

DECEMBER 11, 2023



**BS8233 & BS6472 ASSESSMENT OF
STATION HOUSE,
STATION ROAD, RUABON, WREXHAM,
LL14 6DL**

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1.0 Introduction

- 1.01 E2 Consultants have been commissioned to undertake a noise and vibration impact survey and assessment for Station House, Station Road, Ruabon, Wrexham, LL14 6DL.
- 1.02 The methodology used for this assessment will be BS8233 as this is a new development within the designated area, and BS6472-2 for the vibration aspect of the assessment. The report will assess the completed renovation section of the building as well as the second section that is yet to be converted.
- 1.03 The report will also issue recommendations of acoustic performance of glazing and, if required, ventilation proposals in order for the future dwelling to meet all necessary criteria.

2.0 Development Description

- 2.0.1 The proposed dwelling is located in the old station house just off of station road in Ruabon.
- 2.0.2 The development consists of a single-storey building containing residential dwelling
- 2.0.3 The main noise sources likely to disrupt the proposed building are from the road to the front and the rail line to the rear of the development. The rail line is also seen as a possible source of vibration that may need to be addressed.
- 2.0.4 With the above sources in mind the monitoring took place close to the rail line on the rear boundary of the site.

2.1 Locations of Monitors

- 2.1.1 Two Type 1 sound level meters and a triaxial vibration meter were installed in the area that is likely to be the garden for the proposed development. This allowed calculations to be made from likely screening objects from the proposed development itself, and the noise impact for outdoor spaces in accordance with BS8233.
- 2.1.2 Figure 1 & 2 shows the area where the monitor was installed.
- 2.1.3 All locations are displayed on site map in figure 3.

Figure 1 - Noise



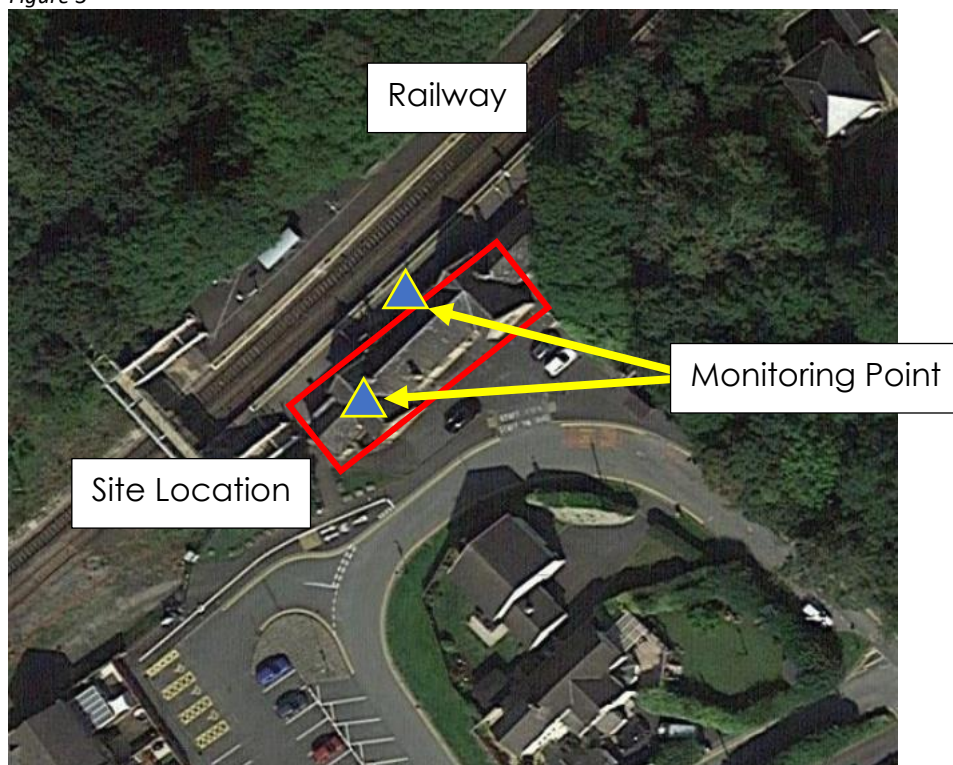
Figure 2 - Vibration



- 2.1.4 Noise measurements were made in 15 minute periods, on 1 second averaging, to allow for the removal of anomalies and increased accuracy. The data was averaged into $L_{Aeq16hr}$ daytime and L_{Aeq8hr} night-time with data also recorded for L_{AMax} in both day and night periods for the BS8233 assessment.
- 2.1.5 The monitoring was conducted using 2 x Type 1 NTI XL2 sound level meter, outdoor case with batteries and outdoor microphone protection, and 1 x Sigicom C22 PPV & VDV triaxial vibration monitor.
- 2.2.6 The measurements were taken by a fully qualified engineer with AMIOA status with the institute of Acoustics.
- 2.2.7 All measurements were taken after a field calibration was undertaken to ensure accuracy and repeatability of measurements. Calibration checks were performed post measurement as well to ensure accuracy of data.
- 2.2.8 Further data such as wind speed, wind direction, rainfall intensity, temperature and cloud cover were all recorded at the beginning and end of the assessment at the monitoring location.
- 2.2.9 Any anomalies (such as noise by the engineer during setup and collection of the kit) were removed from the survey for a true reflection of the ambient levels in the vicinity. This was done by recording audio throughout the survey at each location and listening back through the files during the analysis process to confirm what was recorded manually during the survey.
- 2.2.10 Care was taken to inform any residents in the area that audio recording was taking place.

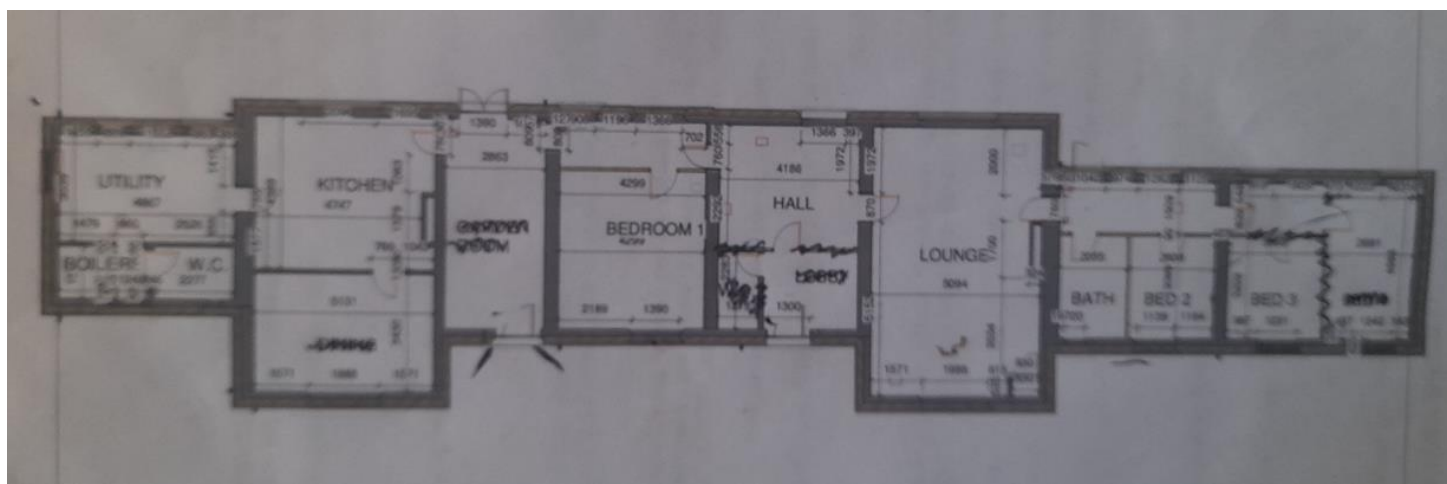
2.2 Plan Views of Site with Designated Work Areas

Figure 3



2.3 Proposed Layout

Figure 4



3.0 Legislation

- 3.0.1 The Planning Policy Wales sets out the Government's economic, environmental and social planning policies. Section 3.22 states;

"Planning authorities should develop and maintain places that support healthy, active lifestyles across all age and socio-economic groups, recognising that investment in walking and cycling infrastructure can be an effective preventative measure which reduces financial pressures on public services in the longer term. The way a development is laid out and arranged can influence people's behaviours and decisions and can provide effective mitigation against air and noise pollution."

- 3.0.2 The guidance also sees traffic consideration and management as key when it comes to noise impact assessments. Section 4.1.45 states

"Local authorities must adopt an integrated approach to traffic management. They should consider how different measures can complement one another and contribute to the achievement of wider planning and transport objectives, implementing the Active Travel Act and reducing exposure to air and noise pollution, taking into account the needs of the disabled and less mobile sections of the community."

- 3.0.3 Section 6 of the document also tackles the likely social and well-being impacts of the preservation of 'distinctive and natural places'. Section 6.7.1 refers to the need to protect the soundscape of areas;

"Clean air and an appropriate soundscape, contribute to a positive experience of place as well as being necessary for public health, amenity and well-being. They are indicators of local environmental quality and integral qualities of place which should be protected through preventative or proactive action through the planning system. Conversely, air, noise and light pollution can have negative effects on people, biodiversity and the resilience of ecosystems and should be reduced as far as possible."

This is then continued in reference to noise in section 6.7.4;

"The planning system should maximise its contribution to achieving the well-being goals, and in particular a healthier Wales, by aiming to reduce average population exposure to air and noise pollution alongside action to tackle high pollution hotspots. In doing so, it should consider the long-term effects of current and predicted levels of air and noise pollution on individuals, society and the environment and identify and pursue any opportunities to reduce, or at least, minimise population exposure to air and noise pollution, and improve soundscapes, where it is practical and feasible to do so."

3.0.4. It is possible to apply objective standards to the assessment of noise and the effect produced by the introduction of a certain noise source may be determined by several methods, as follows:

- The effect may be determined by reference to guideline noise values. British Standard (BS) 8233:2014 and World Health Organisation (WHO) “Guidelines for Community Noise” contain such guidelines.
- Another method is to compare the resultant noise level against the background noise level (L_{A90}) of the area. This is the method employed by BS 4142:2014 to determine the likelihood of complaint from noise of an industrial nature. It is best suited to the assessment of steady or pseudo-steady noise.

3.0.5 British Standard 8233:2014 is principally intended to assist in the design of new dwellings; however, the Standard does state that it may be used in the assessment of noise from new sources being brought to existing dwellings.

3.0.6 The WHO guideline values are appropriate to what are termed “critical health effects”. This means that the limits are at the lowest noise level that would result in any psychological or physiological effect.

The WHO/BS 8233 guideline noise values are summarised in the following table:

Table 1

Guidance Document	L_{AeqT}	L_{AMax}	Outcome
World Health Organisation “Community Noise 2000”	55dB		Serious annoyance, daytime and evening. (Continuous noise, outdoor living areas)
	50dB		Moderate annoyance, daytime and evening. (Continuous noise, outdoor living areas).
	35dB		Moderate annoyance, daytime and evening. (Continuous noise, dwellings, indoors)
	30dB		Sleep disturbance, night-time (indoors)
		60dB	Sleep disturbance, windows open at night. (Noise peaks outside bedrooms, external level).
		45dB	Sleep disturbance at night (Noise peaks inside bedrooms, internal level)
BS 8233:2014 “Sound Insulation	55dB		Upper limit for external steady noise. (gardens and patios).

and noise reduction for buildings"	50dB		Desirable limit for external steady noise. (gardens and patios).
	L _{Aeq} 16 hours = 35 dB		Resting, living room day. (Internal – steady noise)
	L _{Aeq} 16 hours = 40 dB		Dining, dining room day. (Internal – steady noise)
	L _{Aeq} 16 hour = 35 dB		Sleeping, bedroom day (Internal – steady noise)
	L _{Aeq} 8 hours = 30 dB		Sleeping, bedroom day (Internal – steady noise)

3.0.7 For L_{AeqT} criteria the time base (T) given in the documents is 16 hours for daytime limits and 8 hours for night time limits. All surveys are conducted on 1 hour daytime and 15 minute night values – based on 1 second readings on a Type 1 sound level meter. The readings are taken every 5 mins for noise to allow the elimination of erroneous data if required.

3.0.8 The WHO guidelines are also concerned with the L_{AMax} for night-time sleep disturbance. The guideline states:

“For a good sleep, it is believed that indoor sound pressure levels should not exceed approximately 45 dB L_{AFmax} more than 10-15 times per night”

3.0.9 On this basis, for the purpose of assessing night-time L_{AFmax} noise events, it is considered appropriate to adopt the 10th highest L_{AFmax} noise event occurring in a typical night-time (23:00 – 07:00) period.

3.0.10 Audio recordings are taken throughout the measurements to allow for further assessments on high levels. Listening to the audio and performing tonal analysis will allow anomalies to be removed from the data, if required.

3.1 Standards and Guidelines (Vibration)

3.1.1 BS6472-part 1 2008 is the Guide to evaluation of human exposure to vibration in buildings. This is an effective assessment procedure for the likelihood of annoyance from vibration. The standard says:

“Whether at home or at work, the vibration tolerance of people varies over a wide range. As well as a large range of individual vibration sensitivity over the population, specific values depend on social and cultural factors, psychological attitudes and the expected degree of intrusion.

Building vibrations as they affect people can be classified usefully according to a combination of descriptions. The time history of the vibration input to the subject can be:

- *continuous;*
- *intermittent; or*
- *occasional”*

3.1.2 Impulsive vibration levels are seen as the most likely to cause issues and annoyance to property dwellers through ‘startling’. For this reason the standard employs the vibration dose summation procedure. The standard explains this procedure as;

“allows comparison of all types of vibration exposure on a common basis, i.e. the severity of impulsive and/or intermittent vibration is evaluated on a basis applicable equally to continuous vibration.”

3.1.3 Train pass-by measurements are typically done using this Vibration Dose Value measurement technique (VDV) as there is a build-up of energy to a peak.

3.1.4 Vibration dose value ranges which might result in various probabilities of adverse comment within residential buildings.

Table 2

Place and Time	Low probability of adverse comment m·s ^{-1.75} 1)	Adverse comment possible m·s ^{-1.75}	Adverse comment probable m·s ^{-1.75} 2)
Residential buildings 16 h day	0.2 – 0.4	0.4 – 0.8	0.8 – 1.6
Residential buildings 8 h night	0.1 – 0.2	0.2 – 0.4	0.4 – 0.8

3.1.5 In circumstances where there is an expected level of vibration that will result in Adverse comment it is important to determine the true impact levels on human occupiers of the structures. BS6472-1:2008 provides the following recommendations for vibration measurement:

“Vibration should normally be measured on the floor of the room implicated (where any complaint originates, or where the greatest adverse comment is predicted.) at or near the point of greatest weighted acceleration.”

“For external excitation (e.g. ground-borne vibration), it is likely that the response of a floor will be dominated by rigid body motion or by its lowest “dish-shaped” mode

of vibration. In this case, one or two measurement points in a suitable available area, preferably in the central part within one-third and two-thirds of the width/length, are sufficient to determine the vibration response of the floor to this form of excitation.”

- 3.1.6 Where vibration measurement is not an option within the building (i.e. access issues or due to the fact the structure does not exist) measurements are required at the most reasonable locations and the impact on the proposed structure calculated based on the materials to be used in construction

3.2 TAN 11: October 1997

- 3.2.1 The Technical Advise Note (Wales) 11, Noise – October 1997 provides some further criteria in relation to noise criteria categories for Noise-sensitive developments. These categories have been derived to assist local planning authorities in their consideration of planning applications. These categories are part of Annex A of the guidance document and are displayed in the tables below.

- 3.2.2 *“Local planning authorities should consider whether proposals for new noise-sensitive development would be incompatible with existing activities, taking into account the likely level of noise exposure at the time of the application and any increase that may reasonably be expected in the foreseeable future. Such development should not normally be permitted in areas which are, or are expected to become, subject to unacceptably high levels of noise and should not normally be permitted where high levels of noise will continue throughout the night.”*

Table 2: RECOMMENDED NOISE EXPOSURE CATEGORIES FOR NEW DWELLINGS NEAR EXISTING NOISE SOURCES					
Noise Levels ⁽¹⁾ corresponding to the Noise Exposure Categories for New Dwellings L _{Aeq,TdB}					
Noise Source		Noise Exposure Category			
		A	B	C	D
road traffic	0700-2300	<55	55-63	63-72	>72
	2300-0700 ⁽²⁾	<45	45-57	57-66	>66
rail traffic	0700-2300	<55	55-66	66-74	>74
	2300-0700 ⁽²⁾	<45	45-59	59-66	>66

TABLE 1: NOISE EXPOSURE CATEGORIES	
A	Noise need not be considered as a determining factor in granting planning permission, although the noise level at the high end of the category should not be regarded as desirable.
B	Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection.
C	Planning permission should not normally be granted. Where it is considered that permission should be given, for example, because there are no alternative quieter sites available, conditions should be imposed to ensure a commensurate level of protection against noise.
D	Planning permission should normally be refused.

4.0 Results

4.1 Noise Assessment (external) 11.43am 04/12/23 – 10.05am 05/12/23

Table 3

Location	L _{Aeq} _16hr	L _{Aeq} _8hr	L _{Amax} (10th highest)
Day	65.5dBA		91.3dBA
Night		51.5dBA	57.5dBA

4.1.1 Comments: Mainly train pass-by noise. Some passenger noise and low-level announcements audible



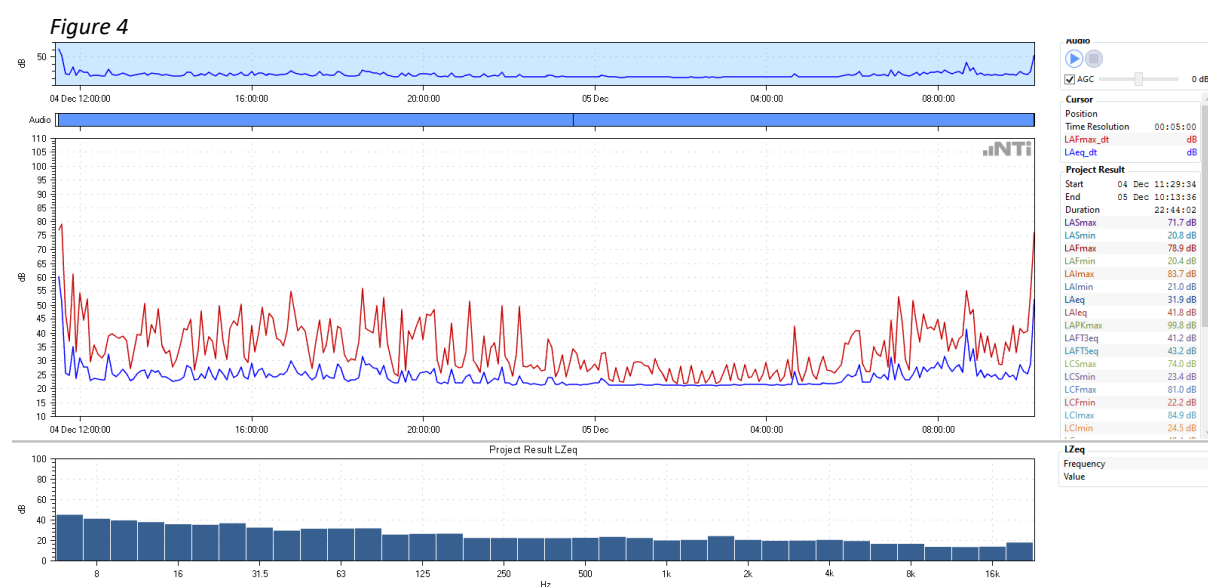
Day/Time	Cloud Cover	Temperature (Celcius)	Presence of fog/snow/ice	Wind Speed (m/s)	Wind Direction
Installation	8	11	No	2.8	NW
Collection	6	9	No	3.4	W

4.2 Noise Assessment (internal) 11.29am 04/12/23 – 10.13am 05/12/23

Table 3

Location	L _{Aeq_16hr}	L _{Aeq_8hr}	L _{Amax} (10th highest)
Day	32.7dBA		61.2dBA
Night		22.4dBA	32.1dBA

4.2.1 Comments: no distinctive audible sounds



4.3 Comparison of Results to BS8233

Table 4

Location	L _{AeqT} (16hr Day & 8hr Night)	L _{AMax}	BS8233 & WHO Internal noise	BS8233 & WHO External Noise	Difference to L _{Aeq} (internal/external) limit	Difference to Max (internal/external)
External						
Day (0700-2300)	66dBA		35dBA	55dBA	(+31dBA/ +11dBA)	-
Night (2300-0700)	52dBA	58 dBA (10th Highest)	30dBA (45dBA L_{AMax})	(60dBA L_{AMax})	(+32dBA)	(+7dBA)
Internal (refurbished)						
Day (0700-2300)	33dBA		35dBA	55dBA	(-2dBA)	-
Night (2300-0700)	22dBA	32 dBA (10th Highest)	30dBA (45dBA L_{AMax})	(60dBA L_{AMax})	(-8dBA)	(-13dBA)

5.0 Observations and Further Discussions

- 5.0.1 The measured L_{Aeq} values for both the day and the night periods are shown in table 4. The day period is 31dBA above the limit for indoor noise levels and 11dBA above the limit for outdoor levels in the section of the building that is yet to be refurbished. As there is no garden to the rear of the property this second value is not relevant for the purposes of this report.
- 5.0.2 The complete area measured internal values of 2dB below the criteria in accordance with BS8233 during the day
- 5.0.3 The night value is 32dBA above the recommended value for internal noise to prevent sleep disturbance in the old section of the building. BS8233 assumes that a standard double-glazed window will provide up to 15dB reduction when open. This would mean that any modern double-glazed window in the building cannot be left open with a low chance of sleep disturbance being had by the inhabitants of the proposed dwellings during the night period. Therefore, alternative methods of ventilation will be required to avoid overheating.

- 5.0.4 The $L_{A\text{Max}}$ value to prevent the likelihood of sleep disturbance is set at 60dBA external and 45dBA internal. Based on the highest value from the tenth-highest daily value measured the reading for $L_{A\text{Max}}$ night was 58dBA externally. This value is 7dBA above the limit for internal $L_{A\text{Max}}$ values during the night period.
- 5.0.5 The guide figures from table 4 can be used in the BS8233:2014 Annex G calculation methodology to ascertain the correct glazing and ventilation specification to be used in the section of the property that is yet to be developed.

5.1 BS8233 Calculations

- 5.1.1 With the above comments in mind the value of 31dBA has been used in the Annex G calcs to gain the glazing and ventilation specification in order to reduce the noise impact of the existing noise sources on the proposed dwelling. This is because there are no bedrooms that face directly out towards the railway platform but the main living area/lounge area does.
- 5.1.2 As the main noise source is to the rear of the building, using the same glazing to the front of the building, on the bedroom windows, will be more than sufficient.

		Overall dBA	Octave Band Frequency (Hz)					
Time Period			125	250	500	1000	2000	4000
Leq,ff	Daytime LAeq	65.5	57	58	60	58	57	55
Room Details	(m)	Lounge						
Height	2.2							
Width	5							
Length	8							
Sample Room Volume	88							
Sample Room Surface Area	57.2							
Element	Area/No.of	Element Specification						
External Wall	11	Traditional solid 9" brick						
Windows	1.37	4 mm / (6 - 16 mm) / 4 mm Pilkington						
Ceiling	40							
Ventilation	1	Standard acoustic trickle ventilator typically ≥ Dn,e,w 35dB						
Element SRI								
		Octave Band Frequency (Hz)						Single Figure Rating
Element	Area/No.of	125	250	500	1000	2000	4000	
Walls	4	39	44	51	58	63	68	50
Windows	1	21	17	25	35	37	31	29
Ceiling	1	28	34	40	45	49	52	
Ventilation (Dn,e)	1	33	33	34	35	32	31	35
Overall Sound Reduction								
Calculated Internal SPL								
		Octave Band Frequency (Hz)						
	Overall	125	250	500	1000	2000	4000	
Leq,2	34.3	23.1	28.7	29.8	24.9	24.4	24.0	
Limit	35							
Value under limit	0.7							

6.0 Glazing, Structural and Ventilation Recommendations

6.1 External Walls

- 6.1.1 External walls of the proposed building are understood to be traditional 9" brick or equivalent:

Table 5

Description	Octave Band Centre Frequency (Hz) Sound Reduction Index <i>R</i> dB					
	125	250	500	1k	2k	4k
Traditional solid 9" brick	39	44	51	58	63	68

6.2 Glazing

- 6.2.1 Suitable sound insulation performance of all windows and patio doors of the development may be achieved with the specification shown in table 6 below.

Table 6

Description	Octave Band Centre Frequency (Hz) Sound Reduction Index <i>R</i> dB						Rw (C; Ctr)
	125	250	500	1k	2k	4k	
4 mm / (6 - 16 mm) / 4 mm Pilkington	21	17	25	35	37	31	29 (-1;-4)

6.3 Ventilation

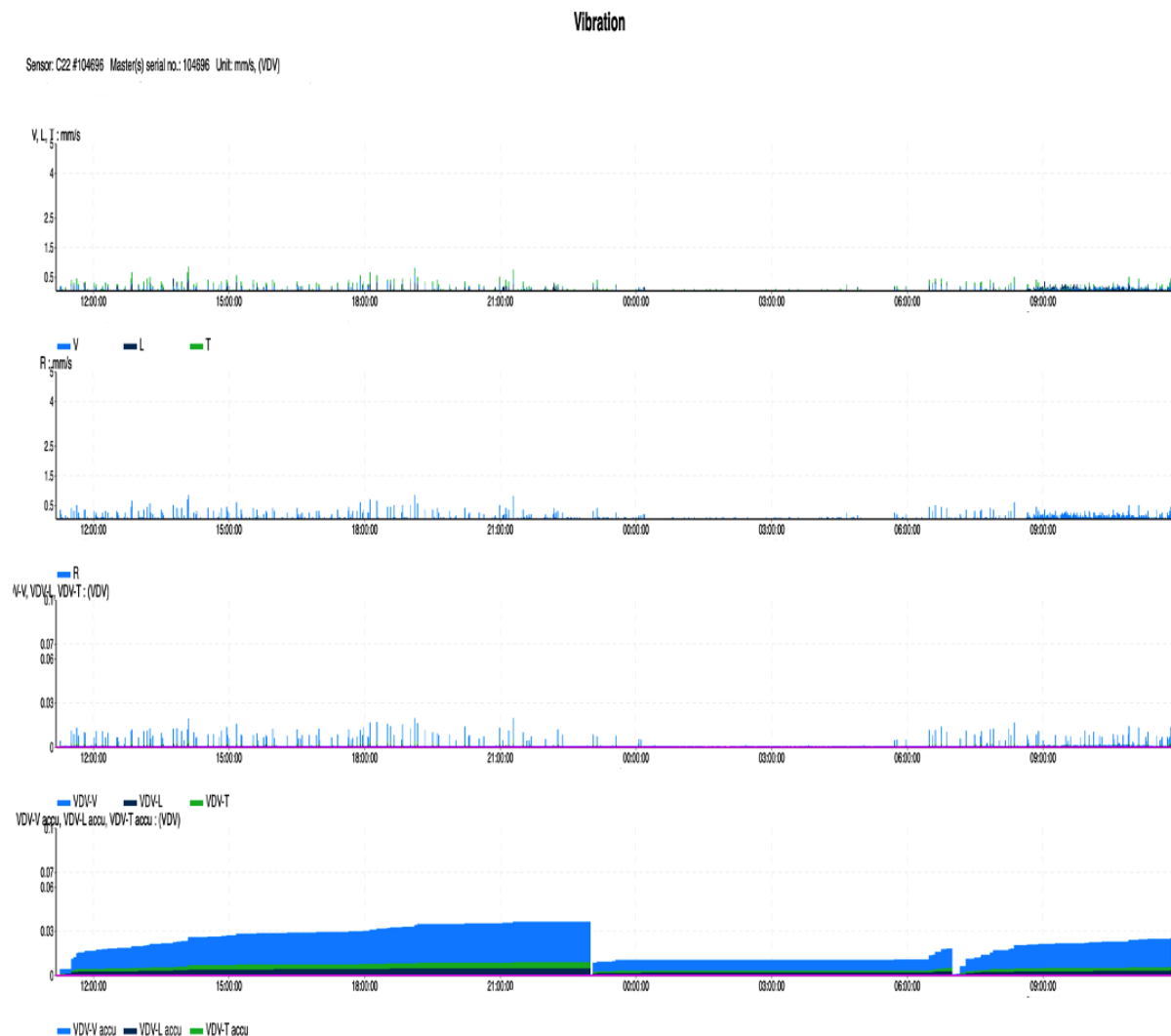
- 6.3.1 It is anticipated that a ventilation system will be needed to be incorporated into the scheme design, such that residents of the properties are able to have background ventilation without necessarily needing to open windows. Table 7 shows the specification for an example suitable product.

Table 7

Description	Octave Band Centre Frequency (Hz) Sound Reduction Index <i>D_{n,e}</i> dB					
	125	250	500	1k	2k	4k
Standard acoustic trickle ventilator typically ≥ <i>D_{n,e,w}</i> 35dB	33	33	34	35	32	31

7.0 Vibration Data

Figure 7



Location	Date/Time	VDV Value ($\text{m/s}^{1.75}$)	Peak Event ($\text{m/s}^{1.75}$)
Station House, Station Road	28/11/23 11.11am – 29/10/23 10.50am	0.036	0.0196

7.1 Vibration prediction values

- 7.1.1 The VDV values measured during the assessment are well below those, described in table 2, from BS6472-1:2008 as having 'low probability of adverse comment' so therefore full models based on the proposed structure construction are not considered necessary.
- 7.1.2 As a check the following procedure for the train pass-by in isolated events was performed: This is where the vibration conditions are constant or repeated regularly, only one representative sample, of duration τ seconds, needs to be measured. If the vibration dose value determined is $VDV_{b/d,\tau}$ then the total vibration dose value for the day, $VDV_{b/d,day}$ will be given by;

$$VDV_{b/d,day} = \left(\frac{t_{day}}{t_{\tau}} \right)^{0.25} \times VDV_{b/d,\tau}$$

Based on the assessment there are an average of 2 trains per hour, resulting in maximum 32 trains over a 16hr day period (28 in the assessment) and $VDV_b = 0.0075$

Therefore:

$$VDV_{b/d,day} = 32^{0.25} \times 0.0196$$

$$VDV_{b/d,day} = 0.0466 \text{ (m/s}^{1.75}\text{)}$$

- 7.1.3 According to Table 2 there is likely to be low probability of adverse comment from the rail route adjacent to the proposed development. There were only 11 events through the night period (mainly from 6am-7am) so this level would be even further below the values for adverse comment from table 2.

8.0 Categorisation to TAN 11: Oct 1997

- 8.0.1 The daytime levels measured at the façade facing the platform of the train station produced L_{Aeq} values of 65.5dBA. This would mean that, in accordance with the Noise Exposure Categories (NEC) provided by the TAN guidelines, the development would be placed into category. This means that noise should be considered and mitigation measures imposed where possible.
- 8.0.2 The glazing and ventilation strategy proposed in section 6 would provide more than sufficient mitigation measures to be considered acceptable under the Tan guidelines. This has been displayed in the renovated section of the building where levels were reduced to L_{Aeq} 32.7dBA internally over the same time period. Specification has also been confirmed for the glazing in the rest of the building to make sure that the levels stay below the values issued in both the BS8233:2014 and WHO guidelines for community noise. As there is no outdoor space, balcony or any other form of social space planned towards the station, there appears to be no further needs for additional mitigation measures.
- 8.0.3 The night values for the external façade of the proposed dwelling were measured as L_{Aeq} 51.5dBA, this reducing to 22.4dBA for the internal measurements. This would also put the proposed development into the Category B NEC with the same comments as the daytime measured values. Existing and proposed mitigation for the glazing and ventilation strategy would again be considered sufficient measures.
- 8.0.4 The further criteria for night-time noise classification is the L_{Amax} should not 'regularly exceed 82dBL_{Amax} several times in any hour'. There are only 7 spikes through the entire night period (11pm – 7am), although only 6 exceed the 82dB L_{Amax} limit. The most frequent gathering of these is from 6-7am where there are 5 trains – 4 of which stop in the station with the 5th passing through. It is open for debate as to whether or not the train every 10mins through this period constitutes 'frequent exceedances. Should this be considered the case the development would be moved into category C. At this point the development would be refused planning approval unless the site is considered required due to the lack of alternative sites, and/or a 'commensurate level of protection against noise' can be provided. In this circumstance, and due to the unusual nature of the building, mitigation measure proposed should mean that there is no need to refuse planning permission for this development. Had outdoor living spaces or balconies been proposed by the developer the author would not consider this to be an appropriate development. As there is not, and there has already been proof that L_{Amax} and L_{Aeq} night values would be well below criteria, both for TAN 11 and BS8233, the development seems to be a reasonable use of otherwise abandoned space.

8.1 Additional Noise Sources

- 8.1.1 The additional noise sources present during the investigation included some patron noise and announcement noise. There were no instances where elevated speech or equivalent sources were collected, nor is this considered likely to be a regular occurrence to warrant further investigation. The station announcements are low-level with the highest measured L_{Amax} value during the assessment being at 68.9dBA. As the

announcements are generally repetition related to baggage being left unattended, alighting instructions, or information on arriving/departing trains, this was also not considered significant enough to warrant further analysis for the proposed development. There were no announcements measured after 9pm or before 7.15am. it is therefore not something that would be considered for the night-period measurements.

9.0 Conclusion

- 9.0.1 If the recommendations of this report are followed the proposed dwelling should produce a residence that does not produce adverse comment on the surrounding noise sources. It is recommended that the same glazing specification is used at the front and back of the proposed developed building. The corridors between the East-end bedrooms and the rail line will provide further reductions in noise and vibration impact that calculated in this report.
- 9.0.2 The vibration levels on site do not warrant any further mitigation measures being imposed on the building to improve the impact on future inhabitants of the proposed dwellings.
- 9.0.3 The current section of the property that has already been refurbished meets the requirements for daytime and night-time levels in accordance with BS8233:2014. This bedroom was 2dB below the criteria for daytime levels, and 8dB below the criteria for night-time. Continuing this standard of build throughout the property will see the full premises being more than acceptable in accordance with BS8233:2014.
- 9.0.4 Although TAN 11 guidelines for night L_{Amax} could be argued to push the development into NEC Cat C, the proposed mitigation measures with glazing and ventilation plus the lack of proposed outdoor space

Appendix A – Acoustic Terminology

Parameter	Description
Ambient Noise Level	The totally encompassing sound in a given situation at a given time, usually composed of a sound from many sources both distant and near ($L_{Aeq,T}$).
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10}(s_1/s_2)$. 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 $20\mu Pa$. The threshold of normal hearing is in the region of 0 dB and 140 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.
dB(A), L_{Ax}	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
Free-field	Sound pressure level measured outside, far away from reflecting surfaces (except the ground), usually taken to mean at least 3.5 metres
Façade	Sound pressure level measured at a distance of 1 metre in front of a large sound reflecting object such as a building façade.
$L_{Aeq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level recorded during a noise event with a period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise. $L_{A10,18h}$ is the A-weighted arithmetic average of the 18 hourly $L_{A10,1h}$ values from 06:00-24:00.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. Generally used to describe background noise level.

Appendix B - Noise Survey Instrumentation



Manufacturer Calibration Certificate

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3. All tests are traceable in accordance with ISO/IEC 17025.

This model of sound level meter submitted for periodic testing successfully completed the applicable pattern-evaluation tests given in IEC 61672-2. The pattern approval certificate is available at www.nti-audio.com/XL2.

Sound Level Meter

Manufacturer	NTi Audio		
Type	XL2-TA	S/N	A2A-22077-F0
Firmware	V4.71		
Microphone Model	M2230		
Preamplifier	MA220	S/N	11392
Microphone Capsule	MC230A	S/N	A24696
Performance class	Class 1		
Customer Inventory Nr.			

Customer

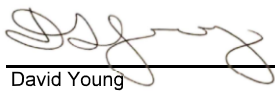
Crimson Remote Services Ltd
7 Hicks Grove
Thoresby Vale
Edwinstowe
Nottinghamshire

Date 07 February 2023

Certificate UK-23-018

Results PASSED
(for detailed report see next pages)

Operator


David Young

NTi Audio UK Ltd • Office 33C Julians Road • Stevenage
Hertfordshire, SG1 3ES, UK • uk@nti-audio.com



Manufacturer Calibration Certificate

The following instrument has been tested and calibrated to the manufacturer specifications.
The calibration is traceable in accordance with ISO/IEC 17025 covering all instrument functions.

- Device Type: **Class 1 Sound Calibrator CAL200**
- Serial Number: **19829**

- Date of Calibration: **20 November 2023**
- Certificate Number: **45250-19829-CAL200**
- Results: **PASSED**
(for detailed report see next page)

Tested by:

D.Young

Signature:

A handwritten signature in black ink, appearing to be 'D. Young', written over a horizontal line.



CALIBRATION DOCUMENT

Document No:	Print Date:	Location of Calibration:	Page No:
Cal 99011	10/11/2022	Horsham, UK	1 / 1

Customer: Crimson Remote Services Ltd

Device under Test: INFRA C22 Triaxial Vibration Monitor
SN: 104696
Software Version: 2.7.0.9

Date of Calibration: 10/11/2022

Ambient Conditions: 23° C ± 2° C (73.4° F ± 3.6° F)

Method of Measurement: C311xB.
(Reference frequency: 80Hz (16Hz), frequency sweep: 1-1000 Hz)

Equipment: Reference Amplifier: B&K 2525 #1899363
Reference Accelerometer: B&K 4381 #30964
Digital Multimeter: Keysight 34465A #MY57505444
Signal Generator: Keysight 33521B #MY58000152
Climate Sensor: Comet T7510 #18966666
Vibration System: Modal Shop K2075E040 #973

Traceability: Reference equipment is calibrated at accredited laboratories, traceable to NIST, PTB or other National Metrology Laboratory.

Result of Measurement: Calibrated with no corrective actions.

Results are within specification limits of the method, which includes the hardest demands of all standards available in the geophone.

Recommended Interval of Calibration: 12 months.

Calibration performed by: Wesley Brown
Signature: 

Appendix C – Weather Conditions Chart Used

(Blank Version)

Weather Conditions				
Measurement Location	Date/Time	Description	Beginning of Survey	End of Survey
		Temperature:		
Cloud Cover Symbol Scale in oktas (eighths) 0 Sky completely clear 1 2 3 4 Sky half cloudy 5 6 7 8 Sky completely cloudy (9) Sky obstructed from view		Precipitation:		
		Cloud cover (oktas - see guide)		
		Presence of fog/snow/ice		
		Presence of damp roads/wet ground		
		Wind Speed (m/s)		
		Wind Direction		
		Conditions that may cause temperature inversion (i.e. calm nights with no cloud)		