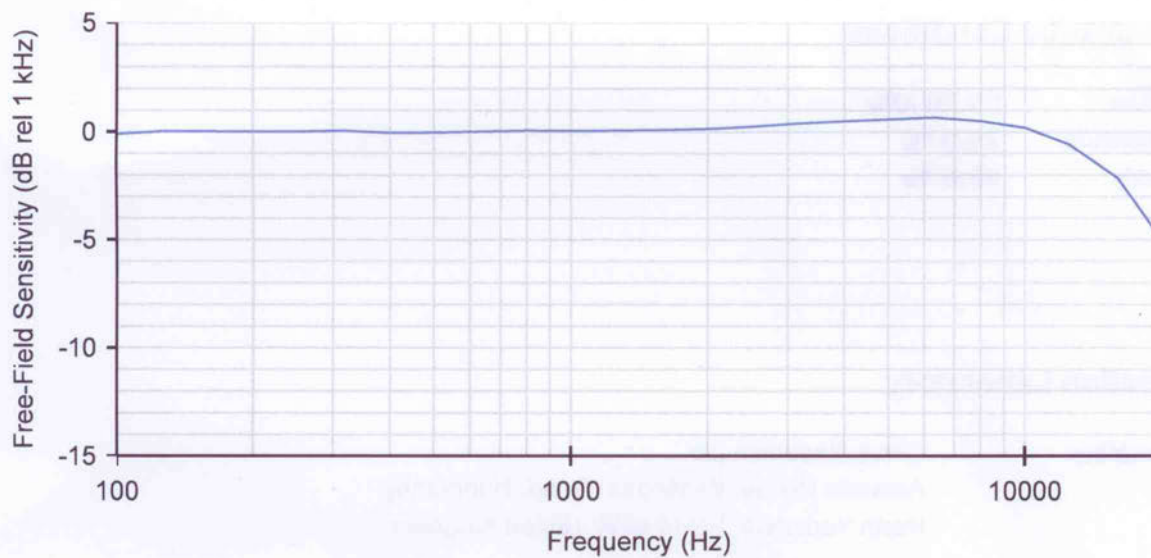


FM 531001

EMS 552104

Free-Field Frequency Response

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
100	-0.13	0.02
125	-0.01	0.12
160	-0.01	0.12
200	-0.03	0.11
250	-0.03	0.10
315	0.01	0.14
400	-0.08	0.03
500	-0.08	0.04
630	-0.03	0.05
800	0.01	0.07
1 000	0.00	0.05
1 250	0.02	0.03
1 600	0.05	-0.01
2 000	0.09	-0.06
2 500	0.19	-0.13
3 150	0.35	-0.26
4 000	0.45	-0.52
5 000	0.54	-0.93
6 300	0.63	-1.61
8 000	0.45	-2.84
10 000	0.14	-4.69
12 500	-0.64	-6.79
16 000	-2.19	-10.01
20 000	-4.99	-14.05



Certificate of Calibration

Certificate Number: **113987**

Date of Issue: **21 September 2017**



Instrument

Manufacturer: **Cirrus Research plc**

Serial Number: **70846**

Model Number: **CR:515**

Calibration Procedure

The sound calibrator detailed above has been calibrated to the published data as described in the operating manual and in the half-inch configuration. The procedures and techniques used are as described in IEC 60942:2003 Annex B – Periodic Tests and three determinations of the sound pressure level, frequency and total distortion were made.

The sound pressure level was measured using a WS2F condenser microphone type MK:224 manufactured by Cirrus Research plc.

The results have been corrected to the reference pressure of 101.33 kPa using the manufacturer's data.

Date of Calibration: **21 September 2017**

Initial Calibration Results

Measurement	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
1	93.93	1000.3	0.26
2	93.92	1000.3	0.26
3	93.94	1000.3	0.26
Average	93.93	1000.3	0.26
Uncertainty	± 0.13	± 0.1	± 0.10

The reported uncertainties of measurement are expanded by a coverage factor of k=2, providing a 95% confidence level.

Adjusted Calibration Results

Measurement	Level (dB)	Frequency (Hz)	Distortion (% THD + Noise)
1	94.00	1000.3	0.27
2	93.99	1000.3	0.26
3	94.01	1000.3	0.26
Average	94.00	1000.3	0.26
Uncertainty	± 0.13	± 0.1	± 0.10

The reported uncertainties of measurement are expanded by a coverage factor of k=2, providing a 95% confidence level.



Environmental Conditions

Pressure: 101.10 kPa
Temperature: 23.6 °C
Humidity: 45.1 %

Evidence of Pattern Approval

The manufacturer's product information indicates that this model of sound calibrator has been formally pattern approved to IEC 60942:2003 Annex A to Class 1. This has been confirmed with the Physikalisch Technische Bundesanstalt (PTB).

Statement of Calibration

As public evidence was available, from a testing organisation responsible for approving the results of pattern evaluation tests, to demonstrate that the model of sound calibrator fully conformed to the requirements for pattern evaluation described in Annex A of IEC 60942:2003, the sound calibrator tested is considered to conform to all the Class 1 requirements of IEC 60942:2003.

Calibration Laboratory

Laboratory: Cirrus Research plc
Acoustic House, Bridlington Road, Hunmanby
North Yorkshire, YO14 0PH, United Kingdom

Test Engineer: Craig Scott

