Anderson Acoustics

PLANNING NOISE AND VIBRATION ASSESSMENT

LAND ADJACENT TO GLYNDE STATION

LF ARCHITECTURE LTD

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Anderson Acoustics

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CONTENTS

1 INTRODUCTION

Anderson Acoustics Ltd has been commissioned by LF Architecture Ltd in March 2022 to undertake a noise and vibration assessment for the proposed residential development at Land Adjacent to Glynde Station, Glynde, to be used in support of a planning application. The project involves the construction of a new-build dwelling, with car parking and outdoor landscaped areas.

This report presents the results of our environmental noise and vibration surveys and provides guidance on appropriate façade elements to ensure that an acceptable internal noise environment is capable of being achieved, as well as an assessment of impact due to vibration from nearby train lines. The report also presents a noise assessment of the proposed external amenity areas, based on the measured levels on site; and measures taken to control noise from any proposed plant to nearby residences and to the proposed development itself.

Environmental noise and vibration criteria relevant to the assessment have been presented and discussed in Section 2 of this report.

A brief description of the site and proposed development is given in Section 3.

The methodology and results of an environmental noise and vibration survey undertaken at the site are given in Section 4.

Section 5 details the commercial noise assessment.

Section 6 details the ProPG Stage 1 assessment, which in turn leads to Section 7 where the ProPG Stage 2 - Acoustic Design Statement is outlined.

Section 8 provides the vibration impact assessment of the nearby railway on the development proposals.

The report is concluded in Section 9.

2 ASSESSMENT POLICY AND CRITERIA

2.1 Noise Criteria

2.1.1 Planning Noise Advice Document: Sussex

The Planning Noise Advice Document: Sussex [1] states that *"Noise assessment shall be required for some permitted development notifications, for certain change of use classes… … Although, not always a legal requirement of permitted development, it is advised that all potentially disturbing noise sources are assessed so that they do not adversely impact on the proposed use"*.

Section 6 of the document details the methodology for assessing noise at New Noise Sensitive Developments, alongside design criteria in relation to Noise Sensitive Development and New Noise Sensitive Development Near to Existing Industrial/Commercial Noise Sources. Paragraphs considered pertinent to this assessment have been reproduced below.

> 6.4.2 – Development affected by transportation noise sources shall use the recommended acoustic approach set out in ProPG: Planning and Noise – Professional Practice Guidance on Planning and Noise- New Residential Development 2017.
>
> 6.5.2 – Design control measures should aim to meet the recommended standards set out in Table 4 of BS 8233:2014 and regular night-time noise events such as scheduled aircraft or passing trains which can cause sleep disturbance shall be minimized and assessed as (LAFmax), as recommended in the WHO's Night Noise Guidelines for Europe (2009), unless there are particular reasons why this is not considered appropriate. In such cases, a clear explanation of the reasons should be provided.
>
> 6.5.3 – As the standards for BS 8233:2014 and the W.H.O relate only to anonymous noise, eg distant road traffic and noise without characteristics such as impulsivity, low frequency content or tones then, if these are present, additional discussion will be required with the LPA for the purpose of establishing suitable assessment techniques and standards to be achieved e.g. BS 4142:2014+A1:2019 for delivery noise.
>
> 6.5.4 – While noise mitigation can be used to achieve suitable internal sound levels, preference is to be given to criteria based on windows being partially open.
>
> 6.5.5 – Where the property is at risk of overheating, an overheating assessment shall be conducted in accordance with Acoustics Ventilation and Overheating (AVO) Residential Design Guide (January 2020) and CIBSE's Design Methodology for the Assessment of Overheating Risk in Homes (TM59:2017).
>
> 6.6.1 – Careful consideration will need to be given to proposals that are likely to site new noise sensitive developments near to existing industrial, commercial, entertainment premises, airfields, airports and sea ports.
>
> 6.6.4 – Where it is apparent to the LPA that existing noise from an existing industrial, commercial, entertainment premises, places of worship, sports clubs, airfields, airports and sea ports is likely to cause unreasonable or adverse effects to new residents, the development is unlikely to be supported unless the applicant (or 'agent of change') provides clear evidence that adequate noise attenuation to the existing noise sources can and will be provided. The applicant (or 'agent of change') will be required to provide a detailed noise mitigation plan with their acoustic assessment.
>
> 6.6.5 – In some circumstances, legal agreements can be entered into, whereby the developers provide the necessary measures to attenuate the existing noise through appropriate techniques including re-engineering the source to reduce emissions, adequate acoustic enclosure/sound proofing or re-locating the noise source.

2.1.2 ProPG: Planning & Noise

ProPG (Professional Practice Guidance: Planning and Noise) [2] was jointly developed by the Institute of Acoustics (IOA), the Association of Noise Consultants (ANC) and the Chartered Institute of Environmental Health (CIEH) to guide Local Planning Authorities (LPA's) and Practitioners in assessing the suitability for residential development on sites predominantly exposed to airborne transport noise.

ProPG introduced a sequential 2-stage approach allowing for early consideration of noise issues at Stage 1 followed by more detailed consideration of noise issues at Stage 2, should this be identified as necessary in Stage 1.

Stage 1 introduces the concept of noise risk categories ranging from Negligible Risk to High Risk to help LPAs in making accelerated straightforward decisions for low risk sites and to provide guidance for more detailed consideration associated with challenging higher risk sites.

Following the outcome of Stage 1, Stage 2 then applies to sites assessed as low to high risk. This stage should not be necessary for sites assessed as negligible risk.

Stage 2 requires consideration be given to four key elements:

Element 1: Good Acoustic Design Process

Element 2: Internal Noise Level Guidelines

Element 3: External Amenity Area Noise Assessment

Element 4: Other Relevant Issues

Further details on these elements are discussed in the acoustic design section of this report.

Table 2-1 provides a summary of ProPG's noise risk categories and their associated fee-field noise levels, along with the assessment implications. It should be noted that ProPG does not consider the impacts of ground-borne noise and vibration.

Table 2-1: Stage 1 - Initial Site Noise Risk Assessment

Risk Category	Indicative Daytime Noise Levels $L_{Aeq,16hr}$	Indicative Night-time Noise Levels $L_{Aeq,8hr}$	Pre-Planning Application Advice
Negligible Risk	< 50 dB	< 40 dB	Indication that the development site is likely to be acceptable from a noise perspective and application need not normally be delayed on noise grounds.
Low Risk	50 - 60 dB	40 - 50 dB	Indication that the development site is likely to be acceptable provided a good acoustic design process is followed and is confirmed in a detailed Acoustic Design Statement confirming how noise will be mitigated.
Medium Risk	60 - 70 dB	50 - 60 dB	
High Risk	> 70 dB	> 60 dB	Indication that the development site may be refused on noise grounds unless a good acoustic design process and detailed Acoustic Design statement can demonstrate the significant noise risk can be mitigated.

Note
1. Noise levels should be assessed without inclusion of the acoustic effect of any scheme specific noise mitigation measures.
2. Noise levels are the combined free-field noise level from all sources of transport noise and may also include industrial/commercial noise where this is present, but not dominant.
3. LAeq,16hr is for daytime 07:00-23:00, LAeq,8hr is for night-time 23:00 to 07:00.
4. An indication that there may be more than ten noise events at night (23:00-07:00) with LAmax,F > 60 dB means the site should not be regarded as negligible risk.

2.1.3 British Standard 8233

British Standard BS 8233:2014: Sound insulation and noise reduction for buildings – Code of practice [3] provides guideline values for internal noise levels within a number of building types including residential dwellings.

In general, for steady external noise sources, it is desirable that the internal ambient noise level does not exceed the guideline values in Table 2-2:

Table 2-2: British Standard 8233 Indoor Noise Levels

Activity	Location	Daytime	Night-time
Resting	Living room	35 dB $L_{Aeq, 16hour}$	-
Dining	Dining room/area	40 dB $L_{Aeq, 16hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq, 16hour}$	30 dB $L_{Aeq, 8hour}$

Note
Daytime assessment period – 07:00 to 23:00 hrs
Night-time assessment period – 23:00 to 07:00 hrs

In respect of external noise levels, the guidance in BS 8233:2014 suggests that "it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments". BS 8233:2014 however acknowledges that "these guideline values are not achievable in all circumstances where development might be desirable", and that "…a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces but should not be prohibited".

In respect of balconies, roof gardens and terraces, BS 8233:2014 states that "In these locations, specification of noise limits is not necessarily appropriate. Small balconies may be included for uses such as drying, washing or growing pot plants, and noise limits should not be necessary for these uses; however, the general guidance on noise in amenity space is still appropriate for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation. In high-noise areas, consideration should be given to protecting these areas by screening or building design to achieve the lowest practicable levels. Achieving levels of 55 dB $L_{Aeq,T}$ or less might not be possible at the outer edge of these areas but should be achievable in some areas of the space".

BS 8233:2014 suggests that proposed development within noisy environments should be designed to ensure that the recommended internal design standards are achieved, and that noise levels in external amenity areas are designed to effectively control and reduce noise levels; although it acknowledges that in certain circumstances meeting the external design recommendations may not be feasible, or necessary, especially where the provision of such spaces is desirable for other technical, planning or policy reasons.

2.1.4 World Health Organisation Guidelines

The following guideline values for community ambient noise levels in specific environments are presented in the World Health Organization (WHO) Guidelines for Community Noise [4].

Table 2-3: WHO Guideline Noise Values

Specific Environment	Critical Health Effect(s)	Time Base hours	$L_{Aeq,T}$ (dB)	$L_{Amax,F}$ (dB)
Dwelling indoors	Speech intelligibility and moderate annoyance, daytime and evening	16	35	-

Specific Environment	Critical Health Effect(s)	Time Base hours	$L_{Aeq,T}$ (dB)	$L_{Amax,F}$ (dB)
Inside bedrooms	Sleep disturbance, night-time	8	30	45

The 45 dB $L_{AF,Max}$ criterion applies to "single sound events" within bedrooms at night. This guideline is generally interpreted as the value that individual noise events should not normally exceed. WHO states that for a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10–15 times per night.

2.1.5 WHO Noise Guidelines for Europe

To ensure compliance with Planning Noise Advice Document: Sussex, night-time max levels should not exceed the L_{Amax} level recommended in WHO Night Noise Guidelines for Europe [5]. The document states "42 dB(A) is proposed as the currently best estimate of the threshold for conscious awakening by transportation noise. This would mean that the no observed effect level (NOEL L_{Amax}) for transportation noise events is at most 42 dB(A). The most sensitive instantaneous effect that has been studied extensively in field studies is motility. A single interval with (onset of) noise-induced motility by itself cannot be considered to be adverse".

2.1.6 British Standard 4142

BS 4142:2014+A1:2019 [6] provides methods for rating and assessing sound/noise of an industrial or commercial nature in relation to residential premises, hence its relevance here. The assessment methodology evaluates the "specific sound level" of each industrial or commercial sound source, corrects for distinguishable features to derive the "rating level", and compares this with the "background sound level".

The advice is that the background sound level ($L_{AF90,T}$) should be derived from continuous measurement of normally not less than 15 minute intervals over the period of interest, and that it should not be the lowest level, but representative of typical conditions at the noise-sensitive receiver(s) relevant to the periods of operation.

The specific sound level ($L_{Aeq,T}$) is obtained (by measurement or calculation) over a reference period of 1 hour in terms of the daytime (07:00 to 23:00) and 15 minutes during the night-time (23:00 to 07:00).
The rating level ($L_{Ar,Tr}$) is the specific sound level corrected to account for any acoustic features present in the sound in question, as experienced at the receptor, such as distinguishable, discrete, continuous note (a whine, hiss, screech or hum etc.) or distinct impulses (bangs, clatters or thumps etc.). Where no correction is warranted, the rating level is equal to the specific level.

The "subjective method" to calculate the rating level incorporates the following corrections (particularly appropriate for new sources that cannot be measured in-situ):

- Up to +6 dB due to tonality, subjectively this might be +2 for a tone that is just perceptible, +4 where it is clearly perceptible and +6 where it is highly perceptible.
- Up to+9 dB for impulsivity, subjectively this might be +3 for impulsivity that is just perceptible, +6 where it is clearly perceptible and +9 where it is highly perceptible; and
- Up to +3 dB for other acoustic features that are neither tonal nor impulsive, though readily distinctive at the receptor.

An "initial estimate" of the impact of the specific sound is calculated by subtracting the measured background sound level from the rating level. The following advice applies:

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 source having a low impact, depending on the context.

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.

Where the initial estimate of the impact needs to be modified due to the context, the assessment should take into account all pertinent factors, including:

- the absolute level of sound;
- the character and level of the residual sound compared to the character and level of the specific sound; and
- the sensitivity of the receptor and whether dwellings will already incorporate design measures that secure good internal and/or outdoor acoustic conditions.

Helpfully, BS 4142 includes some example assessments. In one example, it is concluded that:

> "Although the plant noise is somewhat different in character to the residual acoustic environment the rating level of 30 dB is low and will have little impact on residents using their patio during the evening."

Under similar conditions it is stated:

> "In addition to the rating/background sound level comparison…" where "the primary concern is the potential for disturbance of residents who could be sleeping with open bedroom windows… Other guidance, such as BS 8233, might also be applicable in this instance."

Another example concludes that:

> "…the residual acoustic environment varies considerably with time, which also tends to mask sound from the source, reducing its relative significance…"

An assessment, therefore, is effectively split into two parts. The first part results in an initial indication of the impact, which is subsequently considered in terms of the context unique to the situation at hand; and where this second part may require consideration of alternative guidance and metrics. Alternatively, the context can be considered upfront and a specific threshold (or set of thresholds) determined accordingly in place of the default values presented in points a) to d) quoted above.

2.2 Vibration guidance

2.2.1 British Standard 6472

British Standard BS 6472: 2008: Guide to evaluation of human exposure to vibration in buildings [7] provides guidance on the Vibration Dose Values (VDV) above which various degrees of adverse comment may be expected in residential buildings. Consideration is given to the time of day and use made of occupied space in buildings, see Table 2-4 below.

Table 2-4: Vibration dose value ranges and probabilities of adverse comment within residential buildings

Place and time	Low probability of adverse comment ($m/s^{-1.75}$)	Adverse comment possible ($m/s^{-1.75}$)	Adverse comment probable ($m/s^{-1.75}$)
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

2.2.2 ANC – Measurement of Assessment of Ground borne Noise & Vibration

Ground borne noise occurs when levels of ground borne vibration give rise to vibration of building surfaces, that in turn cause an audible rumbling sound in the frequency range from 25 Hz to 250 Hz by radiation to the air inside room.

Currently there are no British or international standards on ground borne noise. The Association of Noise Consultants' (ANC) Measurement & Assessment of Ground Noise & Vibration Guidelines (red book) [8] is considered by Anderson Acoustics to provide the most relevant criteria.

The ANC guidance document provides design targets for ground borne noise due to vibration sources for different types of buildings. Some relevant and comparative target levels are reproduced in Table 2-5.

Table 2-5: Guidance on target maximum levels of ground borne noise in various building types

Building	Level, $L_{Amax,S}$
Residential	35 – 40 dB
Hotels	40 dB
Offices	40 dB
Large auditoria, concert halls	25 dB

3 SITE DESCRIPTION

3.1 Existing Site

The site is situated approximately 50 – 60 m west of Glynde train station which is just off Lacys Hill, Glynde, East Sussex. The site is currently undeveloped land. The proposed development is located approximately 10 m west of an existing workshop operated by Spiral Staircase Systems, a company that specialises in manufacturing staircases. Rail tracks are located approximately 7 m to the south of the proposed development. Glynde substation is located approximately 70 m to the west of the proposed development.

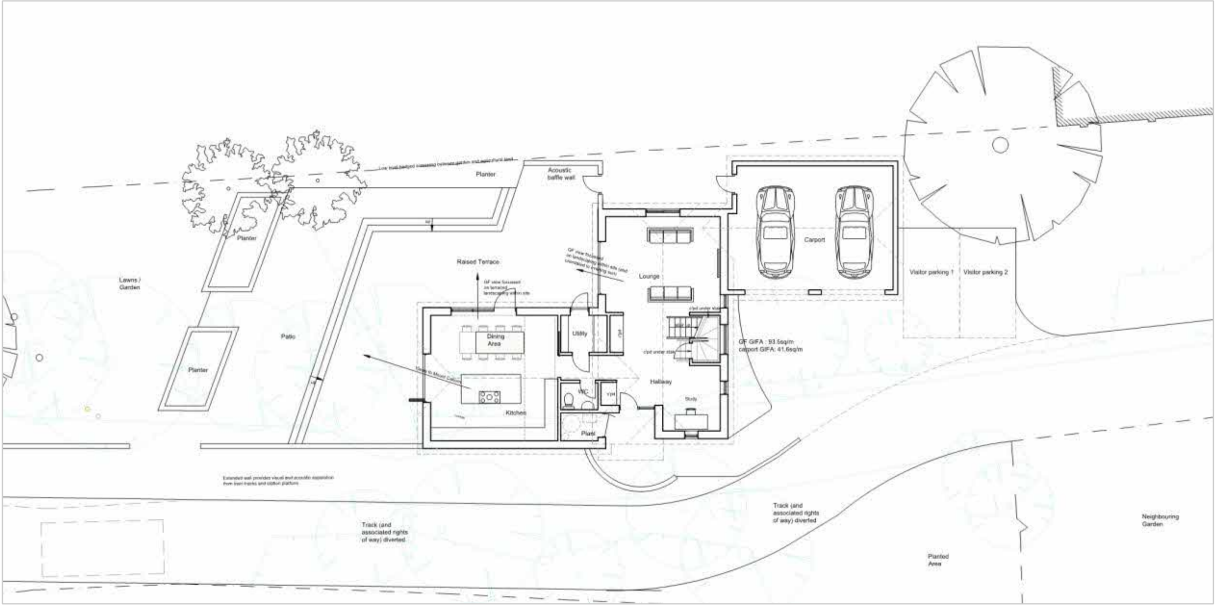
An aerial view of the site location is shown in Figure 3-1, which highlights the proposed site boundary (red) and adjacencies.

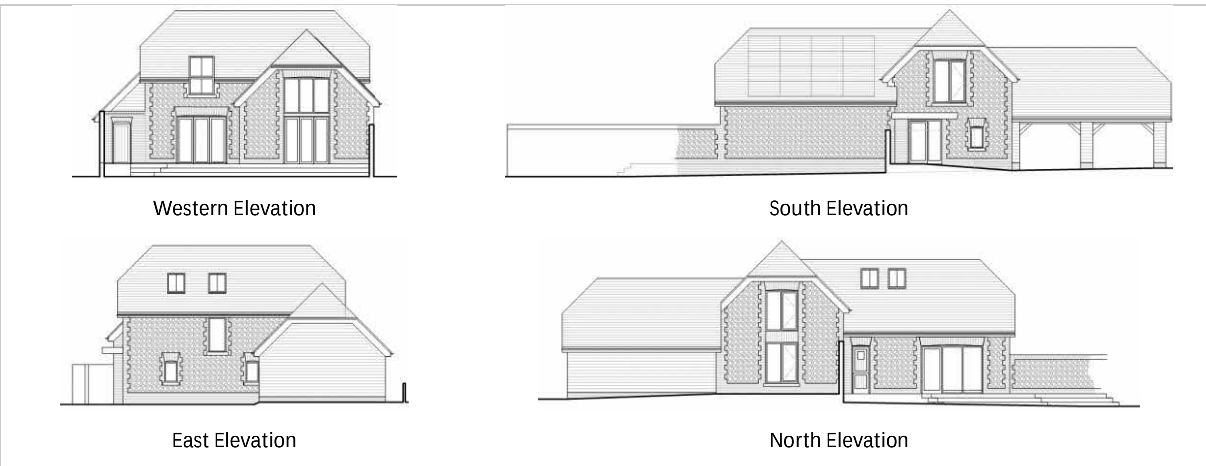
Figure 3-1: Site Location and Boundary

3.2 Proposed Site

The project involves the construction of a 2-storey new build dwelling, with car parking and outdoor landscaped areas. Figure 3-2 shows a site plan and elevations of the proposed development.

Figure 3-2: Site plans and elevations of the proposed development. © LF Architecture Ltd





4 NOISE AND VIBRATION LEVELS ON SITE

The prevailing noise and vibration conditions in the area have been determined by detailed environmental noise and vibration surveys, comprising a mix of attended and unattended measurements (please see Appendix B for further details). The long-term survey was undertaken over a 7-day period at one measurement location, between Tuesday 8th and Wednesday 16th October 2019, in order to determine the environmental noise conditions in the area. Measurements were taken at a height of 1.5 m and under free-field conditions at approximately 12 m from the nearest rail line.

The sound environment of the proposed site is predominantly governed by railway traffic noise and commercial noise from the adjacent Spiral Staircase premises, which are understood to be operational between 09:00 to 17:00 Monday to Friday. Noise levels from nearby roads are considerably lower than those from the railway. During the attended noise monitoring exercise, few cars were noted to pass the measurement position during each 5-minute period.

4.1 Instrumentation

All noise and vibration measurements were undertaken by a consultant certified as competent in environmental monitoring. All acoustic measurement equipment used during the noise survey conformed to Type 1 specification of British Standard 61672 [9]. A full inventory of this equipment is shown in Table 4-1 below. All equipment's calibration certificates are available on request.

Table 4-1: Inventory of Measurement Equipment

Measurement type	Item	Make and Model	Serial Number	Calibration	
				Certificate number	Expiry Date
Noise (Unattended)	Sound Level Meter	Rion NL-52	00610202	UCRT19/1036	10/01/2021
	Preamplifier	NH-25	10611		
	Microphone	UC-59	06171		
Noise (Attended)	Sound Level Meter	Rion NL-52	00620960	UCRT19/1868	05/08/2020
	Preamplifier	NH-25	21001		
	Microphone	UC-59	03878		
Noise	Calibrator	Rion NC-74	35015349	UCRT19/1215	18/02/2020
Vibration	Accelerometer	Wilcoxon Research 731A seismic accelerometer	4453 4486	189914 189913	11/07/2020
	4 channel Analyser	01 dB dB4	00663016	189912	22/07/2020
	Recording software	01 dB dBFA	-	-	-

The noise measurement equipment used during the survey was calibrated at the start and end of each measurement. The calibrator used had itself been calibrated by a UKAS accredited calibration laboratory within the twelve months preceding the measurements. No significant drift in calibration was found to have occurred.

4.2 Weather Conditions

During the surveys undertaken in October 2019, weather conditions were dry with light to moderate winds whilst setting up unattended equipment on 8th October 2019. Weather conditions were noted to be wet with light winds during collection on 16th October 2019. The weather conditions were considered acceptable for noise and vibration measurements. Any periods of adverse weather have been noted.

4.3 Noise Survey Results

4.3.1 Unattended noise survey

Unattended noise measurements were undertaken to the front (south) of the site, overlooking the railway. The location was chosen in order to understand the variation of sound levels throughout typical day and night periods. Third octave band measurements were undertaken in order to obtain the frequency content of the noise impacting on the proposed development, needed to determine the sound insulation performance requirements of the building envelope.

A summary of the daytime $L_{Aeq,16hr}$ and night-time $L_{Aeq,8hr}$ ambient noise levels measured is presented below in Table 4-2, along with the typical $L_{Amax,F}$ and L_{A90} levels. An evening period has also been presented to provide detail during periods where the nearby commercial premises were not in operation. Full time history results are shown in Appendix B.

Table 4-2: Summary results of unattended noise survey (free-field)

Date	Period	Ambient Noise Level $L_{Aeq,T}$, dB	Maximum Night-time Noise Level $L_{Amax,F}$ dB (Top 10 excluded)	Typical Background Noise Level $L_{A90,15min}$ dB
Tuesday 08/10/2019	Daytime (15:45-23:00)	56	78	48
	Evening (18:00-22:00)	56		48
	Night-time (23:00-07:00)	52		36
Wednesday 09/10/2019	Daytime (07:00-23:00)	62	79	63 [1]
	Evening (18:00-22:00)	57		41
	Night-time (23:00-07:00)	54		30
Thursday 10/10/2019	Daytime (07:00-23:00)	62	79	48
	Evening (18:00-22:00)	57		46
	Night-time (23:00-07:00)	53		45
Friday 11/10/2019	Daytime (07:00-23:00)	61	79	51
	Evening (18:00-22:00)	57		49
	Night-time (23:00-07:00)	51		32
Saturday 12/10/2019	Daytime (07:00-23:00)	57	67 [2]	37
	Night-time (23:00-07:00)	49		42
Sunday 13/10/2019	Daytime (07:00-23:00)	56	78	48
	Night-time (23:00-07:00)	53		22
Monday 14/10/2019	Daytime (07:00-21:40)	63	79	66 [1]
	Evening (18:00-22:00)	57		42
	Night-time (23:00-07:00)	52		31
Full Survey Summary	Daytime	61	79	47
	Evening	57		48
	Night-time	53		22

Note
[1] The modal background noise level ($L_{A90,15min}$) has been significantly influenced by external plant noise during this period. The modal $L_{A90,15min}$ is higher than the equivalent $L_{Aeq,16hr}$ due to the existing plant found to be running during core hours of the daytime period.
[2] Further analysis of results indicates that train activity was reduced during this period.

The following L_{Amax} levels have been used as a typical value at which no more than 10 night-time exceedances are likely to occur, in line with guidance detailed within ProPG.

Table 4-3: Summary results of the south position $L_{Amax,F}$ Noise Levels

$L_{Amax,F}$	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
79	81	77	76	77	74	74	67

To undertake an assessment of the nearby commercial noise generated by Spiral Staircase, the daytime background sound level has been determined. Figure 4-1 indicates the typical $L_{A90,5min}$ background sound level during the daytime period and during periods that were not inclusive of plant noise from the nearby Spiral Staircase extract system, as detailed in RED. The influence of the existing plant has been determined through analysis of audio clips and has been indicated in ORANGE. Figure 4-2 details the typical $L_{A90,5min}$ background sound level during the evening period, this further supports the identified typical daytime background sound level.

Figure 4-1: Typical Daytime Background Sound Level Count

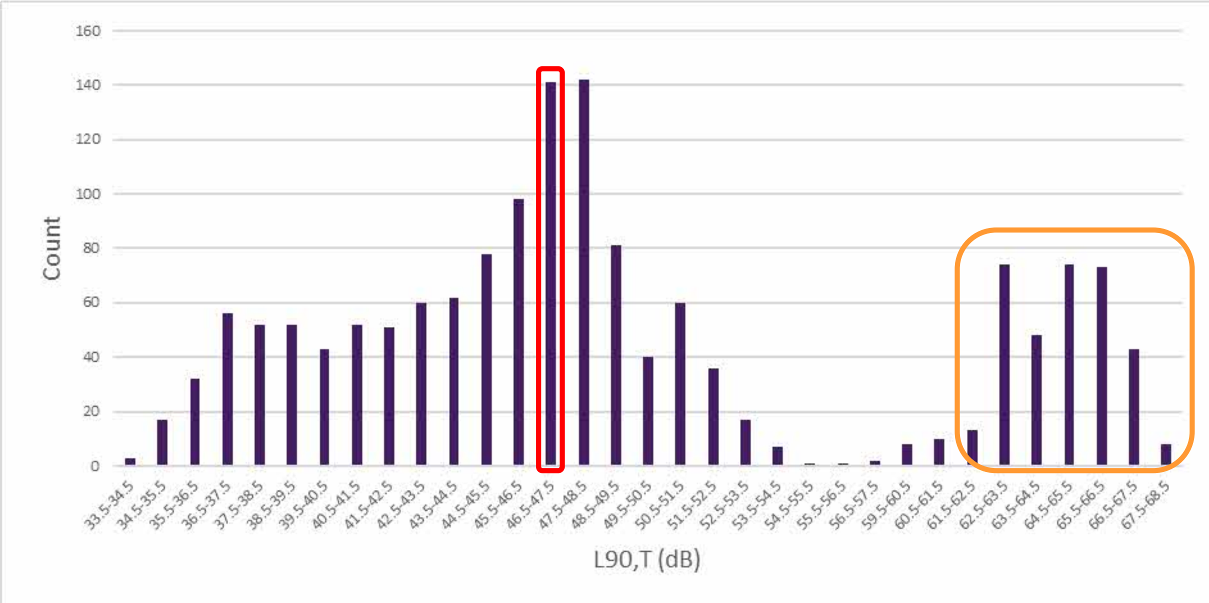
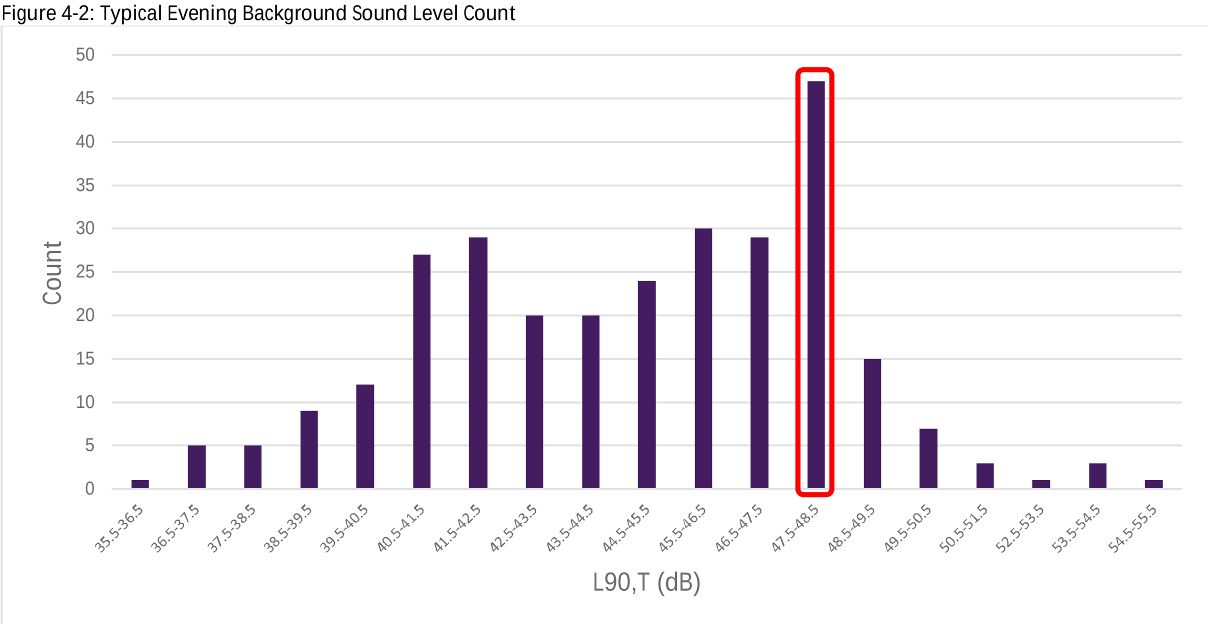


Figure 4-2: Typical Evening Background Sound Level Count



4.3.2 Attended noise survey

Attended noise measurements were undertaken to understand the typical sound levels at various positions across the site through typical day periods.

Noise levels were measured over 1-minute periods. Attended measurements were undertaken to determine the operational noise level of plant that may be active during the daytime period to further understand the influence of sources, and to inform the development of a CadnaA noise model. It is understood that an extract system is operated intermittently during the day between 09:00 to 17:00 hours when needed. The main extract unit is located to the west of the existing workshop, with two flues located at roof level above the workshop. The main noise source associated with the extract system was noted to be an externally positioned centrifugal fan located at approximately 1 m above ground floor level.

Table 4-4: Attended $L_{Aeq,T}$ Measurement Results

Measurement Position	Start Time	Activity	$L_{Aeq,1min}$	$L_{Amax,1min}$	$L_{A90,1min}$	Note
1	14:43	Main extract plant unit at 3 m	86	87	85	External extract plant operated by workshop. Tonal and intermittent characteristics noted during attended measurements. Noise characteristics changes noted during usage.
2	14:45	Main extract plant unit at 1 m	97	98	96	
3	14:49	All equipment off	51	58	50	All equipment off.
4	15:18	Main extract plant unit at substation gates	54	57	53	Main extract at rear of workshop active and highly dominant during measurements.

4.4 Vibration Survey

Vibration measurements were conducted to understand the level of vibration impact due to the train movements of the nearby railway lines to the south of the site. It should be noted that the minimum distance between the nearest train line and the proposed development site is approximately 7 m.

The measurement location was considered representative of the vibration conditions that the nearest point of the proposed dwelling would experience. The locations of both unattended noise and attended vibration measurement positions are identified in Figure B-1 in Appendix B.

Table 4- summarises the results of the attended vibration measurements. The following table shows the maximum vibration dose values (VDV m/s$^{-1.75}$) for identified train events (short term) at the measurement position.

The levels shown below present the VDV values that are derived from the RMS acceleration level, following guidance in BS 6472-1.

Table 4-5: Maximum Vibration Dose Values for train events (Channel 1 and Channel 2)

Channel	Time	Event type	Maximum Vibration Dose Value (m/s$^{-1.75}$) per train event
1 (X axis)	16:51:00	Train event pass-by	0.000037
2 (Z axis)	16:51:00	Train event pass-by	0.000049

5 COMMERCIAL/INDUSTRIAL NOISE ASSESSMENT

5.1 Assessment

Using the data captured during our noise survey, an assessment of commercial activity from the adjacent Spiral Staircase premises has been carried out in accordance with BS 4142:2014 to assess the potential impact on the proposed development.

Spiral Staircase Systems are located adjacent to the East of the proposed development and is considered to impact the proposed development during operation. The premises are used to manufacture spiral staircases and currently operate an extract system that terminates on the western façade of the building with direct line of site to the proposed development. It is understood that the commercial premises are active from 09:00 – 17:00, Monday to Friday.

Attended measurements were undertaken to establish noise levels associated with typical operations at Spiral Staircase Systems. Observations on site indicated that their activity poses a potential noise risk to the residential development. The BS 4142 assessment therefore considers the impact of activity on the proposed residential development during the day-time period only.

Observations indicated that the extract system was clearly audible and dominant at the development site. Noise from internal activities and the condenser unit located at roof level were not considered to be audible during periods where the extract system was operational. As detailed in Section 4.3.2, the main source of noise associated with the extract system was noted to be a fan located at approximately 1 m above ground floor level as shown in Figure 5-1. For reference, the internal layout of the extract system is shown in Figure 5-2.

To assess sound propagating from the extract plant during operation at Spiral Staircase Systems, a computer model has been created using CadnaA environmental noise prediction software, in accordance with the calculation methodologies given in BS ISO 9613 'Attenuation of sound during propagation outdoors' [10]. The external extract fan has been modelled as a point source and attended measurements have been used to inform its source level. Breakout noise from internal operations has not been included within this model, as these activities were not considered to be audible at the assessment position when the extract system was operating. To allow for a worst-case assessment, it has been assumed that the extract plant may be operational continuously for periods of at least one hour during the day.

The assessment has been made to the closest window of the proposed property and within the external amenity areas located at ground floor level towards the west of the proposed development. The resulting noise levels across the development are shown in Figure 5-3 and Figure 5-4.

Figure 5-1: External extract plant

Figure 5-2: Internal workshop extract system

Figure 5-3: Plant noise levels from Spiral Staircase (Contours at 1.5 m height)

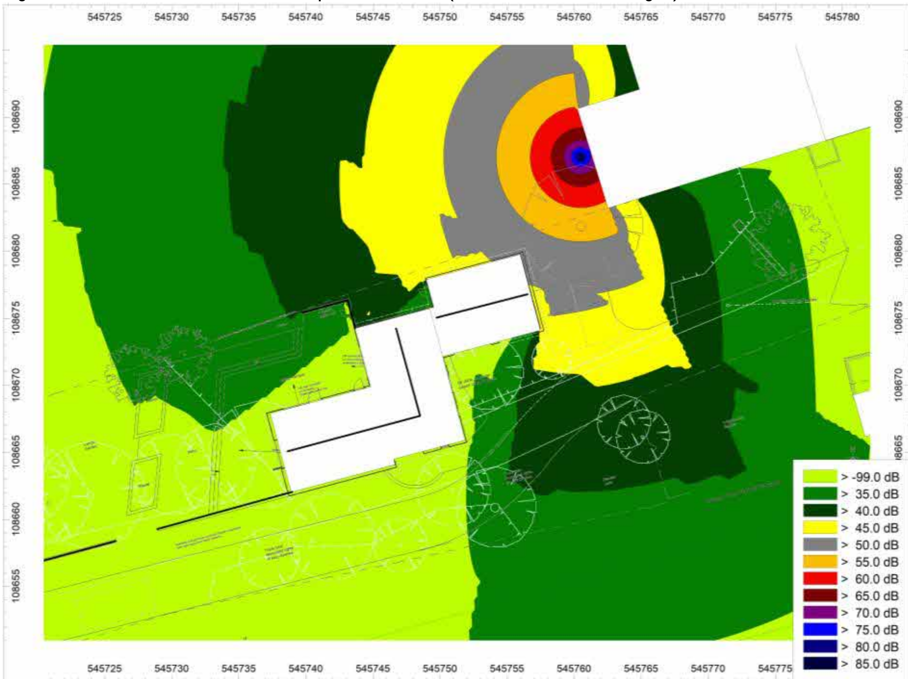
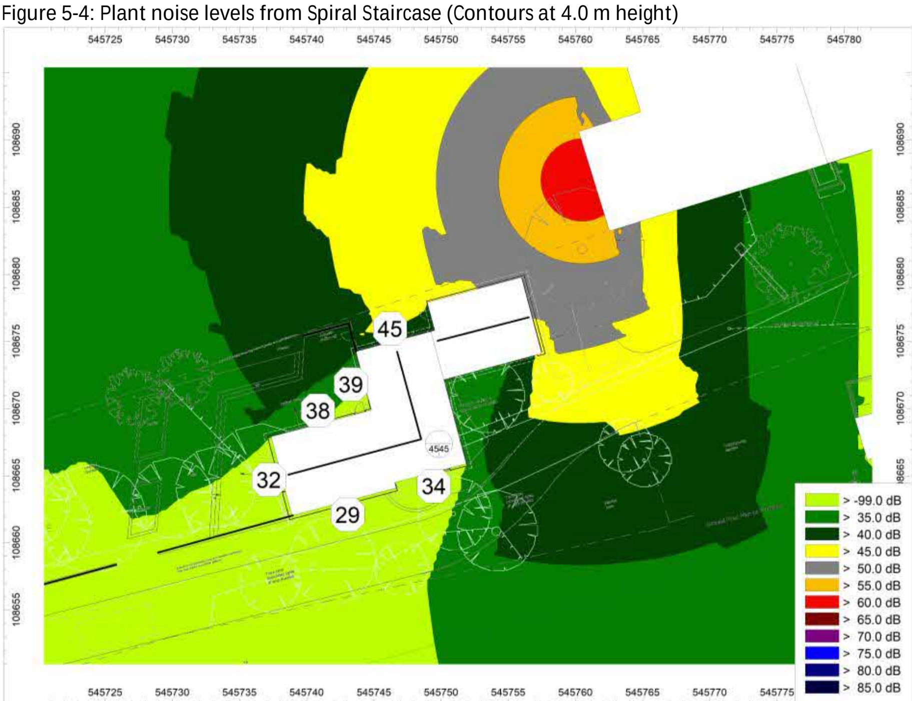


Figure 5-4: Plant noise levels from Spiral Staircase (Contours at 4.0 m height)



A level of 45 dB $L_{Aeq,T}$ has been predicted at 1 m from the façade of the proposed development at the first floor window (4.0 m above ground floor level) and a level of 39 dB $L_{Aeq,T}$ has been predicted within the external amenity area (1.5 m above ground floor level). BS 4142 requires that a correction is applied to the Rating Level if there are any tonal, impulsive or other irregular characteristics likely to attract attention present in the noise source.

Observations indicate that the plant possess irregular characteristics, therefore a penalty of +3 dB has been applied to the rating level. A +6 dB penalty has been applied due to the tonal characteristic of the plant. One-third octave analysis has been used for assessing the audibility of tones.

Table 5-1: Plant Noise Assessment – External Amenity Areas

Description	Noise Level, dB
Specific Noise Level	39
Acoustic Penalties (+6 Tonality, +3 Irregularity)	+9
Rating Level, $L_{Ar,T}$	48
Background Sound Level	47
Level over Background	+1

Based on the above assessment, commercial activity from Spiral Staircase, in the absence of any mitigation, will likely result in a level of 48 dB $L_{Ar,T}$ at 1.5 m above ground level within the external amenity area. This is +1 dB above the typical background level. It should be noted that this assessment includes the worst case and that Figure 5-3 indicates the specific sound level of the plant reduces with areas of the external amenity areas further to west of the property, therefore, it is predicted that there will be areas where the Rating Level does not exceed the measured background sound level.

Table 5-2: Plant Noise Assessment – Closest Window Location

Description	Noise Level, dB
Specific Noise Level	45
Acoustic Penalties (+6 Tonality, +3 Irregularity)	+9
Rating Level, $L_{Ar,T}$	54
Background Sound Level	47
Level over Background	+7

Based on the above assessment, commercial activity from Spiral Staircase, in the absence of any mitigation, results in a Rating Level of 54 dB $L_{Ar,T}$ at 1 m from the nearest window of the proposed property (bedroom at 1st floor). This is +7 dB above the typical background level of 47 dB L_{A90} which, depending on the context of the sound environment at the proposed development, indicates an adverse impact on future occupants, based on BS 4142 assessment guidelines.

As mitigation cannot be applied to the source, and installing an acoustic barrier of sufficient size is not considered feasible, the selection of suitable façade elements to manage internal noise levels is necessary to ensure the impact of plant noise is controlled. As openable windows are not required to provide ventilation as part of this scheme (as it will be a certified Passivhaus dwelling), it is considered reasonable to assume that windows will remain closed. This method of mitigation will ensure that internal noise will remain at a suitable level provided that windows remain closed. Windows opened by occupants of the dwelling may result in adverse impact during commercial activity, should plant noise levels be similar to what has been presented in this report.

The proposed layout has been designed to limit the impact of commercial noise within the amenity areas of the dwelling, by positioning non-sensitive areas of the development towards the existing plant. It is also noted that a 2.4 m "acoustic baffle wall" is proposed towards the north of the site, which is intended to mitigate noise from the extract system impacting on the external amenity area.

6 PRO-PG STAGE 1 ASSESSMENT

Following ProPG guidance, a Stage 1 – Initial Site Noise Risk assessment has been undertaken to characterise the application site in terms of the likely risk of adverse effects from noise on the future occupants of the development.

An unattended survey was completed to establish noise levels at the proposed site. Attended measurements have also been undertaken to further understand the acoustic environment and influence from nearby sources.

As can be seen from the results in Section 4, the noise levels at the site indicate a 'Medium Risk' for both daytime (60 – 70 dB L_{Aeq}) and night-time (50 – 60 dB L_{Aeq}) periods, according to ProPG's Stage 1 – Initial Site Risk Assessment.

ProPG notes that in 'Medium Risk' categories, it should be demonstrated that "good acoustic design process" is detailed and that an "Acoustic Design statement can demonstrate the adverse noise risk can be mitigated and minimised". A detailed Acoustic Design Statement is therefore required to ensure that any potential adverse impacts are mitigated and minimised in the completed development. This is provided in the following section.

It is also noted that the ProPG stage 1 assessment is considered suitable in areas where commercial noise is not considered dominant. Plant noise operated by the adjacent workshop was considered to be clearly audible and dominant at the receiver position when active during site visits. Periods of plant activity are understood to be between 09:00 to 17:00 on Monday to Friday. The daytime noise level measured on Saturday 12th October and Sunday 13th October 2019 did not contain plant noise from the nearby commercial premises, and therefore may be considered to be representative. A level of 57 dB $L_{Aeq,16hr}$ has been measured, which indicates a 'Low Risk' category. Night-time noise levels are not impacted by commercial noise and indicate a medium risk category. Figure 6-2 and Figure 6-3 detail the noise levels across the proposed development without the commercial noise source in operation.

Figure 6-1: ProPG Initial site noise risk assessment

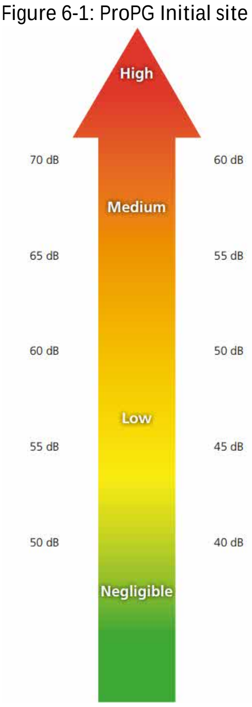
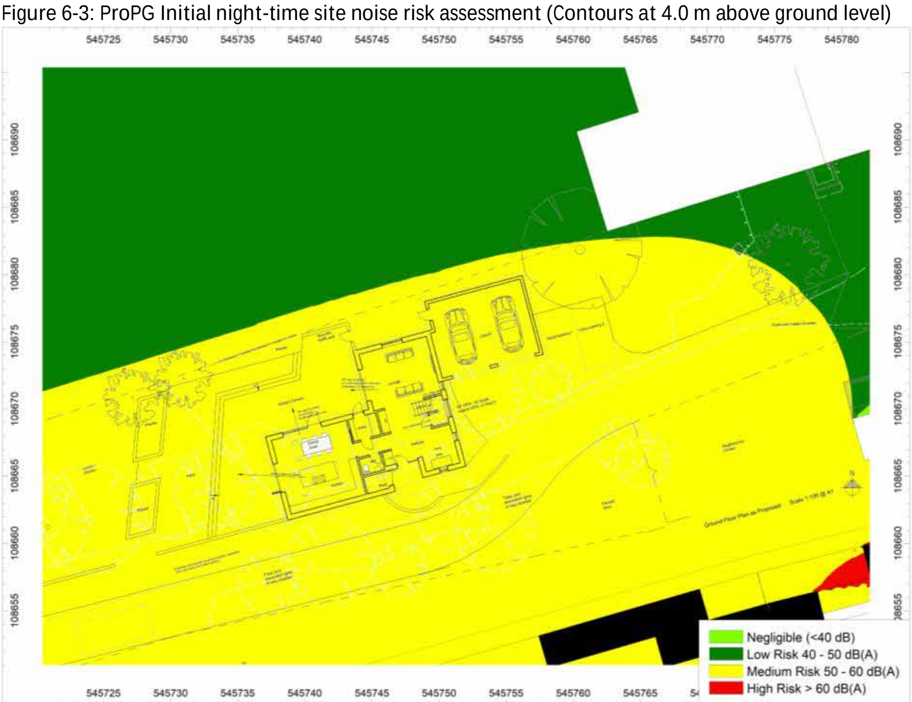


Figure 6-2: ProPG Initial daytime site noise risk assessment (Contours at 1.5 m above ground level)

Figure 6-3: ProPG Initial night-time site noise risk assessment (Contours at 4.0 m above ground level)



7 PRO-PG STAGE 2: FULL ASSESSMENT

Based on the results of the surveys summarised in Section 4.3 and following ProPG guidelines, a Stage 2 - Full Assessment is required. The four key elements to be considered have been assessed based on the assumptions listed in the following section. It is understood that the development is a Passivhaus certified design, which will use MVHR ventilation throughout. Figure 7-1 and Figure 7-2 detail the maximum predicted $L_{Aeq,T}$ noise level at 1 m from the façade of the proposed property for use within calculations. Measured octave band data has been adjusted for use in calculations.

Figure 7-1: Maximum $L_{Aeq,T}$ predicted noise level at 1 m from the façade – Daytime

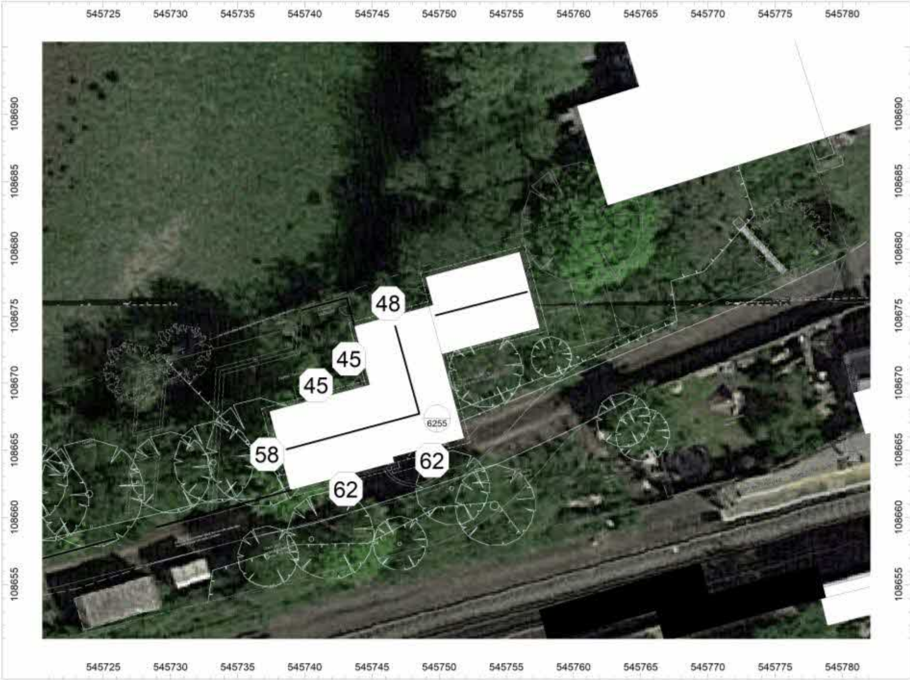
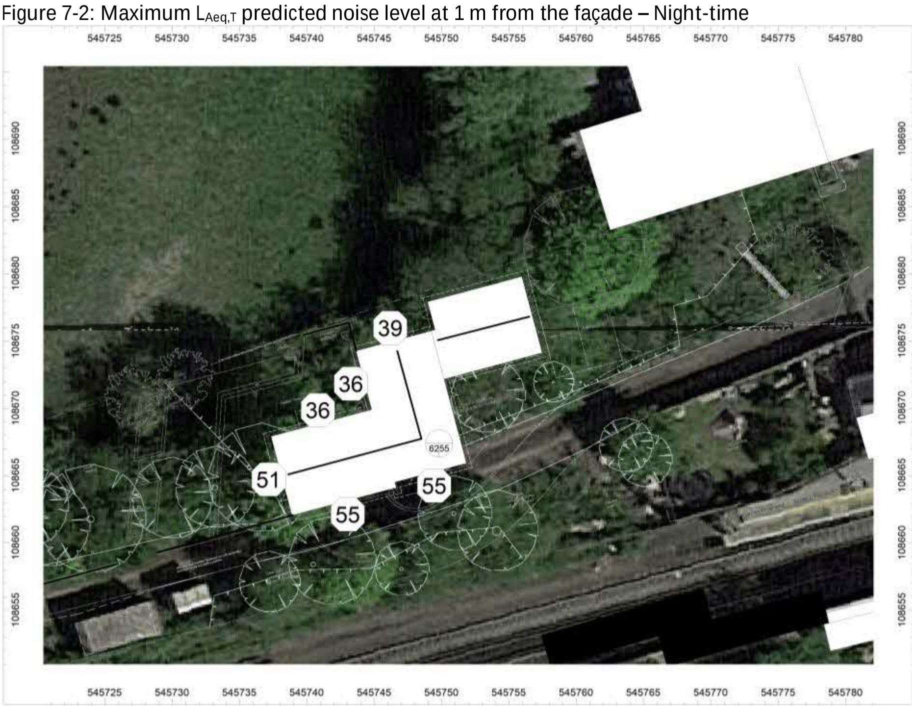


Figure 7-2: Maximum $L_{Aeq,T}$ predicted noise level at 1 m from the façade – Night-time



7.1 Assumptions

7.1.1 Drawings

Our assessment has been based on the following Architect's drawings.

Table 7-1: Drawings used in the assessment

Drawing Title	Drawing Number	Date
Proposals Floor Plans	GSNH/10 A	Jan 2022
Proposals Elevations	GSNH/11 A	Jan 2022

7.1.2 Room Reverberation

In order to calculate the internal ambient noise levels within habitable rooms, our analysis has assumed typical reverberation times in furnished bedrooms and living rooms, which have been based on a flat reverberation time of 0.5 seconds across the frequency spectrum between 125 Hz and 4 kHz.

7.1.3 Non-glazed External Wall Areas

It is understood that the proposed external wall will be of masonry construction. The below assumption has been made for the external wall system.

Table 7-2: Assumed sound reduction index (dB) of the external wall construction

Wall	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	R_w / $R_w + C_{tr}$
Masonry	41	45	45	54	58	58	52 / 48

7.1.4 Non-glazed External Roof Areas

We have assumed the following lightweight roof construction will be used (or similar).

Table 7-3: Sound reduction index (dB) of the roof construction

Roof Area	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	R_w / $R_w + C_{tr}$
Tiled/slated roof, 25mm plasterboard ceiling, sound absorbing layer (e.g. 100m mineral wool)	27	37	43	48	52	52	46 / 39

7.2 Stage 2: Element 1 – Good Acoustic Design Process

Following a good acoustic design process is implicit to achieving good overall design, as required by the Government's planning and noise policy documents NPSE and NPPF.

This process requires a high level, multi-faceted and integrated approach across all disciplines with a view to optimising acoustic conditions inside habitable rooms and in external amenity space.

Section 5 of BS 8233: 2014 contains guidance on the sequence of stages to be followed in the planning and early acoustic design of a new development. Section 5.4 of BS 8233:2014 outlines a general approach to determining appropriate noise control measures including the following suggested steps (which may be iterative):

i. Check the feasibility of reducing noise levels and/or relocating noise sources.
ii. Consider options for planning the site or building layout.

iii. Consider the orientation of proposed building(s).
iv. Select construction types and methods for meeting building performance requirements.
v. Examine the effects of noise control measures on the requirements for ventilation, fire regulation, health and safety, cost, CDM (construction, design and management) etc.
vi. Assess the viability of alternative solutions.

The designer should then decide which of the following options can be applied to reduce noise levels:

i. Quietening or removing the source of noise.
ii. Attenuating the sound on its path to the receiver.
iii. Obstructing the sound path between source and receiver.
iv. Improving the sound insulation of the building envelope.
v. Using agreements to manage noise.

The main source of noise affecting the proposed development is railway noise from the adjacent train station. Given the height, location and specific physical conditions of the site, it is not practicable to attenuate the noise at source nor the sound propagation path between source and receiver. As such, focus must be applied to the internal layout and acoustic design of the development, using appropriate building constructions and ventilation strategies which consider not only noise but also thermal comfort, fire, health and safety, CDM and cost.

7.2.1 Internal Layout

Preliminary drawings provided by LF Architects indicate that the layout of the proposed development has been considered to ensure that noise from the nearby rail line is limited in bedrooms. The development is oriented to allow for the building to screen noise from the nearby railway line.

Measurements and assessments made at the site indicate that bedrooms located in the proposed dwelling, closest to the train line, are likely to be affected by railway noise during night-time hours. Although glazing and ventilation performance specifications can be a method to mitigate noise intrusion levels, consideration is also to be made for thermal control to minimise risk of overheating. It is understood that MVHR is proposed throughout the development, which will certainly benefit the thermal control and ventilation of the dwelling.

7.3 Stage 2: Element 2 – Internal Noise Level Guidelines

In order to achieve the internal noise guidelines as set out in Section 2, it is necessary to estimate internal noise levels with windows closed using standard glazing and ventilation products.

An assessment of the external building fabric elements has been undertaken based on the attended spectral $L_{Aeq, 5min}$ and $L_{Amax,F}$ levels, and the unattended survey daytime and night-time averages, as set out in Section 4 of this report. Guidance is given in the following sections regarding suitable glazing, ventilation and external wall configurations to achieve the required internal ambient noise levels within the proposed dwelling. Calculations have been undertaken following the general method set out in BS EN 12354-3:2017 [11].

7.3.1 Ventilation

It is understood that all habitable rooms will be provided with a mechanical ventilation with heat recovery (MVHR) system due to the proposed Passivhaus design, therefore noise break-in though ventilation openings is considered negligible.

7.3.2 Glazing

Based upon the latest drawings and elevations provided by the architect, detailed calculations have been undertaken in accordance with BS 12354-3 to determine the required worst-case acoustic performances for the glazed elements of the façade, in order to provide appropriate internal noise levels in habitable rooms, during both daytime and night-time periods. The resulting worst-case performance requirements are presented in Table 7-4.

Glazing on the northern façade has been specified to ensure plant noise from the nearby commercial premises is controlled such that internal guideline levels can be achieved during the daytime period.

Table 7-4: Minimum sound reduction performance (dB) for the glazed elements

Façade	Room	Glazing example	125	250	500	1k	2k	4k	R_w / $R_w + C_{tr}$
All	Living room and Lounge	4 mm / 12 mm / 4 mm	24	20	25	34	37	35	31/27
South	Bedroom 2	10 mm / 16 mm / 8.8 mm	28	31	42	45	50	58	44/38
North	Bedroom 1	4 mm / 12 mm / 4 mm	24	20	25	34	37	35	31/27

The sound insulation requirements of the glazing are applicable to the window system as a whole, including frames, mullions and panels. They are based on BS EN ISO 10140: 2021 [12] "Acoustics - Laboratory measurement of sound insulation of building elements" and rated in accordance with BS EN ISO 717-1:2020 [13] "Acoustics – Rating of sound insulation in buildings and of building elements Part 1. Airborne sound insulation".

All glazing systems should be capable of meeting the performance specifications detailed above, with test certificates being made available in support. Glazing proposals which only reflect the guidance constructions indicated in this report will not be sufficient evidence that a glazing system will achieve the required performance specification.

The above sound reduction performances would ensure that appropriate BS 8233 internal noise levels are achieved using suitable façade treatments, when utilising any of the proposed ventilation strategies; which should then in turn equate to No Observed Adverse Effect according to NPSE.

7.4 Stage 2: Element 3 – External Amenity Area Noise Assessment

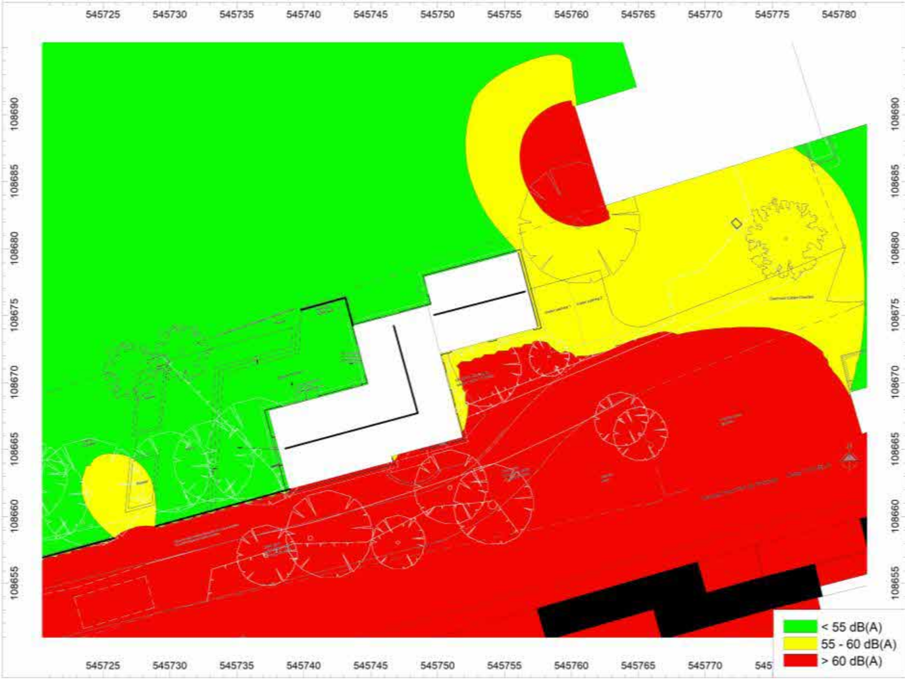
As detailed in Section 2.2, BS 8233 states that "it is desirable that the external noise level does not exceed 50dB $L_{Aeq,T}$, with an upper guideline value of 55dB $L_{Aeq,T}$ which would be acceptable in noisier environments".

7.4.1 Proposed Garden and Outdoor Amenity Areas

The outdoor amenity areas of the development have been designed as a place to relax and have been considered within the assessment under the recommendations of ProPG. "If external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces should be considered so that they can be enjoyed as intended".

The results of the noise survey summarised in Section 4 have been used to produce a CadnaA Noise model to predict levels across the development site, as detailed in Figure 7-3. Noise contours have been modelled at 1.5m above ground level. The proposed "acoustic baffle" has been included as part of this model. It has been assumed that the "acoustic baffle" will technically be an acoustic barrier, constructed of a material with a surface density greater than 10 kg/m^2, be continuous, solid, imperforated and built from the ground to full 2.4m height. As a door is proposed, this should have the same characteristics, such that it doesn't compromise the performance of the barrier.

Figure 7-3: Predicted external amenity area noise levels (1.5 m above ground level)



Predictions indicate that daytime noise levels within the amenity area towards the west of the site are likely to be below the upper-guideline limit of 55 dB $L_{Aeq,T}$, as recommended by BS 8233. Therefore, no further mitigation measures are considered necessary (other than the 2.4m "acoustic baffle" located to the north of the proposed development which has already been included as part of the design, as indicated in Figure 3-2).

8 VIBRATION IMPACT ASSESSMENT

Based on the results of the vibration survey summarised in Section 4.4, predictions have been made to estimate the day and night-time vibration dose values (eVDV $m/s^{-1.75}$) that would be expected at ground level, following guidance in Appendix B from BS6472-1. For these calculations, it has been assumed that train events occur for 20 seconds and that the highlighted 'worst-case' values for train events shown in Section 4.4 occur for the full event period. This is therefore a 'worst-case' method of calculation.

The assessment has found that the predicted $eVDV_{b,day}$ and $eVDV_{b,night}$ for the measurement position are as per Table 8-1.

Table 8-1: Calculated Vibration Dose Value for day and night-time period

Channel	Period	Train event passes per period	Exposure Vibration Dose Value $eVDV_{b,period}$ ($m/s^{-1.75}$)
1 (X axis)	Day (07:00-23:00)	129	0.0025
	Night (23:00-07:00)	20	0.0016
2 (Z axis)	Day (07:00-23:00)	129	0.0050
	Night (23:00-07:00)	20	0.0031

These calculations have been based on the worst-case measured VDV level for a train event and extrapolated for a total 129 train pass-bys per day (between 07:00 – 23:00) and 20 per night (between 23:00 – 07:00), comprising both northbound and southbound directions. It should be noted that this assessment only accounts for train events from the nearest train source. No other vibration sources were identified.

The estimated VDV levels are well below the vibration criteria set out in Table 2.1 from BS 6472 for residential buildings (< 0.2 $m/s^{-1.75}$ and < 0.1 $m/s^{-1.75}$, respectively). This indicates that vibration has a very low probability of adverse comment by the future occupants of the proposed dwelling.

8.1 Re-radiated noise predictions

The acceleration levels measured at a representative ground level position, have been used to calculate the resulting re-radiated noise level in order to assess against the criteria set out in Section 2. Predictions have been conducted in accordance with ANC guidelines based on measured vibration levels from train activity at representative ground floor level.

Table 8-2: Re-radiated vibration predictions

Source Type	Receiving Room (Ground floor residential)	Re-radiated noise level, dB $L_{Amax,S}$
Train Event (CH 1)	Living Room	6
Train Event (CH 2)	Living Room	11

The predicted re-radiated noise levels show that with no treatment the levels of noise from train activities are significantly below the ANC guidelines criteria. Full results are shown in Appendix B.

9 CONCLUSION

Anderson Acoustics Ltd was commissioned by LF Architecture Ltd in March 2022 to undertake a noise and vibration assessment for the proposed residential development at Land Adjacent to Glynde Station, Glynde, to be used in support of a planning application.

The noise conditions on site indicate that it would be categorised as a 'Medium Risk' site according to ProPG Stage 1 - Initial Site Risk assessment guidelines. Following this, a Stage 2 – Full Assessment has been undertaken and advice has been given on the design of the building envelope and on external amenity areas to ensure that both internal noise levels inside habitable rooms and external noise in amenity areas lie within guideline limits recommended in ProPG and BS 8233: 2014. With the proposed glazing specifications, BS 8233 conditions for occupants should be met, which would in turn equate to No Observed Adverse Effect according to NPSE.

Measurements and assessments made at the site indicate that bedrooms overlooking the train line are likely to be adversely affected by the railway noise during night-time hours. Calculations have been undertaken to establish suitable glazing specifications to mitigate noise levels under typical conditions, which are of moderate performance.

The vibration levels from nearby train movements have been measured and an assessment has been undertaken as to the significance of vibration levels incident on the site as per BS 6472. Vibration Dose Value calculations indicated that both day and night-time exposure levels are below thresholds of 'low probability of adverse comment'. Re-radiated noise calculations indicate that $L_{Amax,S}$ levels within the proposed development will be well below the recommended values within the Association of Noise Consultants Guidelines – Measurement and Assessment of Ground borne Noise & Vibration.

Based on the ProPG approach followed in this assessment, our recommendation to the decision maker with regard to noise is that "Planning consent may be granted subject to the inclusion of suitable noise conditions". These would be expected with regard to the achievement of appropriate internal noise levels within habitable spaces intended for residential use, appropriate external amenity areas for relative quiet as well as for noise emissions from building services plant associated with the development to nearby sensitive properties.

10 REFERENCES

[1] "Planning Noise Advice Document: Sussex," 2021.

[2] Acoustics & Noise Consultants; Institute of Acoustics; Chartered Institute of Environmental Health, ProPG: Planning & Noise - New Residential Development, London: IOA, 2017.

[3] The British Standards Institution, BS 8233:2014 - Guidance on sound insulation and noise reduction for buildings, London: The British Standards Institution, 2014.

[4] World Health Organization, Guidelines for Community Noise, WHO, 1995.

[5] World Health Organization, Night Noise Guidelines For Europe, Copenhagen: WHO, 2009.

[6] The British Standards Institution, BS 4142:2014+A1:2019 - Methods for rating and assessing industrial and commercial sound, London: BSI, 2014.

[7] The British Standards Institution, BS 6472-1: Guide to evaluation of human exposure to vibration in buildings, London: British Standards Institution, 2008.

[8] The Association of Noise Consultants, Measurement & Assessment of Ground Noise & Vibration Guidelines.

[9] The British Standards Institution, BS 61672 - Electroacoustics. Sound level meters. Specifications, 2013.

[10] British Standards Institution, ISO 9613-2:1996 - Acoustics. Attenuation of sound during propagation outdoors - General method of calculation, London: BSI, 1996.

[11] The British Standards Institution, BS 12354-3 Building acoustics. Estimation of acoustic Estimation of acoustic performance in buildings from the performance of elements. Airborne sound insulation against outdoor sound, BSI, 2017.

[12] The British Standards Institution, ISO 10140-2:2021 - Acoustics - Laboratory measurement of sound insulation of building elements - Measurement of airborne sound insulation, 2021.

[13] The British Standards Institution, ISO 717-1:2020 - Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation, BSI, 2013.

[14] Department for Environment, Food and Rural Affairs, "Noise Policy Statement for England," DEFRA, London, 2010.

[15] C. &. L. G. Ministry of Housing, "National Planning Policy Framework," London, 2019.

[16] Ministry of Housing, Communities & Local Government, "Planning Practice Guidance - Noise," 2019. [Online]. Available: https://www.gov.uk/guidance/noise--2. [Accessed 2020].

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APPENDIX A

NOISE AND VIBRATION UNITS, POLICY AND CRITERIA

A NOISE AND VIBRATION UNITS, POLICY AND CRITERIA

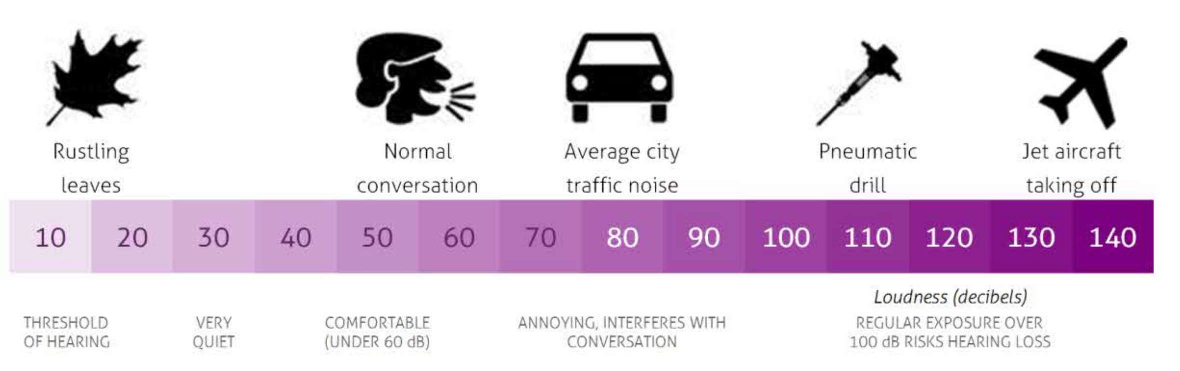
A.1 Noise Units

There is a ten million to one ratio between the acoustic energy associated with the threshold of hearing and the highest tolerable sound pressure. Noise is therefore measured using a logarithmic scale, to account for this wide range, called the decibel (dB). Noise is defined as unwanted sound and the range of audible sound varies from around 0 dB to 140 dB.

The human ear is capable of detecting sound over a range of frequencies from around 20 Hz to 20 kHz, however its response varies depending on the frequency and is most sensitive to sounds in the mid frequency range of 1 kHz to 5 kHz. Instrumentation used to measure noise is therefore weighted across the frequency bands to represent the sensitivity of the ear. This is called 'A weighting' and is represented as dB(A).

It is generally accepted that under normal conditions humans are capable of detecting changes in steady noise levels of 3 dB, whilst a change of plus or minus 10 dB is perceived as a doubling or halving of the noise level. An indication of the range of noise levels commonly found in the environment is given below.

Figure A-10-1: Typical noise levels



A number of different indices are used to describe the fluctuations in noise level over certain time periods. The main indices include:

$L_{A90,T}$ This is the noise level exceeded for 90% of the measurement period and provides a measurement of the quieter 'lull' periods in between noise events. It is often referred to as the background noise level.

$L_{Aeq,T}$ This is the "equivalent continuous A weighted sound pressure level" and is the level of a notional steady sound which has the same acoustic energy as the fluctuating sound over a specified time period. It is often used for measuring all sources of noise in the environment, which can be referred to as the ambient noise.

$L_{Amax,F}$ This is the maximum sound pressure level measured in a given time period with the sound level meter set to 'fast' response.

Reference is often made to acoustic measurements being undertaken in 'free-field' or 'façade' locations. Free-field measurements represent a location away from vertical reflecting surfaces, normally by at least 3.5 metres. A façade measurement is undertaken or calculated to a position 1 metre from an external façade and a correction of up to 3 dB can be applied to account for the sound reflected from the façade. This latter position is often used when assessing the impact of external noise affecting residents inside properties.

A.2 Vibration Units

The main vibration metrics used in this report are:

Acceleration (m/s^2)	The unit used to describe the magnitude of vibration is the acceleration; which is expressed in m/s^2 and is a vector quantity. The acceleration level, La, in dB, is the logarithm of the ratio of a measure of acceleration to a reference acceleration, i.e. La = 20 log (a/a_0) dB, where a_0 is the reference level. Acceleration levels can be used in the prediction of noise levels resulting from ground-borne vibration.
Vibration Dose Value (VDV)	A measure of vibration exposure; the fourth root of the integral, over the measurement period, of the frequency-weighted time varying acceleration. VDVs are used to evaluate human response to structural vibration in buildings. The VDV levels are generally expressed in $m/s^{-1.75}$.

A.3 Relevant Guidance

A.3.1 Noise Policy Statement for England (NPSE, 2010)

The NPSE [14] is the Government's overarching statement on noise policy for England, and applies to all forms of noise other than occupational noise, setting out the long-term vision of Government noise policy, which is to:

> Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development.

Which is supported by the following noise policy aims:

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

e) Avoid significant adverse impacts on health and quality of life;
f) Mitigate and minimise adverse impacts on health and quality of life; and
g) Where possible, contribute to the improvement of health and quality of life.

When discussing the meaning of significant adverse and adverse within an Explanatory Note, the NPSE states:

> There are two established concepts from toxicology that are currently being applied to noise impacts for example, by the World Health Organisation. They are
>
> NOEL – No Observed Effect Level - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
>
> LOAEL – Lowest Observed Adverse Effect Level - This is the level above which adverse effects on health and quality of life can be detected.

To which the NPSE added the following related concept:

> SOAEL – Significant Observed Adverse Effect Level - This is the level above which significant adverse effects on health and quality of life occur.

The Explanatory Note continues:

> It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from

noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

The NPSE concludes by explaining in a little more detail how the LOAEL and SOAEL relate to the three aims listed above. Logically, it starts with the aim of avoiding significant adverse effects on health and quality of life, then addresses the situation where the noise impact falls between the LOAEL and the SOAEL, when *"all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development."* The final aim envisages proactive management of noise to improve health and quality of life, again taking into account the guiding principles of sustainable development.

A.3.2 National Planning Policy Framework (NPPF, 2019)

First published in 2012, and most recently updated in July 2021, the NPPF [15] sets out the Government's planning policies for England, and how these are expected to be applied. Noise is referenced within the NPPF as follows. These are effectively the NPPF's policies on noise.

> 174. Planning policies and decisions should contribute to and enhance the natural and local environments by:
>
> …e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans…
>
> 185. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:
>
> a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life[60]…

Reference number 60 of the above quotation points to the Explanatory Note to the NPSE (see above).

The following policy is also relevant to noise.

> 187. Planning policies and decisions should ensure that new development can be integrated effectively with existing businesses and community facilities (such as places of worship, pubs, music venues and sports clubs). Existing businesses and facilities should not have unreasonable restrictions placed on them as a result of development permitted after they were established. Where the operation of an existing business or community facility could have a significant adverse effect on new development (including changes of use) in its vicinity, the applicant (or 'agent of change') should be required to provide suitable mitigation before the development has been completed.

As mentioned above, the Government has published accompanying web-based planning guidance for a number of categories, including noise (see below).

A.3.3 NPPF Planning Practice Guidance, Noise

Following initial release in 2014, the planning practice guidance now forms part of the NPPF, referred to as relevant planning practice guidance, which includes guidance on the category of Noise. The guidance is often referred to as PPG-Noise, PPG-N or PPG(N) [16].

In keeping with the NPSE and NPPF, no values (in dB) are presented; however, plenty of guidance is provided as to the issues to consider in assessing noise and determining suitable thresholds. Whilst, in keeping with this report, reference is made to BS 8233.

A noise exposure hierarchy table is provided, which summarises the noise exposure hierarchy based on the likely average response of those affected, and is reproduced below. It includes examples of outcomes relevant to the NOEL, LOAEL and SOAEL effect thresholds described in the NPSE. These outcomes are in descriptive form; there is no numerical definition of the NOEL, LOAEL and SOAEL.

Table A-1: Noise exposure hierarchy table (as per PPG-N)

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

It is left to other guidance documents (e.g. BS 8233, as detailed in Section 2.1.3) and professional opinion to determine thresholds where required.

APPENDIX B

FIGURES AND GRAPHS

B FIGURES & GRAPHS

Figure B-1: Site location (highlighted in red)

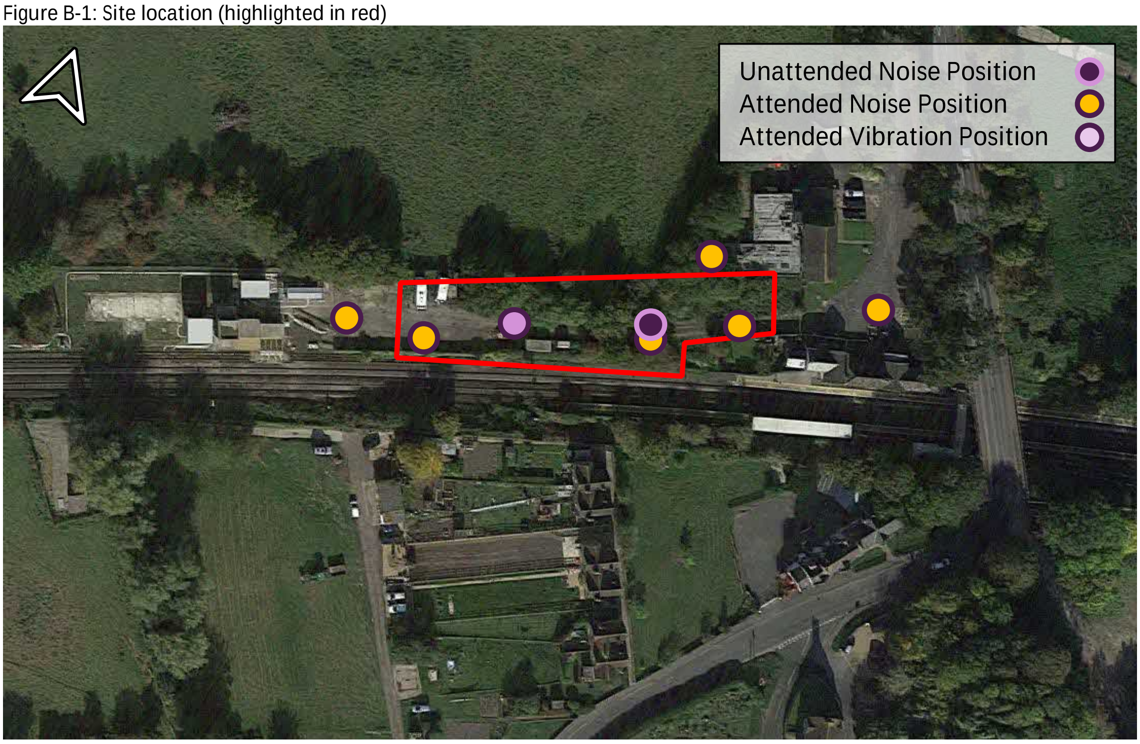


Figure B-2: Unattended Monitoring Position – Time History Results

Figure B-3: Vibration Channel 1 – time history results (Z Axis)

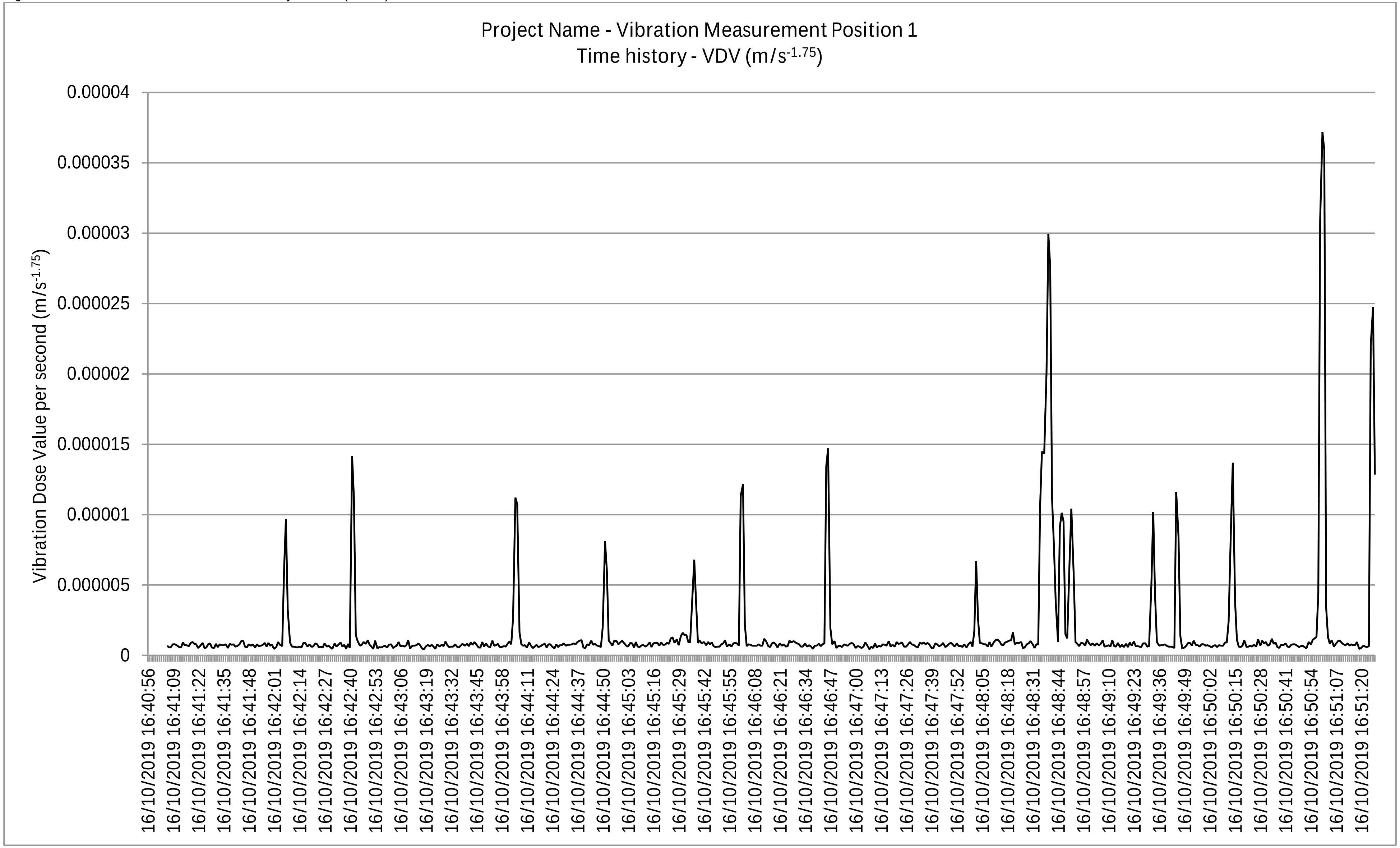


Figure B-4: Vibration Channel 2 – Time History Results (Z Axis)

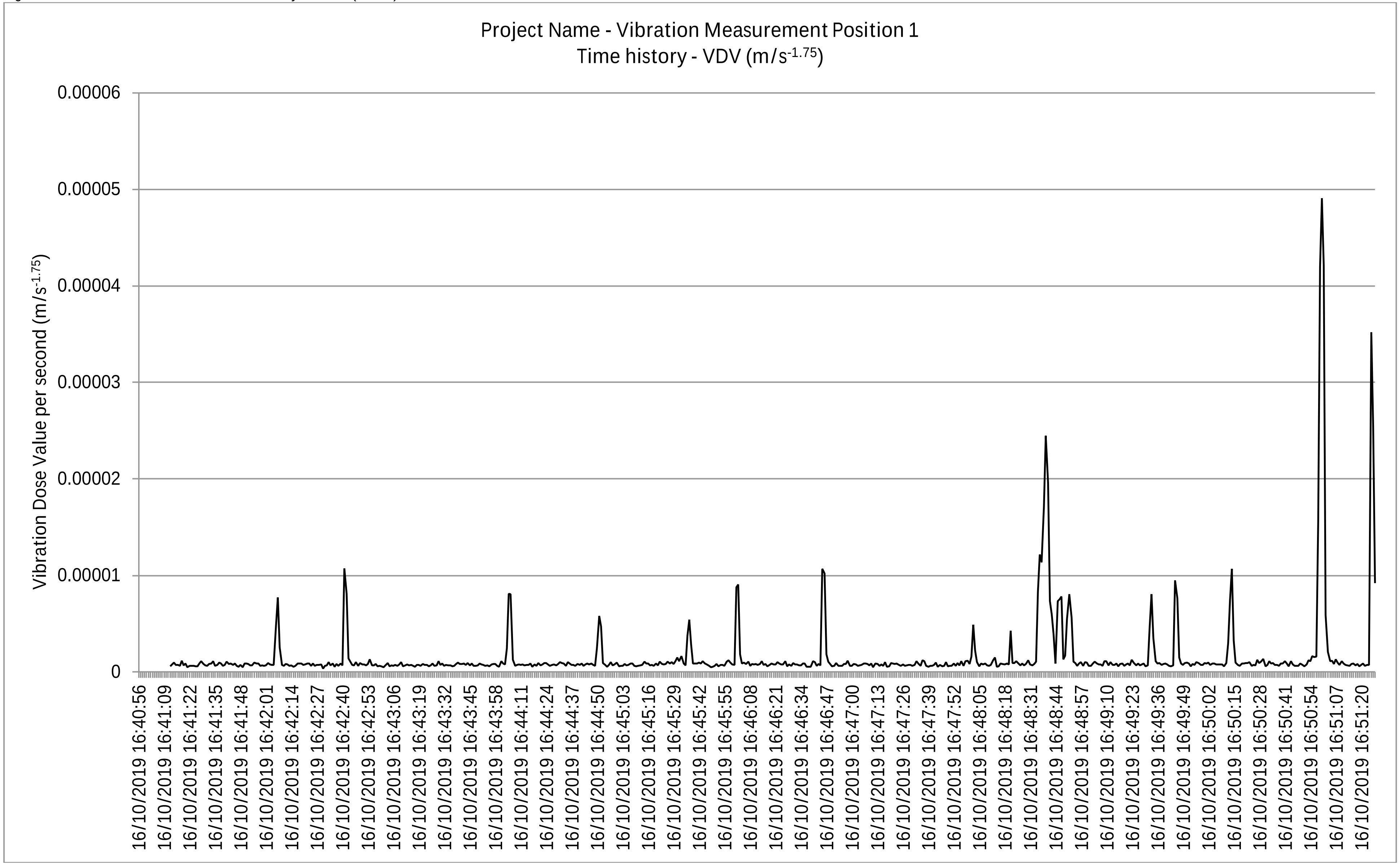


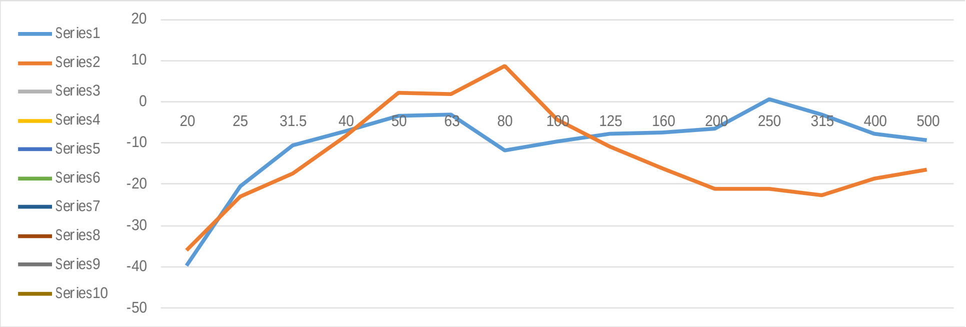
Figure B-5: Re-radiated Noise – Ground borne Vibration

Instruction
1. Insert the dimensions of the room in the "Room Dimension" box

2. Insert the frquency of the isolator and the damping ratio in the 'mitigation measures' box

Room Dimensions			
Floor Dimensions		Height	Vol
X	Y	Z	
5	8	2.5	100

Xaxis	25	
Y Axis	40	
Z Axis	80	Floor and Ceiling



A-weighted Spectrum

Z AXIS	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	Re-radiated noise LASmax dB
Event 1 (Slow) Channel 1	-40	-20	-11	-7	-3	-3	-12	-10	-8	-8	-6	1	-3	-8	-9	6
Event 2 (Slow) Channel 2	-36	-23	-17	-8	2	2	9	-4	-11	-16	-21	-21	-23	-19	-17	11

Z AXIS	20	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	Re-radiated noise LAFmax dB
Run 1 (Fast) Channel 1	-39	-19	-10	-6	-2	-1	-10	-6	-5	-4	-1	5	0	-4	-6	9
Run 2 (Fast) Channel 2	-35	-21	-16	-7	4	4	11	1	-8	-13	-18	-17	-20	-15	-13	13