



Residential Noise Survey

Proposed Residential Development

Durban Road/Ash Grove, Bognor Regis

29th October 2021

ENVIRONMENTAL AND
SUSTAINABILITY CONSULTANTS

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Executive Summary

An environmental noise survey and noise impact assessment has been carried out to determine the suitability of the site at Durban Road/Ash Grove, Bognor Regis for residential development. Sound levels measured in the vicinity of the site have enabled ProPG, BS 8233 and BS 4142 assessments to be undertaken.

A sound insulation scheme has been provided in section 5.0, including glazing and alternative ventilation. These recommendations **are predicted to achieve** the internal noise levels specified in BS8233:2014.

The BS 4142:2014 +A1:2019 outcome indicates that sound from JG Auto Electrics and Servicing is unlikely to have adverse impact even when the worst-case is considered, and as a result, a suitable acoustic environment should be achieved without the implementation of further mitigation measures.

This report finds that after considering the outcomes of the ProPG: Planning and Noise and BS 4142:2014+A1:2019 assessments, an acceptable environment is achievable for the proposed residential development.

A brief summary of findings and recommendations are shown below:

Summary of Findings and Recommendations

- Living Rooms and Bedroom glazing requires a minimum sound reduction of 26 dB based on predictions for performance due to road traffic noise.
- All ventilation within the development requires a minimum sound reduction of 26 dB Dn,e,w.
- The BS 4142 assessment indicates that adverse impact is not likely.

1 Introduction

1.1 Overview

Encon Associates Ltd have been commissioned to undertake a noise assessment at for the proposed development residential development at the land situated on the corner of Durban Road and Ash Grove, Bognor Regis.

The Applicant is preparing to submit a planning application to Arun District Council.

The following technical report has been prepared to accompany the submission of the planning application to the Local Authority.

Prior to measurement, the Environmental Health Department of Arun District Council was contacted.

Due to the necessary technical nature of the report, a glossary of terms can be found in Appendix A to assist the reader.

1.2 Scope & Objectives

The scope of the noise assessment can be summarised as follows:

- Ambient and baseline sound monitoring survey to determine the prevailing sound levels incident on the proposed development;
- A detailed assessment of the suitability of the development, in accordance with relevant standards in respect of external noise sources; and
- Recommendation of mitigation measures, where necessary, to comply with the requirements of ProPG: Planning & Noise, and other relevant standards.

2 Site Description & Background Information

2.1 Site & Surrounding Area

The proposed development is located on the land situated on a corner with Durban Road to the south and Ash Grove to west. The immediate surrounding area comprises a mixture of residential dwellings and commercial units. Immediately to the east of the site is 'JHG Auto Electrics and Services Ltd', a garage which operates approximately between the hours of 08:30 and 18:00 Monday to Friday. Residential dwellings are situated to the south, west, and north of the proposed development. Approximately 90m north-east lies 'Supernatural X Ltd', a manufacturing unit which operates approximately between the hours of 08:00 and 18:00 Monday to Friday.

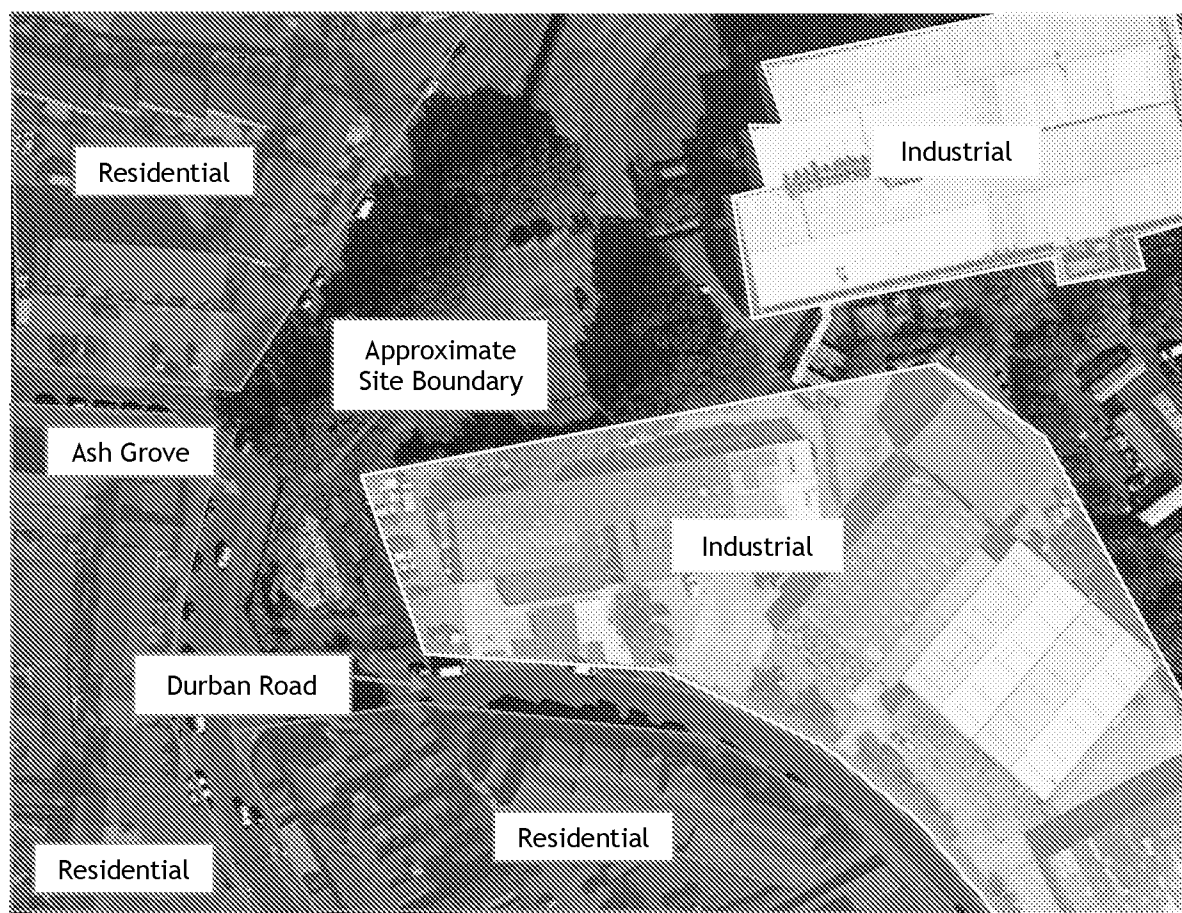


Figure 1.0 - Site and Surrounding Area

2.1 Background

It is proposed that an apartment building containing twenty-four residential dwellings is to be built on the land on the corner of Durban Road and Ash Grove. Consequently, a noise assessment was required in order to provide an acceptable acoustic environment for future occupants. The dominant noise source was road traffic on Durban Road and Ash Grove with aircraft passages also contributing to the acoustic environment. On occasion activity from JG Auto Electrics and Servicing and other commercial units to the east was discernible above the background sound.

Activities observed (and measured) at JG Auto Electrics and Servicing were the use of impact guns, grinders and drills, hammering and the use of compressors.

3 Legislation, Policy and Guidance

This report is based on the following policy, guidance and legislation.

3.1 ProPG: Planning & Noise

ProPG: Planning & Noise was introduced in May 2017 to provide practitioners with noise management guidance for the planning system in England. ProPG acknowledges, reflects and compliments Government Guidance in the NPSE, NPPF and PPG-Noise as well as other authoritative sources of guidance. These include BS 8233:2014 and The World Health Organisations (WHO) Community Noise Guidelines and the WHO Night Noise Guidelines for Europe. It provides detail in assessing factors to be taken into consideration and improving how to determine the extent of potential noise impact

The specific aims of ProPG: Planning & Noise are to:

- Advocate full consideration of the acoustic environment from the earliest possible stage of the development control process;
- Encourage the process of good acoustic design in and around the new residential developments;
- Outline what should be taken into account in deciding planning applications for new noise-sensitive developments;
- Improve understanding of how to determine the extent of potential noise impact and effect;
- Assist the delivery of sustainable development.

ProPG provides internal target noise levels which are desirable within a residential property. These are shown in Table 1.0 below.

Activity	Location	Daytime 07:00 - 23:00	Night-time 23:00 - 07:00
Resting	Living Room	35 dB $L_{Aeq,16\text{hour}}$	-
Dining	Dining Room/ Area	40 dB $L_{Aeq,16\text{hour}}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16\text{hour}}$	30 dB $L_{Aeq,8\text{hour}}$

Table 1.0 - ProPG Internal Noise Levels Criteria

It should be noted that the target levels shown above may be relaxed by 5dB where development is considered necessary or desirable.

The guidance document recommends that the external noise levels should not exceed 50 dB $L_{Aeq,T}$ or 55 dB $L_{Aeq,T}$ in noisier environments for traditional outdoor amenity areas such as gardens. However, it is understood that these guideline values are not achievable in all circumstances where development might be desirable. In areas where noise levels are higher, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors such as convenience of living in these areas or making efficient use of land resources to ensure development needs can be met, may be justified.

ProPG internal night-time L_{Amax} levels inside a bedroom have a guidance level of 45 dB L_{Amax} with windows open. The guidance correlates this to a level of 60 dB L_{Amax} externally. Events exceeding these levels are guided not to occur more than 10 times within the night-time period of 23:00 - 07:00.

3.2 BS4142: 2014 + A1: 2019 'Methods for rating and assessing industrial and commercial sound'

British Standard 4142: 2014 + A1:2019 describes methods for rating and assessing sound of an industrial and/or commercial nature, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as the from fork-lift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The methods described in the standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

The standard presents methods to measure and determine ambient, background and residual sound levels, and the rating levels of industrial/commercial sound. BS4142:2014+A1+2019 requires consideration of the level of uncertainty in the data and associated calculations.

The determination of noise amounting to a nuisance is beyond the scope of BS4142. The standard stipulates that it not intended to be applied to the rating and assessment of sound from the passage of vehicles of vehicles on public roads and railway systems, recreational activities, music and entertainment, shooting grounds, construction and demolition, domestic animals, public address systems and other sources not specified within the document.

The level of impact is assessed by comparing the rating level with the background sound level. Typically, the greater the difference between the rating level and background sound level the greater the magnitude of impact, depending on context. A difference of +5 dB is likely to indicate an adverse impact and a difference of +10 dB is likely to indicate a significant adverse impact, depending on context.

4 Environmental Noise Survey

To characterise the acoustic environment of the area, a long-term noise survey was carried out from the 22nd - 23rd September 2021. Short-term attended measurements were taken on 21st September for the purposes of a BS 4142:2014 +A1:2019 assessment.

4.1 Measurement Methodology

Long-term unattended monitoring was carried out at one location at the west-end Durban Road approaching the junction with Ash Grove (MP1). The sound level meter was installed inside a secure case attached to a lamppost approximately 3.5m above the ground and in free-field conditions i.e. more than 3m away from any other reflective surfaces. This measurement position was chosen to obtain representative sound levels during the daytime and night-time periods at the most exposed part of the development with regard to road traffic noise.

Short-term attended measurements were taken on 21st September 2021 at two locations for the purposes of the BS 4142 assessment. Ambient and residual sound measurements were taken at the end of the drive at JG Auto Electrics and Servicing, 14m South of the garage door (MP2). The microphone was mounted onto a tripod 1.5m above the ground in free-field conditions. Background sound measurements were taken at a position that is representative of what has been identified to be the worst affected noise sensitive receptor. The microphone was mounted onto a tripod 1.5m above the ground in free-field conditions. These measurement positions are shown in Figure 2.



Figure 2.0 - Measurement Positions

4.1 Instrumentation

Equipment	Serial No.	Laboratory Calibration
Cirrus Optimus Green+ Class 1 Sound Level Meter	G303153	19/08/2021
Cirrus Optimus Green+ Class 1 Sound Level Meter	G303154	19/08/2021
Cirrus CR:515 Class 1 Acoustic Calibrator	96656	19/08/2021

Table 2.0 - Instrumentation

All sound level meters were field calibrated immediately before and after the measurement period and no significant drift (≤ 0.5 dB) occurred. Laboratory calibration by a third-party is carried out on all sound level meters every twenty-four months with all calibrators being calibrated every twelve months. All microphones were fitted with a protective windshield. Calibration certificates can be seen in Appendix H.

4.2 Weather Conditions

Localised meteorological conditions were recorded throughout the survey period using a Kestrel 5500 weather meter. The conditions were considered suitable i.e. in accordance with those laid out in BS 7445-2:1991 and provided no significant uncertainty to the measured data. A summary of the meteorological conditions can be found in Appendix C.

4.3 Survey Results

Time History Graphs showing the results of the automated survey can be found in Appendix B. These graphs display the 15-minute L_{A90} , L_{Aeq} , L_{A10} and L_{Amax} sound levels at each monitoring location throughout the survey period.

A summary of the automated survey results used to carry out the subsequent assessments, are presented in the tables below.

Measurement Position 1				
Daytime (07:00 - 23:00)	$L_{Aeq,16hour}$	$L_{Amax,16hour}$	$L_{A10,16hour}$	$L_{A90,16hour}$
Wednesday (16:00 - 23:00) - Thursday (07:00 - 16:00) 22-23/09/21	60.6	92.2	63.0	47.0

Table 3.0 - Daytime Environmental Noise Survey Results - MP1

Measurement Position 1				
Night-time (23:00 - 07:00)	$L_{Aeq,8hour}$	$L_{Amax,8hour}$	$L_{A10,8hour}$	$L_{A90,8hour}$
Tuesday - Wednesday 22-23/09/21	52.1	76.6	51.2	32.6

Table 4.0 - Night-time Environmental Noise Survey Results - MP1

5 External to Internal Noise Break-in Assessment

5.1 Internal Noise Levels

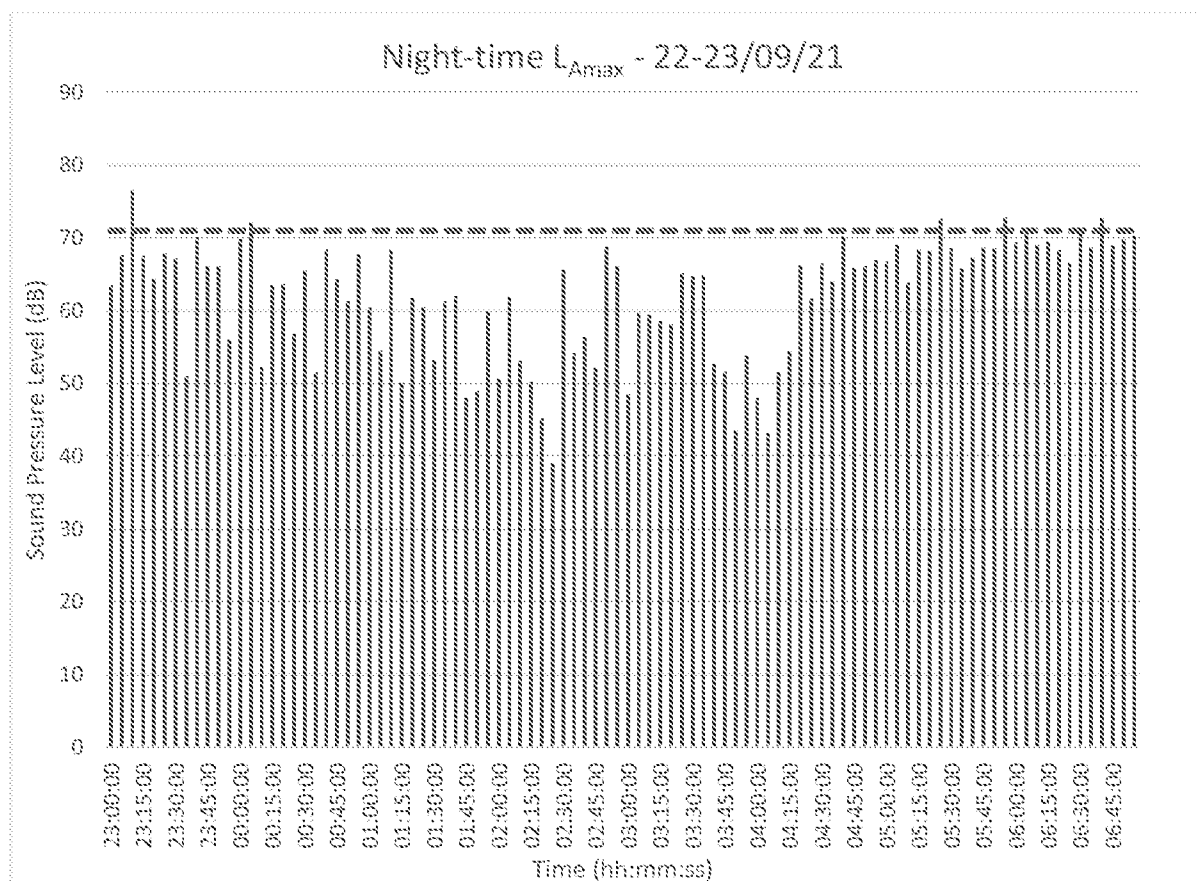
This section of the report analyses the ambient sound levels incident on the development compared to internal noise level criteria outlined in ProPG. Successive 1-hour sound level measurements have been taken over a 24-hour period, thus enabling for daytime and night-time assessment.

The table below outlines the composite SRI requirements of the proposed residential development to achieve the internal noise levels criteria specified in ProPG at the living room and the bedroom on the ground floor just on the south-west corner of the development.

	Time Period	Measured Noise Level	ProPG Criteria	Min. SRI Required (dB)
Bedroom/Living Room	Daytime	60.6	35dB _{L_{Aeq}, 16 hour}	26 R _w
Bedroom	Night-time	52.1	30dB _{L_{Aeq}, 8 hour}	23 R _w

Table 5.0 - Composite SRI requirements

ProPG stipulates that the level of 45dB_{L_{Amax}} should not be exceeded internally more than ten times during the night-time period. Figure 3.0 shows the L_{Amax, 5 min} sound levels during the night-time period. The line indicates the exceedance level, which is achieved by summing exceedance level outlined in ProPG (45 dB) with the worst-case composite SRI requirements (26 dB). This provides a level of 71 dB for any sound event, which if exceeded, would count towards the number of occurrences in the night-time period that exceed 45 dB L_{Amax} internally.

Figure 3.0 - Night-time L_{Amax}

The level of 71 dB was only exceeded six times during the night and therefore the minimum composite SRI requirements do not need to be increased.

5.1.1 Glazing

Considering that windows are often the weakest point of a façade in terms of sound reduction performance, the glazing configuration has been specified to achieve the required internal noise levels as though the entire façade were to consist of glazing. This ensures that the assessment is robust, as the composite sound reduction performance is likely to be greater due to the presence of other building fabrics.

The following table provides glazing configurations that should achieve the sound reduction performance required to achieve the specified internal noise levels criteria at the bedroom considered to be the most exposed. Considering that the configuration below should be able to achieve the required internal required at the most exposed living room, then it should also be appropriate for the rest of the development. This SRI value is for the whole window unit including the frame and other elements.

Location		Glazing Configuration	Attenuation
Most exposed bedroom		Double Glazing 6mm Glass - 6-16mm Air Cavity - 4mm Glass	28 dB $R_{w, Ctr}$

Table 6.0 - Glazing Specification

The values quoted in table 6.0 are taken from page 15 of BS 12758:2011.

Note that any other glazing configurations that would achieve these insulation values should be suitable for the development.

5.1.2 Open Window Assessment

BS 8233:2014 stipulates that if partially open windows are to be relied upon for background ventilation, the sound insulation performance is likely to be reduced to approximately 15dB. The table below shows the internal noise levels that are likely to be achieved with partially open windows.

Location	Time Period	External Noise Level	Predicted Internal Noise Level
Living Room/ Bedroom	Daytime	60.6 dB _{L_{Aeq}, 16hour}	45.6 dB _{L_{Aeq}, 16hour}
Bedroom	Night-time	52.1 dB _{L_{Aeq}, 8hour}	37.1 dB _{L_{Aeq}, 8hour}

Table 7.0 - Open Window Assessment

The table above suggests that the internal noise criteria outlined in BS 8233:2014, ProPG and WHO: Guidelines for Community Noise will not be achieved at the most exposed living room and bedroom space with an open window. Therefore, alternative ventilation is required.

5.1.3 Ventilation

BS8233 states;

“If relying on closed windows to the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.”

and

“The Building Regulations’ supporting documents on ventilation [48, 49, 50] recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant’s choice. Alternatively, acoustic ventilation units are available for insertion in external walls. These can provide sound reduction comparable with double glazed windows. However, ducted systems with intakes on the quiet side of the building might be required in very noisy situations, or where appearance rules out through-the-wall fans.”

It is recommended that the alternative ventilation system should provide the same sound reduction performance as the glazed components. Two alternative ventilation systems are displayed in table 9.

Model	Attenuation (dB)
Titon SF Xtra Sound Attenuator (Acoustic) Vent	44dB Open / 55dB Closed Dn,e,w
Greenwood EAR42W Acoustic Window Ventilator	42dB Open / 45dB Closed Dn,e,w

Table 8.0 - Ventilation Specification

The values quoted in the table above are from following sources:

Titon SF Xtra Sound Attenuator (Acoustic) Vent:

<https://www.titon.com/uk/products/window-door-hardware/window-vents-window-door-hardware/sf-xtra-sound-attenuator-vent/>

Greenwood EAR42W Acoustic Window Ventilator:

<https://www.greenwood.co.uk/product/203/ear42w>

It should be noted that it is beyond the scope/remit of this report to specify the ventilation performance of alternative ventilation systems. The models presented in table 8.0 have only been specified to achieve the required internal noise level criteria and a HVAC engineer should be consulted to confirm whether the systems provide sufficient air flow for the size and use of the room.

If a MHRV system is employed, the self-generating noise from the system will need to conform with the internal noise levels presented in BS8233:2014.

6 BS 4142:2014+A1:2019 Assessment

6.1 Introduction

Due to the proximity of the proposed development with industrial and commercial units, a noise impact assessment in accordance with BS 4142:2014+A1:2019 was required to determine the likelihood of adverse impact at the receptor considered to be the worst affected. Sound measurements were taken on the site of JG Auto Electrics and Servicing and at the location which represents the first-floor living room on the south-east corner of the development, which is considered to be most exposed to activity sounds from the garage. JG Auto Electrics and Servicing and neighbouring industrial only operate during daytime hours and therefore no night-time assessment was required.

6.2 Background Measurement Results

The table below shows the L_{A90} measured at MP3 after JG Auto Electrics and Servicing had finished operating.

Measurement Position 3	
Date and Time	Measured L_{A90} , 20 min
Tuesday 21/09/21 18:31	43

Table 9.0 - Background Measurement Results

6.3 Specific Sound Level

Continuous 15-minute sound measurements were taken at MP2 while JG Auto Electrics was operational. It was observed that for most of the survey period sound from the garage was not contributing to the acoustic environment, which was dominated by road traffic. However, there was one 15-minute period of intense activity where grinding, hammering and a compressor were observed, along with a compressor running. Based on observations, this fifteen-minute period has been identified as a worst-case scenario. BS 4142 specifies a daytime reference time interval of 1-hour and as such presents an on-time correction if the specific sound is intermittent and either steady or cyclic to determine the specific sound level. The equation used to calculate the specific sound level based on the source on-time as well as the determination of the residual sound levels for this period are shown in Appendix G. Residual sound levels were obtained during a non-operational period immediately after the activity sounds.

6.4 BS 4142 Assessment

BS 4142:2014+A1:2019 Assessment			
Assessment		Relevant Clause	Commentary
Ambient Sound Level	68.4 dBL _{Aeq, 15 min}	7.3.1 7.3.3 7.3.5	Specific sound on
Residual Sound Level	58.9 dBL _{Aeq, 15 min}	7.3.2 7.3.3 7.3.5	Specific sound off to determine the correction to be made to the measured ambient sound level
Specific Sound Level @16m	67.9 dBL _{Aeq, 15 min}	7.3.3 7.3.4	The residual sound level of has been subtracted logarithmically from the ambient sound level. See Appendix F for calculations
Background Sound	43 dBL _{A90, 15min}	8.1.1 8.1.2 8.6	Background sound level measured after operations had stopped on-site. Table 10.0
On-time correction	$10\log(15/60) = -6.0$ dB _A	7.3.14	Total on-time of fifteen minutes during 1-hour reference interval
Distance Correction Point Source	-3.7 dB _A		Defined as a point source by (b/π) where b = largest dimension of source (Watson & Downey, 2013)
Change in level $=20\log(r_2/r_1)$ $=20\log(24.5/16)$			Distances shown in Appendix E
Barrier Attenuation	-18.9 dB _A		Barrier Calculations in Appendix F
Specific Sound Level at Receiver	39.3 dB _A		
Acoustic Character Correction	N/A	9.2	1/3 octave band objective method in Appendix G does not identify tones in the specific sound. Hammering was only observed to be light at MP2 and the attenuation provided by the increase in distance and screening from the garage wall should make the impulsivity less distinct.
Rating Level at Receiver	39.3 dB _A	9.1	
Excess of rating level over background level	$(39 - 43) = -4$ dB _A	11	Rounded to nearest integer at the final phase of the calculation
Impact	The Assessment indicates that adverse impact is unlikely, depending on context	11	The rating level is 4 dB _A below the background sound level and is 9 dB _A below the level which indicates likelihood of adverse impact, that of +5 dB _A

Table 10.0 - BS 4142:2014+A1:2019 Assessment

6.5 Discussion

The assessment of adverse impact at the noise sensitive receptors assumed to be the worst affected has been employed by measured sound levels from the environmental noise survey. The measurement and subsequent assessment have been carried out in accordance with methodology outlined in BS 4142:2014+A1:2019. BS 4142 requires that human response to activity sound is rated via numerical values as well as careful consideration for the context in which the sound exists.

The assessment indicates that adverse impact is not likely to occur at the noise sensitive receptor considered to be the most exposed, subject to context. This is due to the rating level falling significantly below the level which indicates adverse effect being likely. The receptor considered to be the worst affected benefits substantially from not having line of sight to the activities taking place inside the garage due to the fine angle between the garage door and the receptor, as well as the garage wall acting as a barrier.

6.6 Context

It is stated in section 11 of BS 4142: 2014+A1:2019 that “where the initial estimate of the impact needs to be modified due to context, take all pertinent factors into consideration”.

The relevant context for the proposed development is that it lies between Durban Road and Ash Grove, as well as being in the proximity of several industrial and commercial units. The assessment considers a worst-case scenario. Observations made over a two-day period suggest that noise activity as intense as shown by the fifteen-minute measurement does not occur as often as the 25% on-time correction suggests and therefore, the level of impact is likely to be overstated.

6.7 Rating Level Assessment

BS 4142 requires the assessment of acoustic features. This was carried out with first-hand observations of the character of the sounds and the absolute level of these activities in relation to the background. Prominent sounds included the use of grinders and drills as well as the compressor running, which have the potential to generate tones. Appendix G presents 1/3 octave-bands for the specific sound and it demonstrates that no tones were present according to the objective method stipulated in BS 4142:2014+A1:2019. It should also be considered that because the rating level is low, the influence of other potential acoustic characteristics also minimised.

6.8 On-time Impact

BS 4142:2014+A1:2019 uses a reference period of 1-hour during the daytime to assess the likelihood of adverse impact. The activities within these periods are required to be typical of the operation under investigation both in terms of level and duration. This identifies whether the sounds associated with the activity have the likelihood of adverse impact, depending on context. The proportion of time the activity takes place within extended periods of time greater than the one-hour reference period provides part of the acoustic context that the BS 4142:2014+A1:2019 assessment is subject to. It was observed over a two-day period that noise activity as intense as the fifteen-minute measurement used to inform the assessment, does not occur for as much as 25% of time and as such, the level of impact is likely to be overstated.

6.9 Uncertainty

Reasonable steps have been undertaken to reduce uncertainty in both measurement and assessment in line with section 10 of BS 4142:2014+A1:2019. These steps include the use of class 1 instrumentation, measurements being taken in suitable weather conditions, the measurement locations chosen to obtain background sound levels being representative of the assessment location, the number of measurements taken, ensuring that residual sound measurements were taken in similar conditions to the ambient sound level and the number of measurements that were taken. Uncertainty has been reduced by the inclusion of considered and supported contextual issues, as they provide a greater understanding of the residual acoustic environment and the level of variability in sound emission from the source.

6.10 Assessment of Impacts

The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs. An effective assessment cannot be conducted without an understanding of the reason(s) for the assessment and the context in which the sound occurs/will occur. When making assessments and arriving at decisions, therefore, it is essential to place the sound in context. An initial estimate of the impact of the specific sound is made by subtracting the background level.

- a) Typically, the greater this difference, the greater the magnitude of the impact.
- b) A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.
- c) A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context.
- d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound having a low impact, depending on the context.

The assessment provides a result, which under worst-case conditions is 9 dB below the level which indicates adverse effect. Contextual observations such as the surrounding noise climate and on-time of 'worst-case' activities suggest that the magnitude of impact may be lower than indicated by the rating level compared to the background sound level.

The assessment concludes that sound from JG Auto Electrics and Servicing is unlikely to have adverse impact and as a result, a suitable acoustic environment should be achieved without the implementation of further mitigation measures.

7 Conclusions

A sound survey was undertaken at the proposed development site on the corner of Durban Road/Ash Grove to inform ProPG: Planning & Noise and BS 4142 assessments to determine the suitability of the development for residential use and to provide an acceptable acoustic environment for future inhabitants.

The external to internal noise-break-in assessment indicates that a minimum SRI performance of 26 dB R_w is required for bedrooms and living rooms. The glazing configuration has been specified in this report to achieve the internal noise levels stipulated in ProPG: Planning & Noise as though the entire façade were to consist of glazing, ensuring a robust assessment. The assessment suggests that internal noise level criteria is not achievable with an open window and as a result, alternative ventilation with a minimum sound reduction of 26 dB $D_{n,e,w}$ is required. Alternative ventilation systems which should provide the required sound reduction performance have been presented in this report.

The BS 4142:2014 +A1:2019 outcome indicates that sound from JG Auto Electrics and Servicing is unlikely to have adverse impact even when the worst-case is considered, and as a result, a suitable acoustic environment should be achieved without the implementation of further mitigation measures.

This report finds that after considering the outcomes of the ProPG: Planning and Noise and BS 4142:2014+A1:2019 assessments, an acceptable environment is achievable for the proposed residential development.

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Appendix A - Acoustic Terminology & Definitions

Sound Pressure	The fluctuations in air pressure, from the steady atmospheric pressure, created by sound, measured in pascals (Pa).
Sound Pressure Level (SPL)	The sound pressure measured on a decibel scale relative to a standard reference pressure of 20µPa (20x10 ⁻⁶ Pascals).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by $20 \log_{10} (s1 / s2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20µPa.
Frequency (Hz)	The pitch of the sound, measured in Hertz (Hz)
Integrating Sound Level Meter	An instrument used for measuring sound levels with the capacity to perform calculations to derive other parameters.
Calibration	A check of the function of a sound level meter by comparing the meter reading with a known sound pressure level. This is performed in the field before and after measurement and by a laboratory every year calibrators and every two years for Sound Level Meters.
A-Weighting, dB(A)	A frequency weighting devised to attempt to take the fact that human response to sound is not equally sensitive at all frequencies into account.
Z-Weighting	A zero frequency weighting (often referred to as unweighted).
Attenuation	Noise reduction, measured in decibels.
Ambient Sound Level $L_{Aeq,T}$	The total encompassing sound in a given situation, at a given time. Usually composed of sounds from many sources, near and far.
Residual Sound Level $L_{Aeq,T}$	The ambient sound remaining when the specific sound source is suppressed to a degree it does not contribute to the ambient sound.
Specific Sound Level $L_{Aeq,T}$	The equivalent continuous A-weighted sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T_r
Rating Level $L_{Ar, tr}$	The specific sound level plus any adjustment for the characteristic features of the sound
Background Sound Level $L_{A90,T}$	A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels.
Frequency Analysis	Analysis of a sound into its frequency components. Commonly 1/1 or 1/3 octave bands
Frequency Spectrum	A graph resulting from frequency analysis and showing different levels of the signal in the various frequency bands.
Octave-bands	A division of the frequency range into bands, the upper frequency limit of each band being twice the lower frequency limit.
Noise Index	A method of evaluating or rating a noise, usually by assigning a single number to it, based on some combination of its physical parameters (sound pressure level, frequency, duration) and other factors such as time of day, tonal characteristics and impulsive characteristics.
Leq, T	Otherwise referred to as the 'continuous equivalent noise level' of a period of time (T). This is the steady noise level which contains the same amount of energy as the time varying sound level that was recorded.
Lmax,T	The maximum RMS sound pressure level that occurs within a specified time period. It is used often to describe occasional loud noise events that may have little influence on the Leq but will have an effect on the overall acoustic environment. The time weighting (Fast or Slow) is usually specified.

L90, T	The noise level exceeded for 90% of the specified time period (T). It is often used to characterise the background noise.
L10, T	The noise level exceeded for 10% of the specified time period (T). It is often used to characterise road traffic noise.
Free-Field	A situation where the radiation from a sound source is completely unaffected by the presence of reflective surfaces. In terms of environmental noise measurement, it is usually taken to mean at least 3.5m away from 3.5m away from reflective surfaces with the exception of the ground.
Façade Noise Level	A noise level measured within 3m of a building façade, which contains a contribution arising from reflection of sound at the façade. The difference between the façade level and free-field level is described as the façade correction factor.
Noise Sensitive Receptor	Premises that are used for purposes sensitive to noise and that require protection.
Line Source	A source of sound that as distance increases away from the source it still appears large in one dimension. Attenuation of this form of source occurs at a distance of (a/π) where a is the largest dimension of the source.
Point Source	A source of sound that as distance increases away from the source it appears as a point in space. Attenuation of this form of source occurs at a distance of (b/π) where b is the smallest dimension of the source.
Time Weighting	One of the standard averaging times (Fast, Slow or Impulsive) used for the measurement of RMS sound pressure level in sound level meters, specified in ISO 61671-1.
Rw	Single number quantity which characterises the airborne the airborne sound insulation of a material or building element over a range of frequencies, based on laboratory measurements.
DnT,w + Ctr	A single value that characterises the airborne sound insulation performance using the Ctr: spectrum adaption terms described in BS EN ISO 717-1. The value is based on field measurements and the value represents total sound transmission including flanking sound, not just the partition.

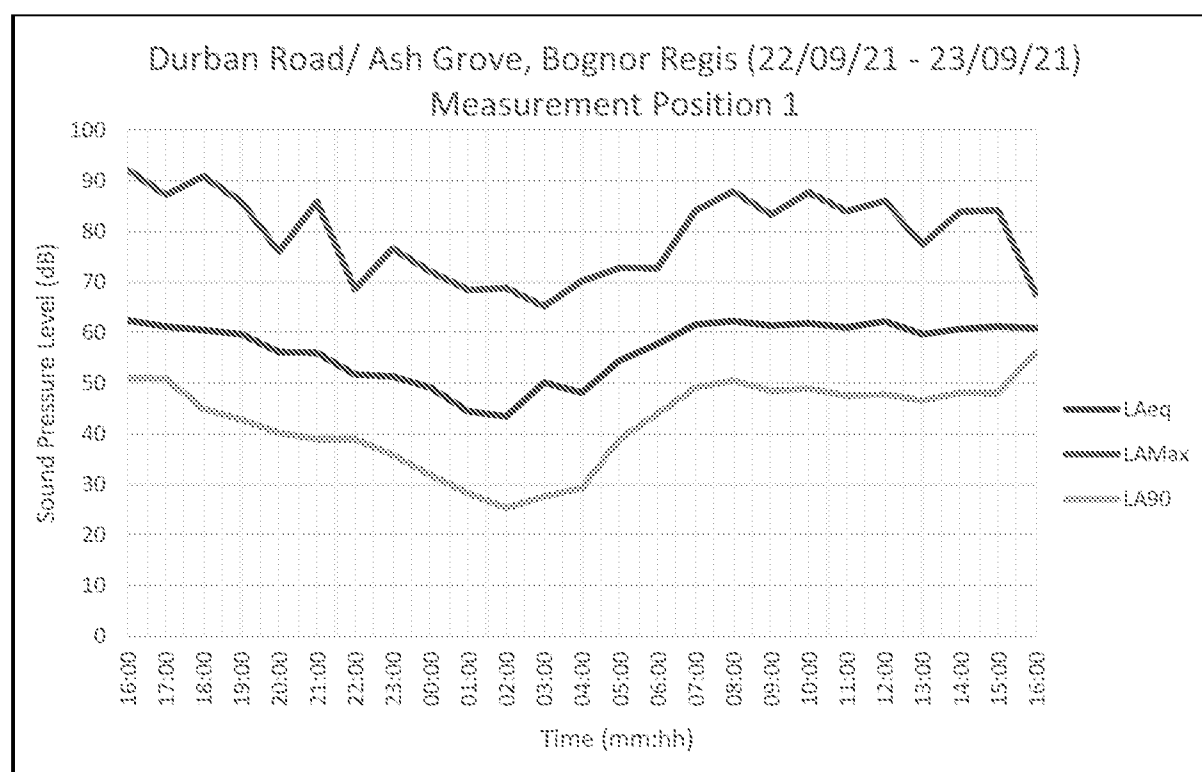
The table below presents an indication of sound levels associated with the environment starting from 0dB (the threshold of hearing) to 140dB (The threshold of pain).

cat

Sound Level	Location/Activity
0 dB(A)	Threshold of Hearing
20 - 30 dB(A)	Inside Quiet Bedroom at Night
30 - 40 dB(A)	Inside a Living Room During the Day
40 - 50 dB(A)	Inside Typical Office
50 - 60 dB(A)	Inside a Car
60 - 70 dB(A)	Typical High Street
70 - 90 dB(A)	Inside Factory
100 - 110 dB(A)	Burglar Alarm at 1m
110 - 130 dB(A)	Jet Aircraft on Take Off
140 dB(A)	Threshold of Pain

The 'A' denotes the A-weighting scale used to replicate the frequency response of the human ear.

Appendix B - Time History Graphs



Appendix C - Weather Conditions

Whilst attended measurement were being taken and upon the setup of monitoring equipment at MP1 the sky was sunny and had 30% cloud cover. Upon collection of the noise monitoring instrumentation the sky was sunny and had 50% cloud cover. There was no precipitation at any point during the survey period.

Device Information:						
Name:	WEATHER - 2852332					
Model:	5525					
Serial:	2852332					
Firmware:	1.47					
Profile Version:						
Hardware Version:	Rev 14					
LINK Version:	1.04.04					
Time:	Temp	Rel. Hum.	Wind	Dir.		
yyyy-mm-dd hh:mm:ss	Celsius	%	m/s	Degrees		
21/09/2021 14:20	23.2	50.6	1	171		
21/09/2021 14:30	23.3	49.5	2	245		
21/09/2021 14:40	23	50.3	0.8	224		
21/09/2021 14:50	23.4	50.5	0.8	191		
21/09/2021 15:00	25.7	45.7	0.5	210		
21/09/2021 15:10	24.5	50.7	0.6	182		
21/09/2021 15:20	25.6	48.6	0.8	209		
21/09/2021 15:30	21.4	48.5	1.1	190		
21/09/2021 15:40	22.6	48.5	1.4	217		
21/09/2021 15:50	23.4	48.8	0.8	188		
21/09/2021 16:00	23.1	48.9	0.9	182		
21/09/2021 16:10	22	50.3	0.8	222		
21/09/2021 16:20	21.4	50.1	0.8	223		
21/09/2021 16:30	21.1	51.3	0.6	191		
21/09/2021 16:40	22	56.3	0.7	234		
21/09/2021 16:50	21.9	55.1	0	217		
21/09/2021 17:00	21.2	54.9	0.8	210		
21/09/2021 17:10	21.9	57.8	0.5	209		
21/09/2021 17:20	21	57.9	0.8	218		
21/09/2021 17:30	19.9	57.7	0.5	208		
21/09/2021 17:40	18.9	57.7	1.3	189		
21/09/2021 17:50	18.6	57.7	0.8	208		
21/09/2021 18:00	18.4	57.8	0	208		
21/09/2021 18:10	19	57.5	0.7	219		
21/09/2021 18:20	18.2	57.4	0.7	237		
21/09/2021 18:30	17.9	57.5	1.1	248		
21/09/2021 18:40	17.5	57.5	0.5	236		
21/09/2021 18:50	18.9	58	0	254		
21/09/2021 19:00	18.1	57.8	0	318		
21/09/2021 19:10	19.6	57.7	0	217		
21/09/2021 19:20	20.8	59	0	325		
21/09/2021 19:30	21.7	58.9	0	325		
21/09/2021 19:40	22.3	58.2	0	265		
21/09/2021 19:50	22.7	59.8	0	289		
21/09/2021 20:00	22.8	60.1	0	269		
21/09/2021 20:10	22.8	60.1	0	269		
21/09/2021 20:20	22.6	59	0	268		
21/09/2021 20:30	22.5	58.8	0	266		
21/09/2021 20:40	22.3	59	0	268		
21/09/2021 20:50	22.1	58.4	0	267		
21/09/2021 21:00	21.9	57.5	0	268		
21/09/2021 21:10	21.8	56.8	0	268		
21/09/2021 21:20	21.3	55.6	0	269		
21/09/2021 21:30	21	54.8	0	267		
21/09/2021 21:40	20.6	53.5	0	289		
21/09/2021 21:50	20.4	52.4	0	268		
21/09/2021 22:00	20.1	51.4	0	269		
21/09/2021 22:10	19.5	50.3	0	268		
21/09/2021 22:20	19.5	48.2	0	269		
21/09/2021 22:30	19.3	49.3	0	268		
21/09/2021 22:40	18.9	47.2	0	269		
21/09/2021 22:50	19.8	46.3	0	269		
21/09/2021 23:00	18.4	45.3	0	269		
21/09/2021 23:10	18.1	44.5	0	268		
21/09/2021 23:20	17.8	43.8	0	269		
21/09/2021 23:30	17.6	42.9	0	268		
21/09/2021 23:40	17.3	42.1	0	268		
21/09/2021 23:50	17	41.4	0	268		

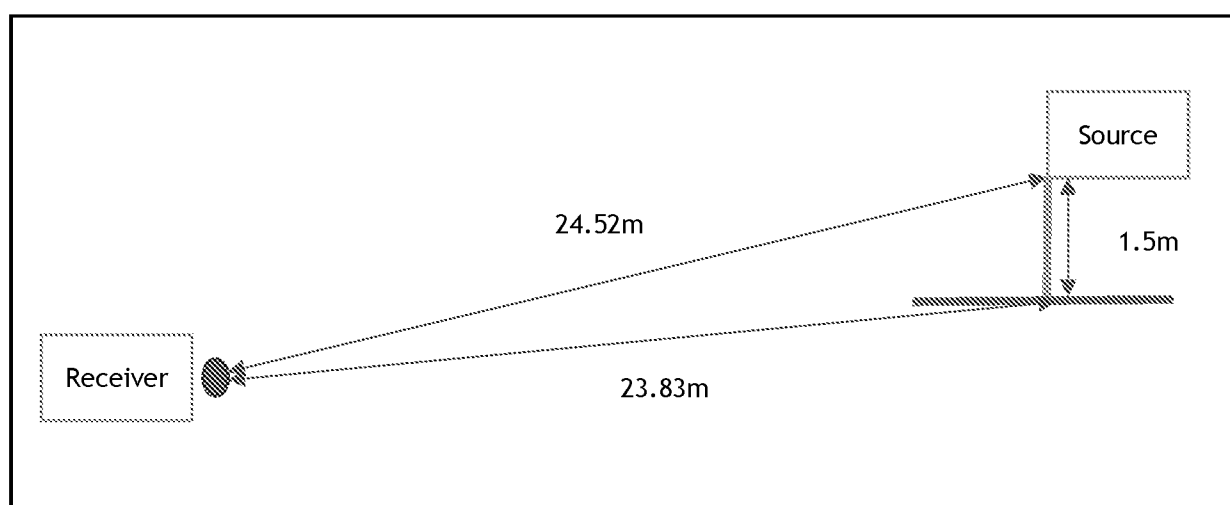
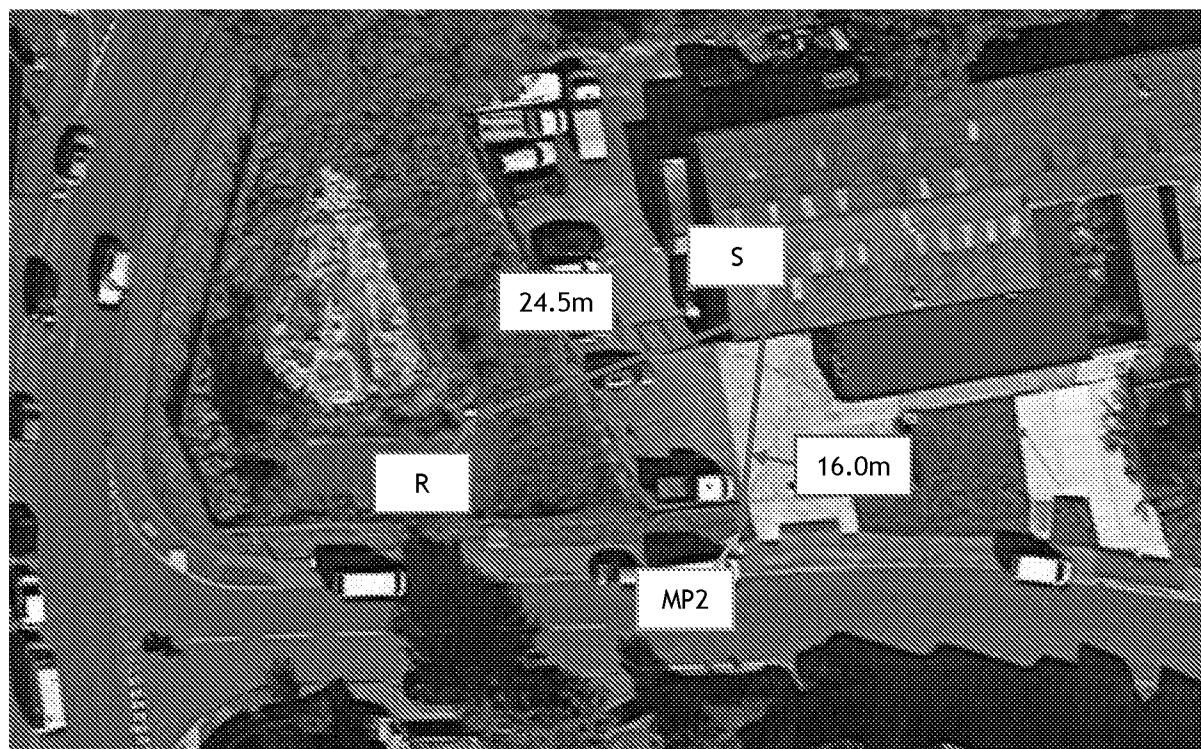
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22/09/2021	00:10	16.5	40.1	0	255
22/09/2021	00:20	16.3	39.5	0	255
22/09/2021	00:30	16	39	0	255
22/09/2021	00:40	15.8	38.5	0	255
22/09/2021	00:50	15.8	38.1	0	255
22/09/2021	01:00	15.4	37.7	0	255
22/09/2021	01:10	15.2	37.3	0	255
22/09/2021	01:20	14.9	36.9	0	255
22/09/2021	01:30	14.8	36.5	0	255
22/09/2021	01:40	14.8	36.1	0	255
22/09/2021	01:50	14.4	35.1	0	255
22/09/2021	02:00	14.2	34.9	0	255
22/09/2021	02:10	14	34.7	0	255
22/09/2021	02:20	13.9	34.5	0	255
22/09/2021	02:30	13.7	34.4	0	255
22/09/2021	02:40	13.6	34.3	0	255
22/09/2021	02:50	13.4	34.2	0	255
22/09/2021	03:00	13.3	34.1	0	255
22/09/2021	03:10	13.1	34	0	255
22/09/2021	03:20	13	34.9	0	255
22/09/2021	03:30	12.9	34.9	0	255
22/09/2021	03:40	12.7	34.8	0	255
22/09/2021	03:50	12.6	34.8	0	255
22/09/2021	04:00	12.5	34.8	0	255
22/09/2021	04:10	12.4	34.9	0	255
22/09/2021	04:20	12.3	34.8	0	255
22/09/2021	04:30	12.2	34.9	0	255
22/09/2021	04:40	12.1	34.9	0	255
22/09/2021	04:50	12	34.9	0	255
22/09/2021	05:00	11.9	35	0	259
22/09/2021	05:10	11.8	35.1	0	259
22/09/2021	05:20	11.7	35.1	0	259
22/09/2021	05:30	11.6	35.2	0	258
22/09/2021	05:40	11.5	35.3	0	258
22/09/2021	05:50	11.4	35.3	0	258
22/09/2021	06:00	11.3	35.4	0	259
22/09/2021	06:10	11.2	35.5	0	258
22/09/2021	06:20	11.2	35.6	0	258
22/09/2021	06:30	11.1	35.8	0	258
22/09/2021	06:40	11	35.7	0	258
22/09/2021	06:50	10.9	35.8	0	258
22/09/2021	07:00	10.8	35.9	0	258
22/09/2021	07:10	10.8	36	0	258
22/09/2021	07:20	10.7	36.1	0	258
22/09/2021	07:30	10.6	36.2	0	258
22/09/2021	07:40	10.6	36.3	0	258
22/09/2021	07:50	10.6	36.3	0	258
22/09/2021	08:00	10.6	36.7	0	255
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22/09/2021	08:20	12.5	45.3	0	27
22/09/2021	08:30	12.2	44.9	0	27
22/09/2021	08:40	14	41.5	0	27
22/09/2021	08:50	15	45.5	0.5	27
22/09/2021	09:00	15.3	49.3	1	31
22/09/2021	09:10	15.5	50.4	0	30
22/09/2021	09:20	15.5	50.6	0.5	37
22/09/2021	09:30	15.8	51.4	0	40
22/09/2021	09:40	17.8	52.5	1	46
22/09/2021	09:50	18.1	54.1	0	48
22/09/2021	10:00	18.8	55.8	0.4	50
22/09/2021	10:10	20.6	57.1	0	19
22/09/2021	10:20	19.5	56.4	0.5	36
22/09/2021	10:30	22.5	59.8	0	5
22/09/2021	10:40	20.3	60.8	0	5
22/09/2021	10:50	21.4	59.9	0	252
22/09/2021	11:00	24.5	56.5	0.3	249
22/09/2021	11:10	20.5	54.8	2.5	216
22/09/2021	11:20	19.8	52.1	1.3	241
22/09/2021	11:30	20.5	58.7	2	135

22/09/2021	11:40	19.7	65.3	1.3	234
22/09/2021	11:50	19.7	70.7	2.1	214
22/09/2021	12:00	21.1	68.5	0.6	224
22/09/2021	12:10	20.9	68.2	0.4	247
22/09/2021	12:20	20.3	67.2	1.4	218
22/09/2021	12:30	19.8	64.4	1.5	238
22/09/2021	12:40	19.8	65.1	1.9	219
22/09/2021	12:50	20.1	64.5	2.7	259
22/09/2021	13:00	20.4	61.7	1	154
22/09/2021	13:10	20.9	61.5	1.3	237
22/09/2021	13:20	19.5	61.7	2.2	237
22/09/2021	13:30	20.2	60.8	1.8	227
22/09/2021	13:40	21.1	59	0.8	242
22/09/2021	13:50	20.9	58	1	154
22/09/2021	14:00	20.5	58.8	0.9	238
22/09/2021	14:10	21.4	57.7	1	245
22/09/2021	14:20	21.1	58.8	1.1	244
22/09/2021	14:30	21.4	59.2	1	180
22/09/2021	14:40	22.5	58.3	0.8	239
22/09/2021	14:50	21.5	56.1	0.9	225
22/09/2021	15:00	20.6	55.8	3.3	217
22/09/2021	15:10	20.9	55.7	1.3	237
22/09/2021	15:20	21.5	54.7	0	279
22/09/2021	15:30	20.8	58.3	0	247
22/09/2021	15:40	22.8	61.5	0	248
22/09/2021	15:50	28.8	64.5	0	249
22/09/2021	16:00	29.3	66.3	0	248
22/09/2021	16:10	29.4	67.5	0	249
22/09/2021	16:20	29.4	67.2	0	237
22/09/2021	16:30	29	65.8	0	235
22/09/2021	16:40	28.5	64.2	0	235
22/09/2021	16:50	28	62	0	229
22/09/2021	17:00	27.5	60.1	0	235
22/09/2021	17:10	27.2	58.8	0	232
22/09/2021	17:20	27	57.3	0	230
22/09/2021	17:30	26.9	58.1	0	233
22/09/2021	17:40	28.9	55	0	223
22/09/2021	17:50	28.6	54.1	0	233
22/09/2021	18:00	26.6	53.1	0	234
22/09/2021	18:10	26.5	52.2	0	233
22/09/2021	18:20	28.3	51.2	0	233
22/09/2021	18:30	28.1	50.4	0	233
22/09/2021	18:40	25.9	49.4	0	232
22/09/2021	18:50	25.7	48.4	0	223
22/09/2021	19:00	25.5	47.4	0	233
22/09/2021	19:10	25.2	46.4	0	233
22/09/2021	19:20	24.9	45.4	0	233
22/09/2021	19:30	24.7	44.5	0	233
22/09/2021	19:40	24.4	43.5	0	235
22/09/2021	19:50	24.1	42.7	0	232
22/09/2021	20:00	23.9	41.8	0	233
22/09/2021	20:10	23.8	41	0	234
22/09/2021	20:20	23.3	40.2	0	233
22/09/2021	20:30	23.1	39.5	0	234
22/09/2021	20:40	22.9	38.8	0	234
22/09/2021	20:50	22.8	38.2	0	235
22/09/2021	21:00	22.4	37.5	0	233
22/09/2021	21:10	22.1	37	0	234
22/09/2021	21:20	21.9	36.5	0	234
22/09/2021	21:30	21.8	36.1	0	234
22/09/2021	21:40	21.4	35.8	0	234
22/09/2021	21:50	21.2	35.2	0	234
22/09/2021	22:00	21	34.9	0	234
22/09/2021	22:10	20.8	34.5	0	234
22/09/2021	22:20	20.6	34.2	0	234
22/09/2021	22:30	20.4	33.9	0	234
22/09/2021	22:40	20.2	33.7	0	235
22/09/2021	22:50	20	33.5	0	234
22/09/2021	23:00	19.9	33.3	0	233
22/09/2021	23:10	19.8	33.1	0	234

23/09/2021	23:20	18.4	32.9	0	234
23/09/2021	23:30	18.2	32.8	0	234
22/09/2021	23:40	18.1	32.8	0	234
22/09/2021	23:50	18.9	32.5	0	234
23/09/2021	00:00	18.7	32.4	0	234
23/09/2021	00:10	18.5	32.3	0	234
23/09/2021	00:20	18.4	32.2	0	235
23/09/2021	00:30	18.2	32.1	0	234
23/09/2021	00:40	18.1	32.1	0	234
23/09/2021	00:50	17.9	32	0	235
23/09/2021	01:00	17.8	32	0	235
23/09/2021	01:10	17.8	31.9	0	234
23/09/2021	01:20	17.5	31.9	0	234
23/09/2021	01:30	17.3	31.9	0	234
23/09/2021	01:40	17.2	31.9	0	235
23/09/2021	01:50	17.1	31.9	0	234
23/09/2021	02:00	16.9	31.9	0	235
23/09/2021	02:10	16.8	31.9	0	235
23/09/2021	02:20	16.7	31.9	0	235
23/09/2021	02:30	16.5	31.9	0	234
23/09/2021	02:40	16.4	32	0	234
23/09/2021	02:50	16.3	32	0	234
23/09/2021	03:00	16.2	32	0	235
23/09/2021	03:10	16.1	32.1	0	235
23/09/2021	03:20	16	32.1	0	235
23/09/2021	03:30	15.9	32.2	0	234
23/09/2021	03:40	15.8	32.3	0	235
23/09/2021	03:50	15.8	32.3	0	235
23/09/2021	04:00	15.5	32.4	0	235
23/09/2021	04:10	15.4	32.5	0	235
23/09/2021	04:20	15.3	32.5	0	235
23/09/2021	04:30	15.2	32.6	0	235
23/09/2021	04:40	15.1	32.7	0	234
23/09/2021	04:50	15	32.8	0	235
23/09/2021	05:00	14.9	32.9	0	235
23/09/2021	05:10	14.9	32.9	0	234
23/09/2021	05:20	14.8	33	0	234
23/09/2021	05:30	14.7	33.2	0	235
23/09/2021	05:40	14.7	33.3	0	235
23/09/2021	05:50	14.6	33.5	0	235
23/09/2021	06:00	14.6	33.6	0	234
23/09/2021	06:10	14.5	33.7	0	235
23/09/2021	06:20	14.5	33.9	0	235
23/09/2021	06:30	14.5	34	0	235
23/09/2021	06:40	14.4	34.2	0	235
23/09/2021	06:50	14.4	34.4	0	234
23/09/2021	07:00	14.4	34.5	0	235
23/09/2021	07:10	14.3	34.8	0	235
23/09/2021	07:20	14.3	35	0	235
23/09/2021	07:30	14.3	35.2	0	235
23/09/2021	07:40	14.2	35.4	0	235
23/09/2021	07:50	14.2	35.6	0	235
23/09/2021	08:00	14.2	35.8	0	235
23/09/2021	08:10	14.2	36	0	235
23/09/2021	08:20	14.1	36.2	0	233
23/09/2021	08:30	14.1	36.3	0	235
23/09/2021	08:40	14.1	36.5	0	235
23/09/2021	08:50	14.2	36.8	0	233
23/09/2021	09:00	14.2	37	0	235
23/09/2021	09:10	14.3	37.2	0	243
23/09/2021	09:20	14.5	37.5	0	242
23/09/2021	09:30	14.9	37.9	0	241
23/09/2021	09:40	15.2	38.5	0	241
23/09/2021	09:50	15.6	39.2	0	241
23/09/2021	10:00	16	40	0	241
23/09/2021	10:10	16.4	41.1	0	241
23/09/2021	10:20	16.8	42.2	0	241
23/09/2021	10:30	17.1	43.5	0	241
23/09/2021	10:40	17.4	44.8	0	241
23/09/2021	10:50	17.8	46.1	0	241

23/09/2021	11:00	17.9	47.3	0	241
23/09/2021	11:10	18.1	48.5	0	241
23/09/2021	11:20	18.3	49.5	0	241
23/09/2021	11:30	18.4	50.5	0	241
23/09/2021	11:40	18.6	51.4	0	240
23/09/2021	11:50	18.7	52.2	0	240
23/09/2021	12:00	18.9	52.9	0	240
23/09/2021	12:10	19	53.5	0	240
23/09/2021	12:20	19.2	54.1	0	239
23/09/2021	12:30	19.5	54.9	0	242
23/09/2021	12:40	19.9	55.7	0	243
23/09/2021	12:50	20.2	56.7	0	242
23/09/2021	13:00	20.7	57.8	0	243
23/09/2021	13:10	21.3	59.2	0	243
23/09/2021	13:20	22	60.8	0	243
23/09/2021	13:30	22.7	62.6	0	243
23/09/2021	13:40	23.3	64.6	0	243
23/09/2021	13:50	23.8	66.6	0	243
23/09/2021	14:00	24.2	68.6	0	243
23/09/2021	14:10	24.6	70.5	0	243
23/09/2021	14:20	25	72.2	0	243
23/09/2021	14:30	25.6	74	0	243
23/09/2021	14:40	26.1	75.8	0	243
23/09/2021	14:50	26.5	77.1	0	243
23/09/2021	15:00	27	78.7	0	243
23/09/2021	15:10	27.4	79.9	0	243
23/09/2021	15:20	27.6	81	0	243
23/09/2021	15:30	27.9	81.7	0	243
23/09/2021	15:40	28.2	72.4	1.7	253
23/09/2021	15:50	28.3	74	1.9	261
23/09/2021	16:00	28.6	71.8	0.6	244
23/09/2021	16:10	19.8	74.2	2.4	236
23/09/2021	16:20	20.1	74.1	1.2	234
23/09/2021	16:30	20.3	73.3	1	266
23/09/2021	16:40	24.5	73.1	0	271
23/09/2021	16:50	26.9	72.9	0	265
23/09/2021	17:00	26.4	72.7	0	275
23/09/2021	17:10	26.8	72.3	0	277
23/09/2021	17:20	26.4	71.8	0	277
23/09/2021	17:30	26.2	70.8	0	277
23/09/2021	17:40	26	69.7	0	277
23/09/2021	17:50	25.8	68.7	0	278

Appendix D - Distances



The dominant source being the grinders was estimated to be operating at a height of 1.3m, 1.5m inside the centre of the garage. The distances from the source to the receiver and the edge of the garage to the receiver have been calculated accounting for the height difference between the source and the receiver at first floor level, assumed to be 4.5m.

Appendix E - Barrier Calculations

Barrier Calculation Source Data

Source to barrier edge (a): 1.5m
 Source to receiver direct (c): 24.52m
 Receiver to barrier edge (b): 23.83m

Broadband LAeq with barrier	
Measured Level	68.4
Reduction	18.9
Mitigated Figure	49.5

Path difference (c-(a+b)): 0.81m

Reduction = $10 \cdot \log(3 + (40 \cdot \text{Path Difference} \cdot \text{Frequency}) / 344)$

Frequency Band (Hz)	Path Difference (m)	Reduction (dB)	Reading (Day)	With Barrier
12.5	0.81	6.2	0.0	0.0
16	0.81	6.5	0.9	0.0
20	0.81	6.9	5.8	0.0
25	0.81	7.3	16.3	9.0
31.5	0.81	7.8	23.1	15.3
40	0.81	8.3	28.3	20.0
50	0.81	8.9	36.6	27.7
63	0.81	9.5	43.7	34.2
80	0.81	10.2	48.0	37.8
100	0.81	10.9	45.3	34.4
125	0.81	11.7	42.4	30.7
160	0.81	12.6	43.0	30.4
200	0.81	13.4	46.3	32.9
250	0.81	14.2	47.6	33.4
315	0.81	15.1	50.3	35.2
400	0.81	16.1	52.9	36.8
500	0.81	17.0	56.8	39.8
630	0.81	17.9	54.1	36.2
800	0.81	18.9	61.6	42.7
1000	0.81	19.9	61.0	41.1
1250	0.81	20.8	60.2	39.4
1600	0.81	21.9	58.7	36.8
2000	0.81	22.8	56.3	33.5
2500	0.81	23.8	53.2	29.4
3150	0.81	24.8	53.5	28.7
4000	0.81	25.8	52.7	26.9
5000	0.81	26.8	50.4	23.6
6300	0.81	27.8	47.0	19.2
8000	0.81	28.8	44.7	15.9
10000	0.81	29.8	42.4	12.6
12500	0.81	30.7	37.4	6.7
16000	0.81	31.8	31.5	0.0
20000	0.81	32.8	23.6	0.0
Broadband LAeq with Barrier	-	-	-	49.5

Appendix F - Calculations

The following equation is used to calculate the on-time correction:

$$L_s = 10 \lg(10^{L_a/10} - 10^{L_r/10}) + 10 \lg(T_o / T_r)$$

L_s is the specific sound level;

L_a is the ambient sound level; and

L_r is the residual sound level.

T_o is the on-time

T_r is the reference time interval

$$\text{Specific Sound Level} = 10 \log(10^{6.84} - 10^{5.89}) + 10 \log(15/60) = 61.9 \text{ dB}_A$$

BS 4142 - Objective Method for Assessing Tonality (One-third Octave method)

BS 4142 presents an objective method for assessing the audibility of tones in sound. For a prominent, discrete tone to be identified as present, the time-averaged sound pressure level in the one-third octave band of interest is required to exceed the time-averaged sound pressure levels of both adjacent one-third octave bands by some constant level difference.

The level differences between adjacent one-third octave bands that identify a tone are:

- 15 dB in low-frequency one-third-octave bands (25 Hz to 125 Hz);
- 8 dB in middle-frequency one-third-octave bands 160 Hz to 400 Hz);
- 5 dB in high-frequency one-third-octave bands (500 Hz to 10 000 Hz).

The following table shows the Z-weighted one-third octave bands of the specific sound. The residual sound level has been subtracted logarithmically from the ambient sound level for each 1/3 octave band.

Frequency Band (Hz)	Specific Sound Level dB
12.5	55.4
16	54.7
20	52.8
25	54.7
31.5	52.7
40	56.3
50	61.0
63	58.5
80	57.8
100	63.5
125	69.0
160	70.2
200	63.3
250	58.5
315	50.5
400	55.5
500	53.2
630	55.6
800	56.8
1000	59.2
1250	54.9
1600	62.1
2000	60.6
2500	59.2
3150	57.2
4000	54.4
5000	51.3
6300	52.0
8000	51.5
10000	49.8
12500	46.8
16000	45.4
20000	44.8
Broadband LAeq :	68.4

The table above shows that the level differences between 1/3octave bands do not identify any tones.

Appendix G - Photographs

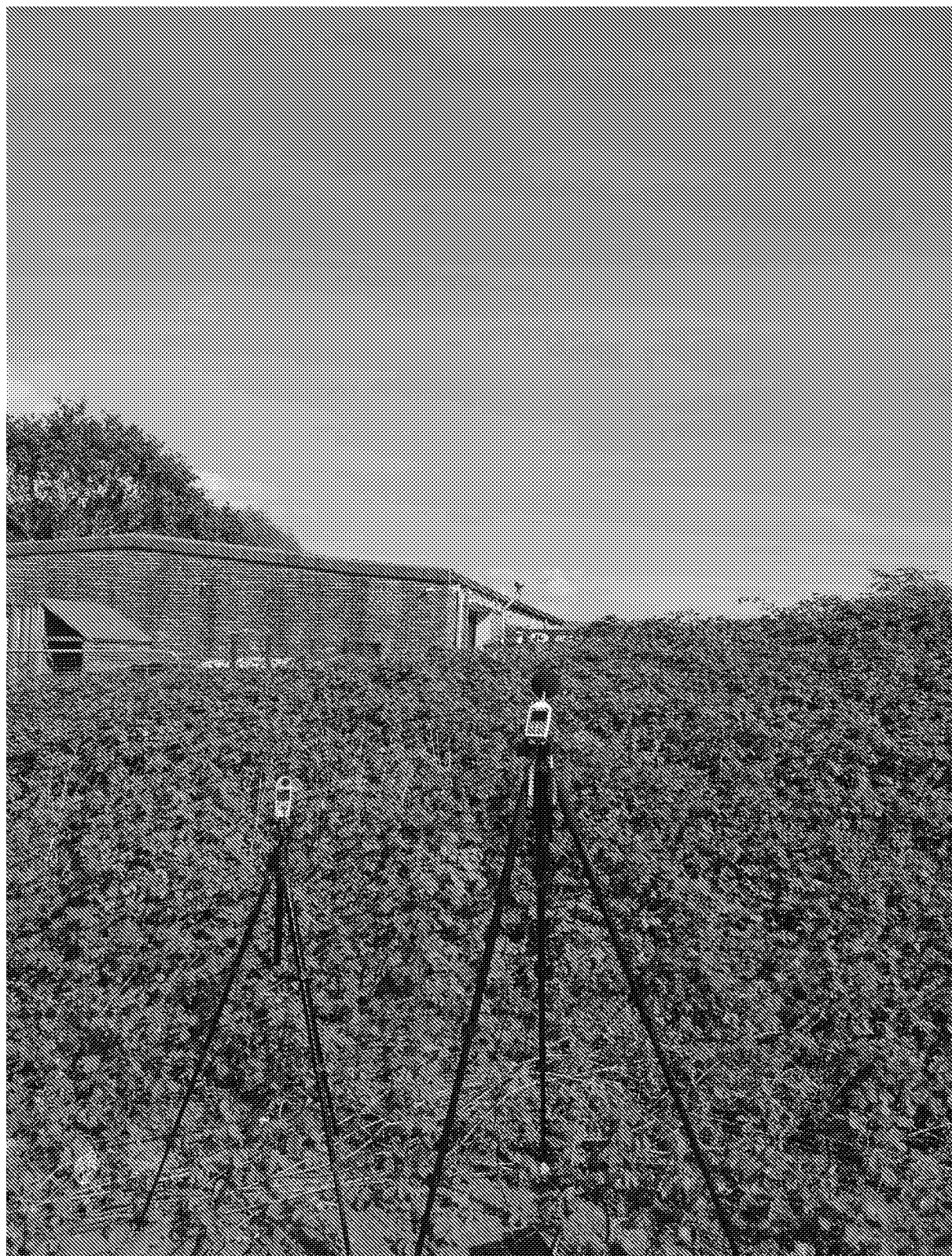
Measurement Position 1



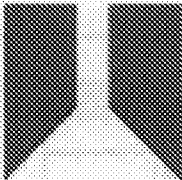
Measurement Position 2



Measurement Position 3



Appendix H - Instrument Calibration Certificates

CERTIFICATE OF CALIBRATION		
ISSUED BY	Cirrus Research plc	
DATE OF ISSUE	19 August 2021	CERTIFICATE NUMBER 161680
 Cirrus Research plc Acoustic House Bridlington Road Hunmanby North Yorkshire YO14 0PH United Kingdom		Page 1 of 2 Approved signatory M McDonald Electronically signed
Sound Level Meter : IEC 61672-3:2013		
Instrument information		
Manufacturer:	Cirrus Research plc	
Model:	CR 171B	
Serial number:	G383163	
Class:	1	
Firmware version:	5.6.3177	
Test summary		
The calibration was performed respecting the requirements of ISO/IEC 17025:2017 Periodic tests were performed in accordance with procedures from IEC 61672-3:2013. The sound level meter submitted for testing successfully completed the class 1 periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to determine that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.		
Notes		
This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%.		

CERTIFICATE OF CALIBRATION

Certificate Number:

161688

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test

Before Pressure: 99.90 kPa Temperature: 21.9 °C Humidity: 38.7 %
After Pressure: 99.97 kPa Temperature: 22.0 °C Humidity: 42.1 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTI	TGA1241	459193
Attenuator	Cirrus Research	ZE 952	80381
Environmental Monitor	Comet	T7810	17983955

Additional instrument information

Instruction manual:

Reference level range: Single range

Pattern approval: No

Source of pattern approval:

Preamplifier

Model: MV250F

Serial number: 11542F

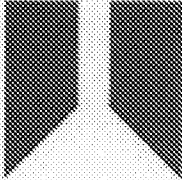
Microphone

Model: MK224

Serial number: 214523A

Test results summary

Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
High level stability	Complies
Long-term stability	Complies

CERTIFICATE OF CALIBRATION		
ISSUED BY	Cirrus Research plc	
DATE OF ISSUE	19/08/21	CERTIFICATE NUMBER 181682
		
Cirrus Research plc Acoustic House Bridlington Road Hunmanby North Yorkshire YO14 0PH United Kingdom		
Page 1 of 2		Test engineer: D. Swainwell
		
Microphone		
Microphone capsule		
Manufacturer:	Cirrus Research plc	
Model:	MK224	
Serial Number:	214523A	
Calibration procedure		
Open circuit:	50.1 mV/Pa	
Sensitivity at 1 kHz:	-26.0 dB re 1 V/Pa	
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 a National Measurement Institute.		
The absolute sensitivity at 1 kHz was measured using an acoustic calibrator conforming to IEC 60942:2003 Class 1.		
Environmental conditions		
Pressure:	99.60 kPa	
Temperature:	20.0 °C	
Humidity:	31.0 %	

CERTIFICATE OF CALIBRATION

Certificate Number:

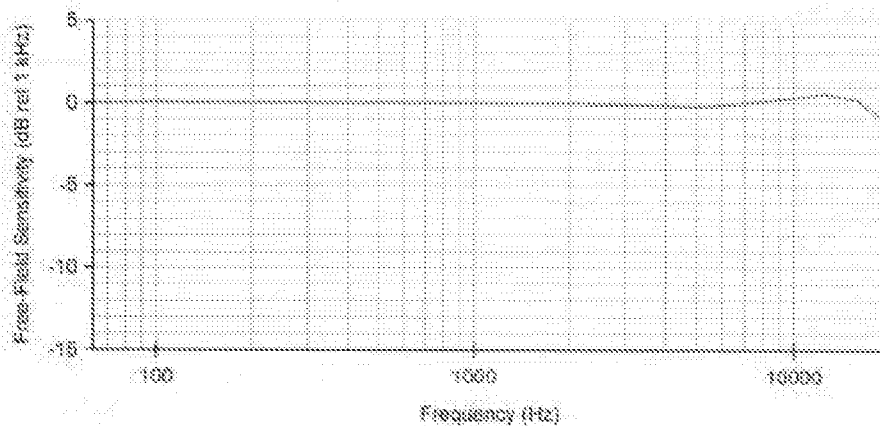
161682

Page 2 of 2

Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
63	0.05	-0.11
80	0.05	-0.01
100	0.09	0.12
125	0.06	0.09
160	0.05	0.11
200	0.04	0.11
250	0.05	0.13
315	0.04	0.09
400	0.02	0.09
500	0.04	0.10
630	0.03	0.08
800	0.01	0.06
1 000	0.00	0.03
1 250	-0.02	-0.03
1 600	-0.03	-0.10
2 000	-0.02	-0.20
2 500	-0.06	-0.36
3 150	-0.13	-0.57
4 000	-0.16	-1.05
5 000	-0.19	-1.55
6 300	-0.11	-2.19
8 000	0.14	-3.03
10 000	0.33	-4.33
12 500	0.56	-5.54
16 000	0.21	-7.58
20 000	-1.38	-10.39

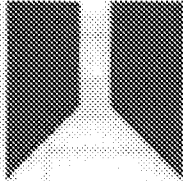
Free-Field Frequency Response : Graphical



~~SECRET~~ ~~CONFIDENTIAL~~

DATE OF ISSUE 10 August 1993

CORPAC DE NUMBER 181879



Cirrus Research plc
Acoustic House
Bridlington Road
Hunnamby
North Yorkshire
YO14 3PH
United Kingdom

11/20/2011 11:23

Abstract

SECRET

1. Introduction

Instrument Information

Manufacture: _____ Date Received: _____

~~SECRET~~

~~CONFIDENTIAL~~ CA 1715

~~SECRET~~ ~~CONFIDENTIAL~~

11

Forming version: 84.117

XXXXXXXXXXXXXXXXXXXX

The calibration was performed respecting the requirements of ISO/IEC 17025:2017

Parabolic tests were performed in accordance with procedures from AEC 6-1672-3 2013

The sound level meter submitted for testing successfully completed the class 1 periodic tests of NIOSH 33813, for the environmental conditions under which the tests were performed.

However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 because (a) evidence was not publicly available, from an independent testing organisation responsible for pattern approvals, to determine that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual; and (b) because the periodic tests of IEC 61672-1:2013 cover only a limited subset of the specifications in IEC 61672-1:2013.

1998

This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realized at the National Physical Laboratory or other recognized national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items outlined. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%.

CERTIFICATE OF CALIBRATION

Certificate Number

161679

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test:

Before Pressure: 99.97 kPa Temperature: 22.0 °C Humidity: 43 %
 After Pressure: 99.91 kPa Temperature: 22.2 °C Humidity: 43 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Signal Generator	TTI	TGA1241	439193
Attenuator	Cirrus Research	ZE 952	80381
Environmental Monitor	Comet	T7510	17963955

Additional instrument information

Instruction manual

Reference level range: Single range

Pattern approval: No

Source of pattern approval: -

Preamplifier

Model: MV 200F

Serial number: 11733F

Microphone

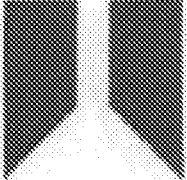
Model: MK224

Serial number: 214535A

Test results summary

Test	Result
Toneburst response	Complies
Electrical noise-floor	Complies
Linearity	Complies
Electrical Frequency weightings	Complies
Frequency and time weightings at 1 kHz	Complies
C-weighted peak	Complies
Overload indication	Complies
High level stability	Complies
Long-term stability	Complies

CERTIFICATE OF CALIBRATION		
ISSUED BY	Cirrus Research plc	
DATE OF ISSUE	19/08/21	CERTIFICATE NUMBER 101001

	Cirrus Research plc Acoustic House Bridlington Road Hunmanby North Yorkshire YO14 0PH United Kingdom	
	Page 1 of 2	
	Test engineer: G. Swales Electronically signed: 	

Microphone

Microphone capsule

Manufacturer: Cirrus Research plc

Model: MK 224

Serial Number: 214535A

Calibration procedure

Open circuit: 45.9 mV/Pa

Sensitivity at 1 kHz: -26.8 dB rel 1 V/Pa

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 responses derived via standard correction data traceable to a National Measurement Institute.

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

Environmental conditions

Pressure: 99.60 kPa

Temperature: 20.0 °C

Humidity: 31.0 %

CERTIFICATE OF CALIBRATION

Certificate Number

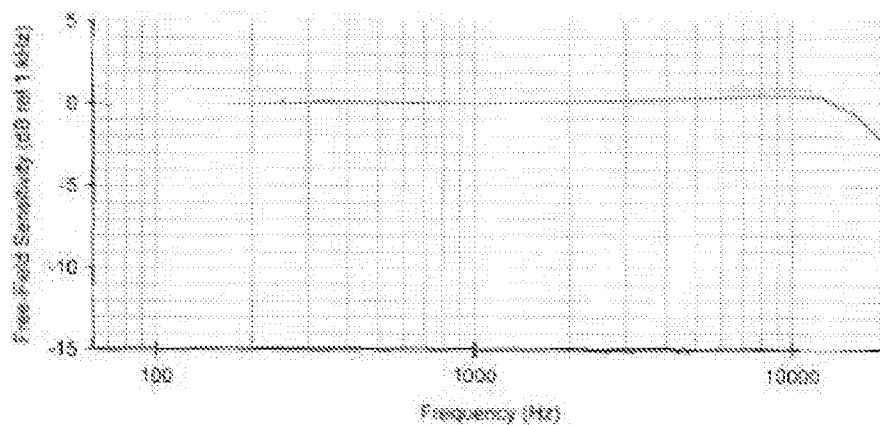
161681

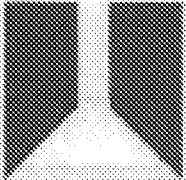
Page 2 of 2

Free-Field Frequency Response : Tabular

Frequency (Hz)	Free-Field Sensitivity (dB rel 1 kHz)	Actuator Response (dB)
53	0.01	-0.19
90	0.02	-0.07
100	0.00	-0.08
125	0.03	0.02
180	0.00	0.04
200	0.02	0.05
250	0.03	0.06
315	0.01	0.01
400	0.01	0.03
500	0.01	0.02
630	0.01	0.02
800	0.02	0.01
1000	0.00	-0.02
1250	0.01	-0.04
1600	0.03	-0.08
2000	0.06	-0.15
2500	0.09	-0.25
3150	0.14	-0.43
4000	0.19	-0.70
5000	0.26	-1.09
6300	0.36	-1.71
8000	0.46	-2.70
10000	0.57	-4.25
12500	0.52	-6.19
16000	-0.75	-8.70
20000	-2.59	-11.71

Free-Field Frequency Response : Graphical



CERTIFICATE OF CALIBRATION	
ISSUED BY: Cirrus Research plc	
DATE OF ISSUE: 19 August 2021	CERTIFICATE NUMBER: 101677
 Cirrus Research plc Acoustic House Bridlington Road Hunmanby North Yorkshire YO14 6PH United Kingdom	Page 1 of 2 Approved signatory: M. McDonald Electronically signed:
Sound Calibrator : IEC 60942:2003	
Instrument information	
Manufacturer: Cirrus Research plc	Notes:
Model: CR 515	
Serial number: 86658	
Class: 1	
Test summary	
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 IEC60942_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 V552F 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. The manufacturer's product information indicates that this model of sound calibrator has been formally pattern approved to IEC60942_2003 Annex A to Class 1. This has been confirmed with the Physikalisch-Technische Bundesanstalt (PTB), Laboratoire National d'Essais (LNE) and APPLUS.	
Notes:	
This certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory. The results within this certificate relate only to the items calibrated. The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%.	

CERTIFICATE OF CALIBRATION

Certificate Number

161677

Page 2 of 2

Environmental conditions

The following conditions were recorded at the time of the test:

Pressure: 102.00 kPa

Temperature: 23.0 °C

Humidity: 38.2 %

Test equipment

Equipment	Manufacturer	Model	Serial number
Acoustic Calibrator	Brüel and Kjær	4231	1790641
Distortion Meter	Kethley	2015	1175401
Multimeter	Fuke	8845A	9440017

Results

	Expected	Sample 1	Sample 2	Sample 3	Average	Deviation	Tolerance	Uncertainty
Level (dB)	94.00	94.00	94.00	93.99	94.00	0.00	±0.40	0.11 dB
Distortion (%)	< 3.00	1.26	1.34	1.34	1.31	1.31	+3.00	0.13 %
Frequency (Hz)	1000.0	1000.0	1000.0	1000.0	1000.0	0.0	±10.0	0.1 Hz

The measured quantities or deviations (as applicable), extended by the expanded combined uncertainty of measurement, must not exceed the corresponding tolerance.

End of results