Residential Noise Assessment

Site Address: Imperial Buildings, King Street, Wrexham, LL11 1HE

Client Name: M1 Investments

Project Reference No: NP-011172

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1. Introduction

NOVA Acoustics Ltd has been commissioned to prepare a noise assessment for a residential development ('the proposed development') at Imperial Buildings, King Street, Wrexham, LL11 1HE ('the Site'). The proposed development is for change of use of the first and second floor from offices to residential apartments.

The applicant has submitted planning application No. P/2022/0837 ('the Application') to the Local Planning Authority ('LPA'), Wrexham County Borough Council. This report has been prepared to accompany the application and provides supplementary technical information regarding the site's suitability for the proposed use. Additionally, the scheme has been assessed against the requirements of the LPA's draft planning conditions, specifically Condition 3 and Condition 4.

A noise survey has been undertaken to establish the prevailing sound levels at the proposed development. The findings have been subsequently used to assess the suitability of the site for residential use. Measures required to mitigate noise impacts for the proposed development have been assessed in accordance with the relevant performance standards, legislation, policy and guidance.

This noise assessment is necessarily technical in nature; therefore, a glossary of terms is included in Appendix A to assist the reader.

1.1 Standards, Legislation, Policy & Guidance

The following performance standards, legislation, policy and guidance have been considered to ensure good acoustic design in the assessment:

- The LPA's draft conditions; specifically, Condition 3 and Condition 4.
- Planning Policy Wales (2024).
- Planning Guidance (Wales), Technical Advice Note (Wales) 11, Noise – October 1997.
- British Standard BS 4142:2014+A1:2019 – 'Methods for rating and assessing industrial and commercial sound'.
- British Standard BS8233:2014 – 'Guidance on sound insulation and noise reduction for buildings'.
- ProPG: 'Planning and Noise 2017' (including supplementary documents 1 & 2).
- Approved Document F: Volume 1 Dwellings (2021).
- Acoustics Ventilation Overheating: Residential Design Guide 2020' (AVO Guide).

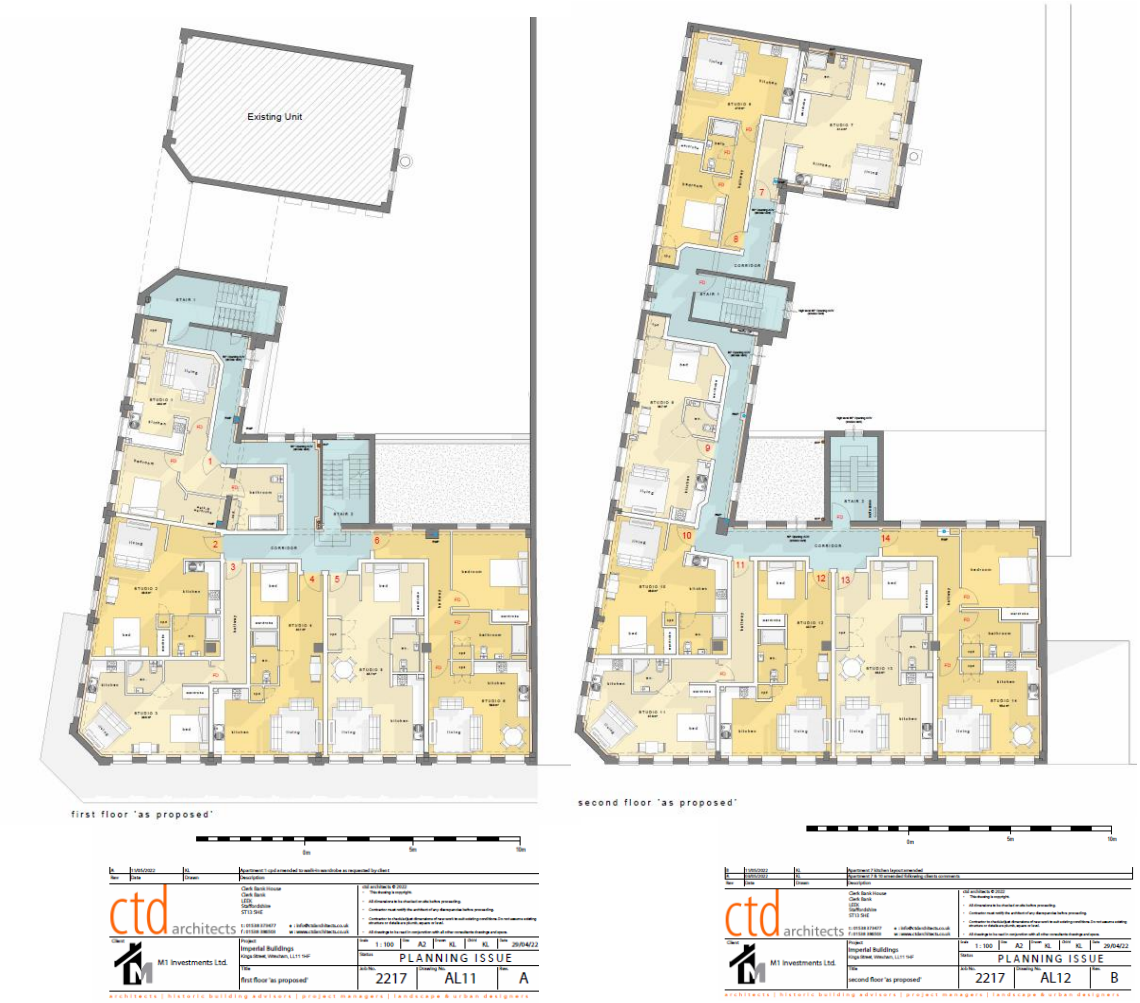
Further information on the legislation can be found in Appendix B.

1.2 Proposal Brief

The proposal is for the change of use of first and second floor offices to form 10 No. studio apartments and 4 No. one bedrooms apartments. The existing retail use of the ground and partial first floor is to be retained.

Due to the layout of the building, the only shared partition between the existing retail and new residential shall be the party floor, which has been included within the assessment to ensure that noise breakthrough from within the structure does not result in unsuitable noise levels within the residential areas.

The figure below shows the proposed development.



Drawing Ref No. 2217 AL11 A and 2217 AL12 B from 'ctd architects'

Figure 1 – Proposed Development

1.3 Local Planning Authority and Background

Draft planning conditions have been provided by the LPA for the proposed development, with Conditions 3 and 4 directly applicable to noise. The conditions state:

"3. No part of the development shall commence until a noise survey has been carried out, and a detailed report of the survey findings has been submitted to, and approved in writing by, the Local Planning Authority. The noise survey shall determine noise levels for both Day (07:00 – 23:00 hours) and Night (23:00 – 07:00 hours), having regard to Planning Policy Wales (PPW) Guidance, Technical Advice Noise (TAN) 11 – Noise. The report of the noise surveys findings shall include:

a) *Noise levels arising from day / night time activities in the vicinity of the proposed development site and the impact upon the existing or proposed accommodation, and*
b) *A detailed scheme of noise insulation and / or attenuation measures so designed to safeguard the amenity of the existing or occupants of the proposed accommodation hereby approved. The measures as are approved shall be fully implemented prior to the first occupation / use of the development."*

And

"4. No part of the development shall commence until a scheme of noise insulation and attenuation measures between the ground and first floors and the first and second floors, in compliance with Building Regulations Guidance: Part E – Resistance to the Passage of Sound, has been submitted to, and approved in writing by, the Local Planning Authority. The measures as are approved shall be fully implemented in strict accordance with the scheme prior to first occupation / use of the development and shall thereafter be permanently retained."

2. Environmental Noise Survey

2.1 Measurement Methodology

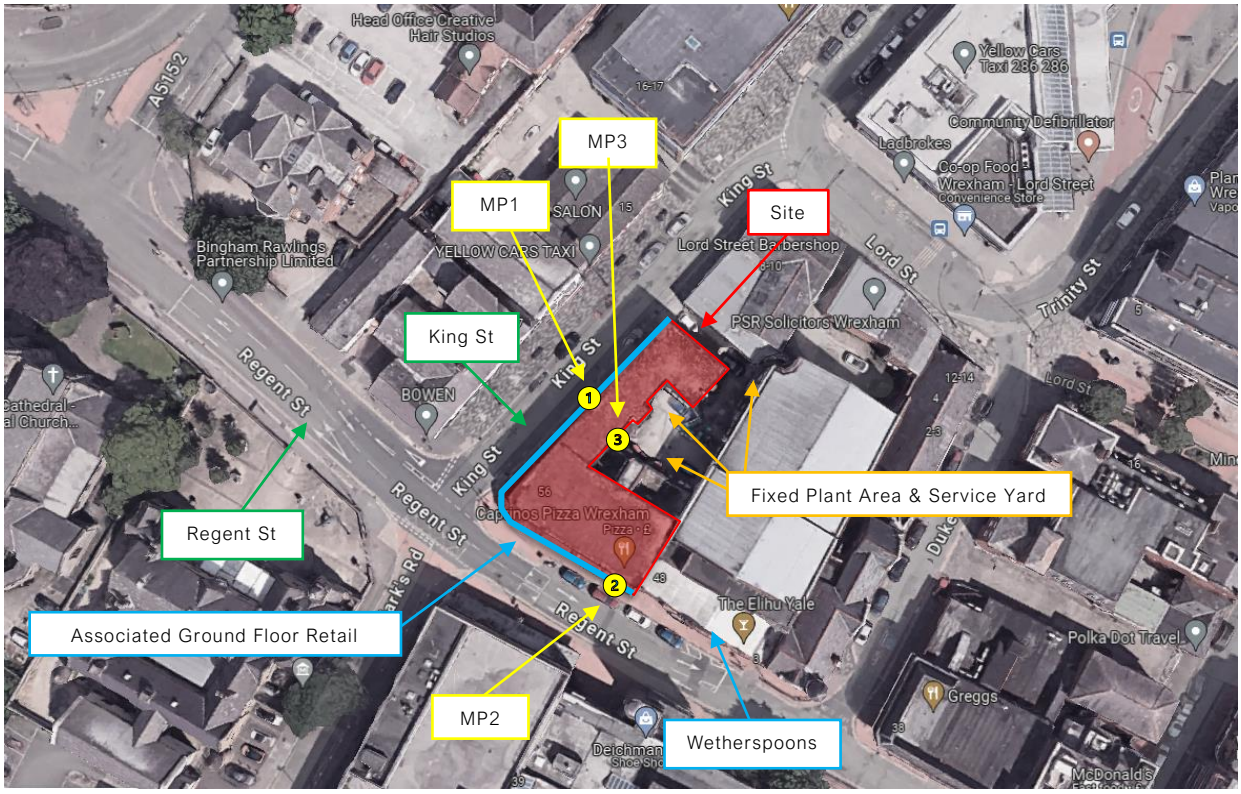
The following table outlines the measurement dates and particulars. In all instances a 130mm diameter windshield was fitted to the microphones along with a suitable outdoor environmental kit. Details of the equipment used, and the meteorological conditions are available in Appendix D.

Note that a -3dB façade correction has been applied to all measured levels at MP1, MP2 and MP3 to account for increased façade reflections.

Location	Survey Dates	Measurement Particulars
MP1	31/05/24 – 03/06/24	Equipment protruding 1.5m from the first-floor north façade overlooking King Street, directly above 'Grow' sales and lettings estate agents.
MP2	31/05/24 – 03/06/24	Equipment protruding 1.5m from the first-floor south façade overlooking Regent Street, directly above 'Shoezone' retail shoe shop.
MP3	31/05/24 – 03/06/24	Equipment protruding 1.5m from the second-floor east façade overlooking the rear service yard and plant area which services the existing ground floor retail units.

Table 1 – Measurement Methodology

The figure below outlines the site surroundings and measurement locations:



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Figure 2 – Measurement Locations and Site Surroundings

2.2 Context & Subjective Impression

The site is situated within the city centre of Wrexham in what is a very built up and urban area. The surrounding properties are predominantly commercial in nature, including multiple restaurants, takeaways, a pub, and other commercial premises typical of a main high street. North of the site off Lord Street is the local bus station, with a high volume of buses and taxis present within the area.

Numerous items of fixed plant were identified to service both the associated retail units on the ground floor and other separate commercial units within the local area. The table below contains the details of commercial premises within proximity to the proposed development, including the known operating times of each business. All premises not listed are either regarded as being low noise generation, such as a hairdresser, or limited to daytime use only.

Name	Description	Opening Hours
Caprinos Pizza Wrexham	A dine-in and takeaway pizza restaurant situated on the ground floor of the site	11:00 – 01:30 hours Sunday to Thursday, 11:00 – 03:30 hours Friday and Saturday
Wrexham Bakeshop & Café	A bakery and dine-in café situated on the ground floor of the site	08:30 – 17:00 hours Monday to Friday, 09:00 – 17:00 hours Saturday, 10:00 – 16:00 hours Sunday
Town & Country	Sales and lettings estate agents situated on the ground floor of the site	09:00 – 17:30 hours Monday to Friday, 09:00 – 16:00 hours Saturday, Closed on Sundays
Perfect Pizza	Takeaway pizza restaurant occupying both the ground floor and first-floor of the site	17:00 – 03:00 hours Monday to Thursday, 15:00 – 04:00 hours Friday, 15:00 – 05:00 hours Saturday, 15:00 – 03:00 hours Sunday
Subway	A dine-in and takeaway sandwich restaurant located next door to the proposed development	09:00 – 19:00 hours Monday to Thursday, 09:00 – 20:00 hours Friday and Saturday, 10:00 – 18:00 hours Sunday
The Elihu Yale Wetherspoons	A restaurant and pub neighbouring the proposed development off Regent Street	08:00 – 00:00 hours Sunday to Thursday, 08:00 – 01:00 hours Friday and Saturday
Wrexham Kebab & Pizza	Takeaway pizza restaurant located opposite the proposed development and Perfect Pizza on King Street	16:30 – 00:00 hours Monday to Tuesday, 16:30 – 00:30 hours Wednesday 16:30 – 01:30 hours Thursday and Friday, 16:30 – 02:00 hours Saturday, 16:30 – 00:30 hours Sunday

Table 2 – Measurement Methodology

The under croft that separates Town & Country and Perfect Pizza was noted to be used as staff parking for the surrounding businesses. All deliveries both for the associated and immediate non-associated businesses appear to take place directly outside Perfect Pizza, with deliveries observed to take place on Monday morning between 08:00 and 10:00 hours.

Overall, the existing noise climate in all positions is moderate to high in level. The dominant noise sources at MP1 and MP2 were from vehicle passbys on the King Street and Regent Street respectively, although it was noted that Regent Street features significantly fewer heavy vehicles and is subjectively quieter. Buses accelerating down King Street were particularly noticeable when present. At both positions, noise arising from pedestrian footfall and retail activity was secondary in nature, with plant emissions subjectively inaudible here. MP3 was dominated by plant noise which completely masks any road noise or other sources that may be present in the area. Of the plant present, noise from the kitchen extract ductwork and chillers were dominant, which are assumed to be servicing Subway and Perfect Pizza given their location. Spot measurements were undertaken of some plant; however, most plant was inaccessible.

2.3 Environmental Noise Survey Results

The following section outlines the measured sound levels during the unattended survey. The time history results and $L_{A90,15min}$ histograms can be found in Appendix D.

Location	Measurement Period ('T')	Octave Frequency Band (Hz, $L_{eq,T}$ dB)							$L_{Aeq,T}$ (dB)	$L_{AFmax,1min}$ (dB)*
		63	125	250	500	1k	2k	4k		
MP1	$L_{eq,16hr}$ (Day)	67	61	59	57	56	53	47	60	--
	Highest $L_{eq,1hr}$ (Day)	71	65	66	64	64	59	54	68	--
	$L_{eq,8hr}$ (Night)	62	55	56	54	53	49	44	57	78
	Highest $L_{eq,15min}$ (Night)	68	64	69	68	65	60	57	70	--
MP2	$L_{eq,16hr}$ (Day)	69	64	61	59	59	59	58	65	--
	Highest $L_{eq,1hr}$ (Day)	72	70	66	65	65	72	74	78	--
	$L_{eq,8hr}$ (Night)	62	58	57	55	58	53	47	61	80
	Highest $L_{eq,15min}$ (Night)	70	70	73	70	74	71	65	77	--
MP3	$L_{eq,16hr}$ (Day)	67	66	61	55	52	49	45	59	--
	Highest $L_{eq,1hr}$ (Day)	70	69	63	57	55	54	52	62	--
	$L_{eq,8hr}$ (Night)	66	65	60	53	49	45	42	57	71
	Highest $L_{eq,15min}$ (Night)	69	69	62	57	52	49	45	60	--

Table 3 – Sound Level Results Summary

**Exceeded 10 times or fewer per night.*

3. BS4142 Noise Impact Assessment

3.1 BS4142 Noise Impact Assessment

Noise Sources & Subjective Impression

As mentioned in the previous section, there are multiple items of fixed plant are present within a very close radius of the site, multiple of which are mounted to the external walls of the proposed development. The noise emissions from said plant have been assessed in accordance with BS4142:2014+A1:2019. Any identified items of fixed plant are illustrated in the figure below.

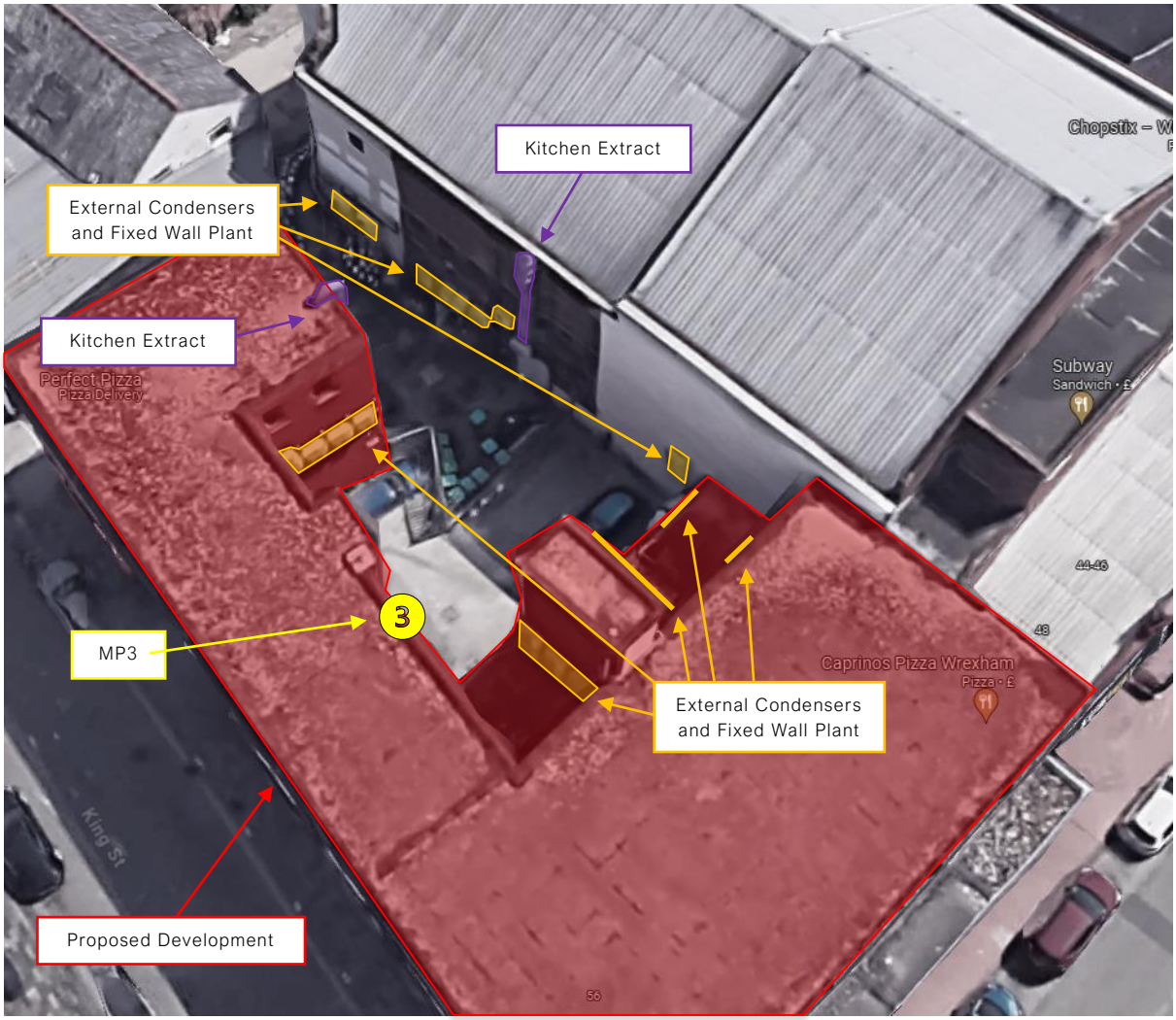


Figure 3 – Nearby Fixed Plant

The external fixed plant noise emissions are clearly audible at the most exposed window of the proposed development (MP3). No distinctive acoustic characteristics, such as tonality, intermittency or impulsivity were noted whilst on site, although a low hum synonymous with this type of plant was present and not all plant was accessible. The fixed plant noise emissions are not tonal; however, they do include a perceptible low frequency hum.

The figure on the overleaf presents the time history graph in from MP3.

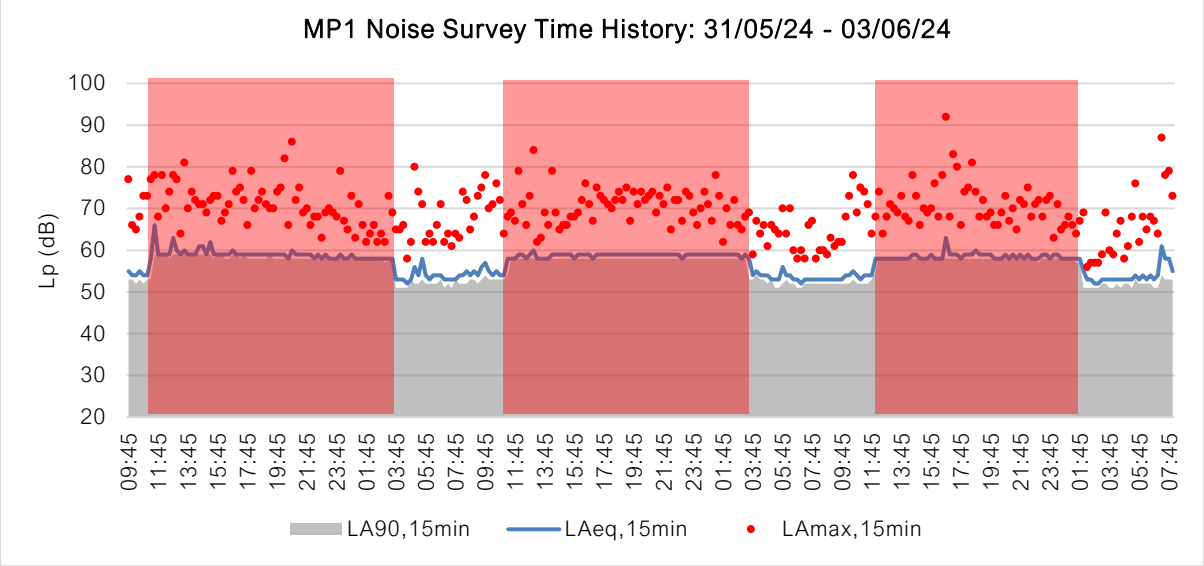


Figure 4 – Time History of MP3 with Operating Hours Highlighted

Background Sound Level Analysis

The following section outlines the measured background sound levels that have been used as the baseline for the subsequent BS4142 noise assessment. Statistical analysis of the measured $L_{A90,15min}$ levels have been undertaken at each position to ascertain what the most typical background level is. Where the results were bimodal, the lowest representative value was selected instead. The $L_{A90,15min}$ levels at MP3 exclude the operating hours Caprinos Pizza Wrexham which is when the main plant dominance is observed.

The table below presents that representative background level at each position. The background histograms are available in Appendix D.

Position	Daytime Background Level ($L_{A90,15min}$ dB)	Night-time Background Level ($L_{A90,15min}$ dB)
MP1	50	45
MP2	52	44
MP3	53	52

Table 4 – Background Sound Level Comparison

Even with the dominant plant periods removed, it still appears that the background is affected by residual plant noise and as such, the background levels from this position is not the true background. Accounting for the shielded location, excluding plant this area should be quieter than MP1 and MP2. Therefore, the lowest values from MP1 and MP2 have been used as the representative background level at MP3, resulting in an $L_{A90,15min}$ of **50dB** and **44dB** during the daytime and night-time respectively.

Specific Sound Levels

Whilst short-term spot measurements were undertaken by two items of plant, the majority of plant was inaccessible. As MP3 best encapsulates the plant noise incident on the façade, the specific level has been calculated by deducting the residual level from the ambient level, as presented in the table on the overleaf.

Description	1/1 Octave Frequency Band (Hz, $L_{eq,T}$ dB)							Overall (dBA)
	63	125	250	500	1k	2k	4k	
Daytime Ambient level at MP3, using the worst-case hour	70	69	63	57	55	54	52	62
Daytime Residual level at MP3, between 07:00 and 08:00 hours	67	58	57	54	50	46	42	56
Daytime Specific level at MP3	**67**	**69**	**62**	**54**	**53**	**53**	**52**	**61**
Night-time Ambient level at MP3, using the worst-case 15 mins	69	69	62	57	52	49	45	60
Night-time Residual level at MP3, outside of businesses operating hours	67	57	57	52	47	42	38	54
Night-time Specific level at MP3	**65**	**69**	**61**	**55**	**50**	**48**	**44**	**59**

Table 5 – Specific Level Calculations

The residual level has been taken from 07:00 and 08:00 hours during the day. For the night, the residual level has been taken from 04:00 to 07:00 hours Friday, 05:00 – 07:00 hours Saturday, and 03:00 – 07:00 hours Sunday. These periods were selected as they are outside of the surrounding businesses operating hours. Note that plant that operates continuously regardless of the businesses opening hours, such as chillers, may still be present. However, as the loudest ambient period is +6dB louder than the residual, plant operating during this period will be dominant and unaffected by any quieter plant operating continuously.

BS4142 Noise Impact Assessment

The BS4142 noise impact assessment is presented in the following tables.

Daytime BS4142 Assessment								
Description	1/1 Octave Frequency Band (Hz, dB)							Overall (dBA)
	63	125	250	500	1k	2k	4k	
Specific sound level outside the bedroom window (MP3)	67	69	62	54	53	53	52	61
Acoustic feature correction	A +4dB penalty has been applied for a clearly low frequency hum that exists within the fixed plant noise emissions.							+4
Rating sound level ($L_{Ar,Tr}$)								65
Background sound level	Surrogate background from MP1 $L_{A90,15min}$ in Table 4.							50
Exceedance								+15
BS4142 assessment outcome	Significant Adverse Impact, dependent on context.							
NPPF & NPSE outcome	Significant Observed Adverse Effect Level ('SOAEL').							
Mitigation measures are required to reduce noise impact.								

Table 6 – Daytime BS4142 Noise Impact Assessment

Night-time BS4142 Assessment								
Description	1/1 Octave Frequency Band (Hz, dB)							Overall (dBA)
	63	125	250	500	1k	2k	4k	
Specific sound level outside the bedroom window (MP3)	65	69	61	55	50	48	44	59
Acoustic feature correction	A +4dB penalty has been applied for a clearly low frequency hum that exists within the fixed plant noise emissions.							+4
Rating sound level ($L_{Ar,Tr}$)								63
Background sound level	Surrogate background from MP2 $L_{A90,15min}$ in Table 4.							44
Exceedance								+19
BS4142 assessment outcome	Significant Adverse Impact, dependent on context.							
NPPF & NPSE outcome	Significant Observed Adverse Effect Level ('SOAEL').							
Mitigation measures are required to reduce noise impact.								

Table 7 – Night-time BS4142 Noise Impact Assessment

Discussion

As can be seen above, a significant adverse impact is expected at the proposed development. The majority of the windows overlooking the plant are for hallways and circulation areas and are therefore not sensitive; however, Studio 7 on the 2nd floor and bedrooms within Studio 6 and Studio 14 will be situated directly overlooking plant with plant affixed to the external walls. Additionally, there is a high element of uncertainty in this assessment due to the plant being inaccessible so plant noise emissions could be even higher, particularly those from the extract systems.

3.2 Recommendations & Mitigation Measures

In the following section, the recommendations and mitigation measures required to reduce the noise impact from the external fixed plant are proposed.

The ProPG supplementary document 2 provides the following 'Good Acoustic Design' hierarchy of noise management measures which LPAs should encourage. These are shown in the following table, in descending order of preference:

Order of Preference	Noise Management Measure
1	Reduction of the noise generated at source by redesign, relocation or containment. *
2	Maximising the spatial separation of noise source(s) and receptor(s).
3	Using existing topography and existing structures (that are likely to last the expected life of the noise-sensitive scheme) to screen the proposed development site from significant sources of noise.
4	Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.
5	Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.
6	Using the layout of the scheme to reduce noise propagation across the site.
7	Using the orientation of buildings to reduce the noise exposure of noise sensitive rooms.
8	Using the building envelope to mitigate noise to acceptable levels.

Table 8 – Hierarchy of Noise Management Measures

**Not from ProPG*

The TAN 11 document for Wales also states that measures introduced to control the source of, or limit exposure to, noise should be proportionate and reasonable, and may include:

- Engineering: a reduction of noise at the point of generation, containment of noise generated such as through acoustic housing being placed around plant, and the protection of noise-sensitive buildings by improving sound insulation or screening them with purpose-built barriers.
- Layout: adequate distance between noise source and noise-sensitive building or area.
- Administrative: limiting operating time of noise source, restricting activities allowed on the site or specifying an acceptable noise limit.

Proposed Mitigation Measures

Using the table above, it is apparent that many of the options will not be realistically achievable. Given the quantity of plant present, mitigation measures would be required to all equipment, some of which has no relation to the proposed development. Mitigating the plant at source or relocating a lot of the plant is therefore not considered to be viable. Through careful specification of the glazing, appropriate internal noise levels can be achieved internally providing windows are forced closed and a mechanical ventilation strategy is installed. It is also recommended that layout of Studio 6, 7 and 14 is reconfigured to avoid locating the bed by the windows directly adjacent or overlooking plant. These two mitigation options are in line with the first point provided within the TAN 11 document with reference to 'Measures to mitigate the impact of noise'.

Furthermore, all plant either affixed to the external wall or roof above a residential apartment should be fitted with anti-vibration mounts to limit structure-borne noise ingress. If the kitchen extract ductwork for Perfect Pizza can be relocated to the northern façade where there are no windows, then it is strongly advised that it is to reduce the risk of complaints.

4. Noise Break-in Assessment and Sound Insulation Scheme

4.1 Internal Noise Level Criteria

The following table outlines the internal acoustic design criteria used in the following assessment.

Activity	Location	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Resting	Living Room	35 dB $L_{Aeq,16hr}$	--
Dining	Dining Room/Area	40 dB $L_{Aeq,16hr}$	--
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$ 45 dB L_{AFmax}*

**Note 1: The maximum criteria have been taken from the World Health Organisation (WHO) Guidelines for Community Noise.*

**Note 2: ProPG:2017 which is relevant to 'New Residential' states; "In most circumstances in noise sensitive rooms at night (e.g., bedrooms) good acoustic design can be used so that individual noise events do not normally exceed 45dB $L_{Amax,F}$ more than 10 times a night. However, where it is not reasonably practicable to achieve this guideline then the judgement of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number, distribution, predictability, and regularity of noise events".*

Note 3: BS8233:2014 states: "Where development is considered necessary or desirable, despite external noise levels above WHO guidelines, the internal target levels may be relaxed by up to 5 dB and reasonable internal conditions still achieved".

Note 4: BS8233:2014 states: "The levels shown in Table 4 (criteria shown above) are based on the existing guidelines issued by the WHO and assume normal diurnal fluctuations in external noise. In cases where local conditions do not follow a typical diurnal pattern, for example on a road serving a port with high levels of traffic at certain times of the night, an appropriate alternative period, e.g., 1 hour, may be used, but the level should be selected to ensure consistency with the levels recommended in Table 4.

Note 5: BS8233:2014 states: "If relying on closed windows to meet the guide values, there needs to be an appropriate alternative ventilation that does not compromise the façade insulation or the resulting noise level.

Table 9 – Acoustic Design Criteria

To the front and side of the property the noise environment follows a typical diurnal pattern and is dominated by road traffic and general pedestrian footfall to the retail areas. For all road facing facades, the average level has been used to inform the glazing specification to achieve the relative criteria above.

To the rear the noise environment does not follow a typical diurnal pattern as it is clearly influenced by external fixed plant noise emissions during both the day and night. In line with Note 4 of the above table, the highest measured $L_{eq,1hr}$ has been compared to relevant criteria from Table 9 above.

4.2 Glazing and Background Ventilation Specification

The following section provides a glazing and background ventilation specification that achieves the relevant internal noise criteria. The calculations considering the following sound insulation scheme can be found in Appendix E.

Sound Insulation Scheme – Road Facing Facades								
Description	Octave Frequency Band (Hz, dB)							Overall (dB)
	63	125	250	500	1k	2k	4k	
6mm Glass / 16mm Air Cavity / 6.8mm Optiphon Glass	21	21	28	37	48	48	54	39 R_w (-6; C_{tr})
Greenwoods 2500EA.AC1 (2 No. Trickle)	31	41	40	37	47	43	46	42 $D_{ne,w}$ (-2; C_{tr})
Sound Insulation Scheme – Rear Plant Facing Rooms								
10mm Glass / 16mm Air Cavity / 8.8mm Optiphon Glass	25	28	31	42	45	50	58	44 R_w (-6; C_{tr})

Table 10 – Glazing & Background Ventilation Specification

Any other window or ventilation specification capable of providing this attenuation will be suitable provided the glazing suppliers can provide an acoustic test report in accordance with BS EN ISO 10140-2:2010 or an evidence-based calculation.

Note that the apartments overlooking the plant the glazing specification has been increased to account for the acoustic character correction applied in the previous section for tonality. Due to the high noise levels incident on the rear façade and hours in which the plant activity occurs, a hybrid ventilation strategy with passive trickle ventilators will not be viable in apartments overlooking the plant area and must be ventilated by fully mechanical means.

5. Overheating Assessment

In order to avoid excessively high temperatures and provide adequate levels of thermal comfort within dwellings, an overheating mitigation strategy must be developed. In low noise areas, this strategy can often rely upon opening windows as the primary source of ventilation, however, in areas with higher levels of noise, this would present a risk of adverse effects on health and quality of life.

5.1 Criteria

Considering that the development is a change of use and not new build, it is not a requirement to achieve the criteria defined in Approved Document O ('ADO'). However, to allow for a reasonable living environment, it is recommended that the less onerous criteria given in the 'Acoustics Ventilation and Overheating Design Guide' ('AVO') should be applied. Considering that a partially open window provides approximately 13dB of attenuation (as stated in 'AVO') the proposed internal and external noise criteria are summarised as follows:

Period	Proposed Criteria (dB)	
	Internal	External
Daytime ($L_{Aeq,16hr}$)	50 [1]	63
Night-time ($L_{Aeq,8hr}$)	42 [1]	55
Night-time ($L_{AFmax,T}$) [2]	65 [1]	78

Notes:

[1] *Criterion taken from the AVO guide. Above this level, it is stated: "Noise causes a material change in behaviour, e.g. having to keep windows closed most of the time."*

[2] L_{AFmax} *exceeded fewer than 10 times per night.*

Table 11 – External Noise Level Limits for Overhearing Criteria

5.2 Assessment

The noise levels measured on site exceed the external noise criteria shown in the table above. As such, an assessment of whether the development is at risk of overheating would need to be undertaken by a suitably qualified person. Should the outcome indicate the site is at low risk of overheating, then a secondary ventilation strategy may not be required. If the outcome is that the site is at moderate to high risk, then it is recommended that openable windows are not used as the primary source of ventilation.

Alternative forms of ventilation include passive systems (such as acoustic louvres) and mechanical systems (such as 'centralised mechanical extract ventilation' and 'mechanical ventilation with heat recovery'). The installation of passive systems is generally preferable; however, the precise requirements must be confirmed with a ventilation specialist. Further to this, it must also be ensured that all ventilation strategies are compliant with the requirements of Approved Document F.

It should be noted that this assessment relates exclusively to overheating mitigation, and as such, open windows may be used for purge ventilation without acoustic constraint; with the exception of windows to the rear directly overlooking the fixed plant which must be forced closed following the outcome of the BS4142 assessment earlier in the report. Further advice can be provided by NOVA Acoustics, if required.

6. Noise Breakthrough Assessment and Sound Insulation Scheme

6.1 Noise Breakthrough Criteria

The proposed development structurally adjoins a commercial property via separating floors. BS8233:2014 states that the internal noise criteria include 'overall noise' which is the sum of structure borne and airborne noise sources. Noise breaking through from structurally adjoining commercial property will be considered to ensure the total noise from both structurally adjoining commercial properties and external noise ingress, does not exceed the proposed acoustic design criteria. Guidance on sound insulation between adjoining domestic and non-domestic dwellings is discussed in Approved Document E (ADE) of the Building Regulations, section 0.8 of Part E states.

"The performance standards set out in Tables 1a and 1b are appropriate for walls, floors and stairs that separate spaces used for normal domestic purposes. A higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these situations, the appropriate level of sound insulation will depend on the noise generated in the communal or non-domestic space. Specialist advice may be needed to establish if a higher standard of sound insulation is required and, if so, to determine the appropriate level."

The higher standard of sound insulation required is dependent on the level of noise generated within the commercial property. Noise from structurally adjoining commercial sources can lead to elevated impact and as such further consideration is given to the level of audibility, dominance, attention grabbing features, spectral distribution, regularity, change in level, duration, and time of day the sound is occurring. The commercial properties 'Use Classes' can assist in defining a suitable higher standard of sound insulation.

Furthermore, the sound insulation performance of the floors and walls between the flats must also be assessed to ensure that they provide reasonable resistance to sound.

Residential to Residential

The following table contains the criteria for flats formed by a material change of use, the criteria in the following table applies; as taken directly from ADE.

Flats – performance standard for separating walls, separating floors, and stairs that have a separating function		
Flats formed by material change of use	Airborne sound insulation $D_{nT,w} + C_{tr}$ dB (min. value)	Impact sound insulation $L'_{nT,w}$ dB (max. value)
Walls	≥43	--
Floors and Stairs	≥43	≤64

Table 12 – ADE Dwelling-houses and Flats Performance Standards

Commercial to Residential

The following table outlines the expected level of risk associated with the 'Class Use' of the structurally adjoining commercial property and provides a required sound insulation standard including a discussion to justify the standard.

Planning Class	Level of Risk from Noise	Required Sound Insulation Standard (dB)
E(b) Sale of food and drink for consumption (mostly) on the premises	High	≥65 $D_{nT,w}$

Discussion: The noise emissions produced by food and drink premises includes both amplified music, noise from patrons and noise from kitchen / food preparation areas. Amplified music associated with primarily dining premises is normally of a background level to facilitate conversation and as such is not a primary concern. The noise from patrons can vary significantly and is highly dependent on the nature of the establishment. The required level of sound insulation should consider raised and elevated vocal efforts occurring regularly. The permitted opening hours extend into the night-time period (23:00 – 07:00) and as such the sensitivity of the adjoining residential requires additional consideration during this period.

Table 13 – Noise Breakthrough Assessment

6.2 Noise Breakthrough Specification – Floors

Residential to Residential

The full floor construction is not currently known however, it is understood that the party floors include a concrete slab, with the addition of a suspended ceiling with ceiling tiles to the ground floor. Due to the structural nature of the concrete, it is likely that the existing slab is at least 150mm thick with a minimum density of 1500 kg/m^3.

In addition to the existing slab, the following system should be installed:

- MuteMat2 resilient layer
- Existing concrete slab (assumed minimum 150mm depth and 1500 kg/m^3 density)
- Suspended ceiling with min. cavity of 150mm and 50mm Rockwool RW45 (45kg/m^3) tightly and evenly fitted
- 1 No. 12.5mm SoundBloc Plasterboard (with overlapping joints and sealed with flexible mastic at the perimeter)

The above construction will comply with ADE providing high quality workmanship is used and the build-up is installed as per the manufacturer's instructions. Any party walls should sail past the suspended ceiling, with flexible mastic or acoustic sealant used where the walls and ceiling connect.

Commercial to Residential

The existing floor construction between commercial and residential spaces will require improvements in order to achieve the above criteria. The following indicative specification is provided below which can achieve the required sound insulation between the existing commercial premises and the residential above. The airborne sound reduction provided by the proposed system has been modelled in INSUL 9.0.

- 2no. layers of 18mm particle board
- 70mm resilient batten/batten and cradle system (void filled with 50mm mineral wool insulation)
- Existing concrete slab (assumed minimum 150mm depth and 1500 kg/m3 density) and suspended ceiling systems

6.3 Noise Breakthrough Specification - Walls

The current internal wall build-ups are also unknown; therefore, two viable constructions have been provided to allow flexibility based on what it currently in situ. The specified wall construction must be used where party walls have a separating function either between flats or between flats and communal areas, such as corridors and stairwells.

Wall type one features a 100mm masonry wall and comprises of the following:

- 1 No. 12.5mm SoundBloc plasterboard (min. surface mass 10.6 kg/m^2 per board)
- 100mm brick wall
- 63mm timber stud filled with 50mm acoustic mineral wool insulation (min. density 45kg/m^3)
- Isolation clips (iKoustic MuteClips® or equivalent) and furring channels
- 2 No. 12.5mm SoundBloc plasterboard (min. surface mass 10.6 kg/m^2 per board)

Alternatively, the following configuration based on a steel stud construction would also be suitable.

- 2 No. 15mm SoundBloc plasterboard (min. surface mass 12.6 kg/m^2 per board)
- 48mm Steel Stud
- Min. 50mm Air Cavity filled with 50mm mineral wool insulation (min. density (45 kg/m^3)
- 48mm Steel Stud
- 2 No. 15mm SoundBloc plasterboard (min. surface mass 12.6 kg/m^2 per board)

It should be noted that this report provides an indicative specification that can achieve the required acoustic performance and considers that all flanking routes for sound have been appropriately suppressed. As with any construction project, the ability to meet the specification will rely upon the quality of the built structure. As such the works should be carried out to a high standard of workmanship to ensure that any sound insulation measures are not breached, for example by installing a rigid connection across an isolated connection. The development cannot achieve compliance until sound insulation testing is carried out by a UKAS accredited sound insulation testing company upon completion and assessed against the required sound insulation standard.

6.4 Noise Breakthrough Assessment

To ensure that the cumulative internal level from noise breaking in through the external envelope and noise transmission from within the structure does not exceed the criteria.

The little red book of acoustics provides typical internal noise levels for a variety of spaces and has been used as a reference internal level within the existing commercial premises. The restaurant areas at ground floor level are considered to present the highest risk for noise breaking through the partition floor. The octave band sound levels for a busy restaurant are presented in the table below.

Description	1/1 Octave Frequency Band (Hz, $L_{eq,T}$ dB)							Overall (dBA)
	63	125	250	500	1k	2k	4k	
Busy Restaurant	60	70	75	75	75	75	70	80

Table 14 – Reference Internal Noise Levels for Existing Commercial

Using the above spectrum, noise breaking through the separating floor between the commercial units and the residential flats above will be masked by noise breaking in through the façade and not contribute to the internal level. It can therefore be seen that providing the glazing and existing structure provides sufficient levels of sound insulation, suitable internal noise levels within the residential spaces can be achieved.

7. Internal M&E Noise Limits

Noise emissions from plant forming the ventilation strategy must be controlled to ensure that internal noise levels do not exceed BS8233 and an appropriate internal acoustic environment for residential use can be achieved.

Plant noise can provide masking to noise transmission through the structure and breaking in through the external façade. With this in mind, internal noise levels from plant servicing the new residential flats should not exceed 28dB during the daytime and night-time periods.

Plant should be regularly serviced and maintained to ensure it is operating at optimal efficiency. All plant should be properly vibration isolated and ductwork runs carefully considered to prevent the create of any flanking paths.

8. Conclusion and Action Plan

The proposed development has been assessed against the acoustic design criteria and a sound insulation scheme has been provided to ensure the criteria has been achieved.

A BS4142 noise impact assessment has indicated that 'significant adverse impact' is present due to the external fixed plant noise sources associated with the neighbouring businesses. As it will not be possible to attenuate and restrict the usage of all plant, apartments directly overlooking the rear plant area must have forced closed windows and a mechanical ventilation system to negate the expected impact. In doing so, a suitable acoustic environment can be achieved within the dwellings.

Flats overlooking the road can have openable windows at the occupant's choice, however, an overheating assessment should be undertaken to determine if secondary ventilation is required.

Providing the measures contained within this report are implemented, the proposed development can be seen to meet the requirements of Condition 3 and Condition 4 provided by the LPA. The following 'Action Plan' is outlined to ensure the design considerations and specifications from this report are duly implemented:

1. Windows overlooking the rear plant area should be forced closed and plant relocated away from the bedroom windows if possible.
2. The proposed glazing and background ventilation system, or a suitable alternative, should be installed as shown in Section 4.2.
3. The separating floor between the structurally adjoining commercial property and the proposed development should be designed to achieve the required sound insulation. The party walls between residential flats must also be installed so that they meet the requirements of ADE. Two different configurations have been provided, both of which can achieve the required levels of airborne sound insulation. An indicative specification has been provided in Section 6. Further design assistance can be provided by NOVA Acoustics Ltd if required.
4. Any plant installed to service the new residential areas should be designed so that the internal noise level from plant does not exceed 28 dB, as outlined in Section 7.

The findings of this report will require written approval from the Local Authority prior to work commencing.

Appendix A – Acoustic Terminology

A-weighted sound pressure level, L_{pA}	Quantity of A-weighted sound pressure given by the following formula in decibels (dBA). $L_{pA} = 10 \log_{10} (pA/p_0)^2$. Where: pA is the A-weighted sound pressure in pascals (Pa) and $p0$ is the reference sound pressure (20 µPa)
Background Sound	Underlying level of sound over a period, T, which might in part be an indication of relative quietness at a given location
Equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$	Value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within a specified time interval, T, has the same mean-squared sound pressure as the sound under consideration that varies with time
Facade level	Sound pressure level 1 m in front of the facade
Free-field level	Sound pressure level away from reflecting surfaces
Indoor ambient noise	Noise in a given situation at a given time, usually composed of noise from many sources, inside and outside the building, but excluding noise from activities of the occupants
Noise Criteria	Numerical indices used to define design goals in a given space
Noise Rating (NR)	Graphical method for rating a noise by comparing the noise spectrum with a family of noise rating curves
Octave Band	Band of frequencies in which the upper limit of the band is twice the frequency of the lower limit
Percentile Level, $L_{AN,T}$	A-weighted sound pressure level obtained using time-weighting “F”, which is exceeded for N% of a specified time interval
Rating Level, $L_{Ar,Tr}$	Equivalent continuous A-weighted sound pressure level of the noise, plus any adjustment for the characteristic features of the noise
Reverberation time, T	Time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped
Sound Pressure, p	root-mean-square value of the variation in air pressure, measured in pascals (Pa) above and below atmospheric pressure, caused by the sound
Sound Pressure Level, L_p	Quantity of sound pressure, in decibels (dB), given by the formula: $L_p = 10\log_{10}(p/p_0)^{2.}$ Where: p is the root-mean-square sound pressure in pascals (Pa) and $p0$ is the reference sound pressure (20 µPa)
Weighted sound reduction index, R_w	Single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies

Appendix B – Standards, Legislation, Policy, and Guidance

This report is to be primarily based on the following standards, legislation, policy, and guidance.

B.1 – National Planning Policy Framework (2023)

Government policy on noise is set out in the National Planning Policy Framework (NPPF), published in 2023. This replaced all earlier guidance on noise and places an emphasis on sustainability. In section 15, Conserving and enhancing the natural and local environment, paragraph 180e, it states:

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.

Paragraph 191 states:

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 impact resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life:*
b) *Identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and*
c) *Limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes, and nature conservation.*

B.2 – Technical Advice Note for Wales 11:1997 Noise

The Technical Advice Notes (Wales) (TAN) should be read in conjunction with "Planning Guidance (Wales): Planning Policy, Technical Advice Notes, and circulars.

"This note provides advice on how the planning system can be used to minimise the adverse impact of noise without placing unreasonable restrictions on development or adding unduly to the costs and administrative burdens of business."

The TAN 11 details:

- Noise impacts in development plans and development control,
- Adverse noise mitigations,
- Noise exposure categories for dwellings,
- Assessment of noise from different sources,
- Examples of planning conditions,
- Specifying noise limits,
- Information on other noise control regimes; and
- Statutory instruments and British Standards.

B.3 – British Standard BS4142:2014+A1:2019 – Methods for rating and assessing industrial and commercial sound

Overview

BS4142:2014 sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS4142:2014 for assessing the effect of sound on residential receptors is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ 'specific sound level', immediately outside the dwelling with the $L_{A90,T}$ background sound level.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ 'rating sound level'. A correction to include the consideration of a level of uncertainty in sound measurements, data and calculations can also be applied when necessary.

Rating Penalty

Section 9 of BS4142:2014 describes how the rating sound level should be derived from the specific sound level, by deriving a rating penalty.

BS4142:2014 states:

"Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level. This can be approached in three ways:

a) subjective method;
b) objective method for tonality;
c) reference method."

Due to the nature of the development the subjective method has been adopted to derive the rating sound level from the specific sound level. This is discussed in Section 9.2 of BS4142:2014, which states:

"Where appropriate, establish a rating penalty for sound based on a subjective assessment of its characteristics. This would also be appropriate where a new source cannot be measured because it is only proposed at that time, but the characteristics of similar sources can subjectively be assessed. Correct the specific sound level if a tone, impulse or other characteristics occurs, or is expected to be present, for new or modified sound sources."

BS4142:2014 defines four characteristics that should be considered when deriving a rating penalty, namely; tonality; impulsivity; intermittency; and other sound characteristics, which are defined as:

a) Tonality

A rating penalty of +2 dB is applicable for a tone which is "just perceptible", +4 dB where a tone is "clearly perceptible", and +6 dB where a tone is "highly perceptible".

b) Impulsivity

A rating penalty of +3 dB is applicable for impulsivity which is "just perceptible", +6 dB where it is "clearly perceptible", and +9 dB where it is "highly perceptible".

c) Other Sound Characteristics

BS4142:2014 states that where "the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distance against the residual acoustic environment, a penalty of +3 dB can be applied."

d) Intermittency

BS4142:2014 states that when the "specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time … if the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3 dB can be applied."

Background Sound Level

The background sound level is the underlying level of sound over a period, T, and is indicative of the relative quietness at a given location. It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

To ensure the background sound level values used within the assessment are reliable and suitably represent both the particular circumstance and periods of interest, efforts have been made to quantify a 'typical' background sound level for a given period. The purpose has not been to simply select the lowest measured value. Diurnal patterns have also been considered as they can have a major influence on background sound levels, for example, the middle of the night can be distinctly different (and potentially of lesser importance) compared to the start or end of the night time period for sleep purposes.

Since the intention is to determine a background sound level in the absence of the specific sound that is under consideration, it is necessary to understand that the background sound level can in some circumstances legitimately include industrial and/or commercial sounds that are present as separate to the specific sound.

Assessment of Impact

BS4142:2014 states: "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 estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

- "Typically, the greater this difference, the greater the magnitude of the impact."
- "A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context."
- "A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context."
- "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 negligible impact, depending on the context."

Interpreting the guidance given in BS4142:2014, with consideration of the guidance given in the NPSE and NPPG Noise, an estimation of the impact of the rating sound is summarised in the following text:

- A rating sound level that is +10 dB above the background sound level is likely to be an indication of a Significant Observed Adverse Effect Level;
- A rating sound level that is +5 dB above the background sound level is likely to be an indication of a Lowest Observed Adverse Effect Level;
- The lower the rating sound 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 sound level does not exceed the background sound level, this is an indication of the specific sound source having a negligible impact and would therefore classified as a No Observed Adverse Effect Level.

During the daytime, the assessment is carried out over a reference time period of 1-hour. The periods associated with day or night, for the purposes of the Standard, are 07.00 to 23.00 and 23.00 to 07.00, respectively.

B.4 – BS8233:2014 'Guidance on Sound insulation and noise reduction for buildings'

BS8233 provides guidance on noise levels from sources without specific character in the built environment, based on the recommendations of the World Health Organization; specifically, 'WHO Guidelines on Community Noise, 1999'. The Guidelines on Community Noise (1999) document defines community noise to include noise from "industries" and "construction". The desirable criteria levels of steady state, "anonymous" noise in unoccupied spaces within dwellings, from sources such as road traffic, mechanical services and other continuously running plant, are tabulated below.

BS8233:2014 Internal Ambient Noise Level Criteria			
Activity	**Location**	**Daytime (07:00 – 23:00)**	**Night-time (23:00 – 07:00)**
Resting	Living Room	35 dB $L_{Aeq,16hour}$	--
Dining	Dining Room/Area	40 dB $L_{Aeq,16hour}$	--
Sleeping (Daytime resting)	Bedroom	35 dB $L_{Aeq,16hour}$	30 dB $L_{Aeq,8hour}$ 45 dB L_{AFmax}*

Table 15 – BS8233:2014 Internal Ambient Noise Level Criteria

**ProPG:2017 states that's good acoustic design can be used so that individual noise events do not normally exceed 45 dB L_{AFmax} more than 10 time a night within noise sensitive rooms such as bedrooms. However, where it is not reasonably practicable to achieve the guideline then the judgment of acceptability will depend not only on the maximum noise levels but also on factors such as the source, number distribution, predictability, and regularity of noise events.*

It is noted, however, that where development is considered necessary or desirable, despite external noise level above WHO guidelines, the above target levels may be relaxed by up to 5 dB.

General recommendations for mitigation to enable these targets to be achieved are provided, including the use of bunds and barriers to reduce external noise and space planning and sound insulation for the control of internal noise levels.

For this assessment, the above criteria are considered to be the 'LOAEL' as defined in the NPSE in Appendix B.

B.5 – ProPG: Planning and Noise (2017)

ProPG Planning and Noise published May 2017 by the Association of Noise Consultants (ANC) was produced to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England. ProPG aims to encourage better acoustic design of new residential developments promoting good health and wellbeing through the effective management of noise. It therefore outlines four key elements which should be considered in the assessment of noise:

- Element 1 – demonstrating a "Good Acoustic Design Process".
- Element 2 – observing internal "Noise Level Guidelines".
- Element 3 – undertaking an "External Amenity Area Noise Assessment".
- Element 4 – consideration of "Other Relevant Issues".

The ProPG supplementary document 2 provides the following 'Good Acoustic Design' hierarchy of noise management measures which LPAs should encourage. These are shown below, In descending order of preference:

Order of Preference	Noise Management Measure
1	Reduction of the noise generated at source by redesign, relocation or containment. *
2	Maximising the spatial separation of noise source(s) and receptor(s).
3	Using existing topography and existing structures (that are likely to last the expected life of the noise-sensitive scheme) to screen the proposed development site from significant sources of noise.
4	Investigating the necessity and feasibility of reducing existing noise levels and relocating existing noise sources.
5	Incorporating noise barriers as part of the scheme to screen the proposed development site from significant sources of noise.
6	Using the layout of the scheme to reduce noise propagation across the site.
7	Using the orientation of buildings to reduce the noise exposure of noise sensitive rooms.
8	Using the building envelope to mitigate noise to acceptable levels.

Table 16 – Hierarchy of Noise Management Measures

**Not from ProPG*

B.6 – Approved Document F Volume 1: Dwellings (2021)

Approved Document F states the following in relation to noise:

- Mechanical ventilation systems, including both continuous and intermittent mechanical ventilation, should be designed and installed to minimise noise. This includes doing all of the following.
    - Correctly sizing and jointing ducts.
    - Ensuring that equipment is appropriately and securely fixed, such as using resilient mountings where noise carried by the structure of the building could be a problem.
    - Selecting appropriate equipment, including following paragraph
- For mechanical ventilation systems, fan units should be appropriately sized so that fans operating in normal background ventilation mode are not overly noisy. This might require fans to be sized so that they do not operate near maximum capacity when in normal background ventilation mode.
- Account should be taken of outside noise when considering whether openable windows are appropriate for purge ventilation.
- If an exposed façade is close to an area of sustained and loud noise (e.g. a main road), then a noise attenuating background ventilator should be fitted.

B.7 - Acoustics Ventilation and Overheating – Residential Design Guide 2020

It is suggested that the desirable internal noise criteria within BS8233:2014 should be achieved considering adequate ventilation as defined by Building Regulations 'Approved Document F' ('ADF') whole dwelling ventilation. However, for a whole dwelling ventilation system such as MVHR it is considered reasonable to allow higher levels of internal ambient noise from transport sources when higher rates of ventilation are required in relation to the overheating condition.

The 'Institute of Acoustics' ('IOA') and the 'Association of Noise Consultant's ('ANC') have published 'The AVO Guide: 2020' document 2020. It provides guidance for those acousticians involved in the design of buildings to prevent noise ingress to and achieve reasonable internal levels. This provides valuable guidance on ventilation and overheating in support of the "Good Acoustic Design" principle advocated by ProPG. Along with guidance showing an acoustic assessment during the overheating condition, the AVO Guide (2020) provides a framework that has a two-level assessment procedure to estimate the potential impact on occupants:

Level 1 Risk Assessment

AVO 'Level 1' risk assessment criteria guide based on external free field ambient noise levels for dwellings relying on purge ventilation (e.g., opening windows) to prevent summertime overheating. AVO Guide Table 3-2 detailed in the figure below. To assess the possibility of overheating it is reasonable to relax the BS 8233:2014 internal ambient noise levels from opening a window by 5 decibels (5 dB). Also, it is assumed that a partially open window will provide a sound reduction of 13 dB. Therefore, to achieve internal noise levels in line with BS 8233:2014 the façade external noise levels should fall inside the levels shown in Table 3-2.

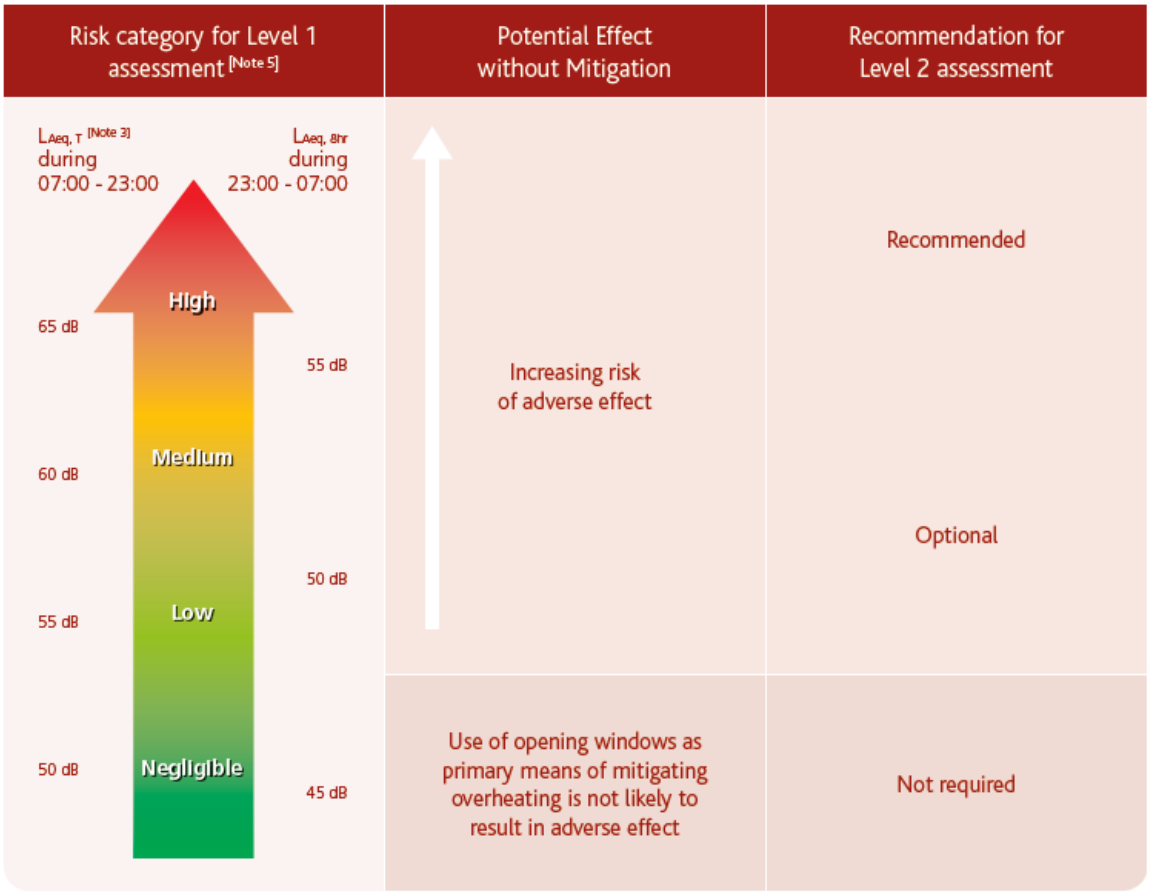


Table 3-2 of AVO Guide (2020)

Figure 5 – AVO Guide Level 1 Risk Category

The AVO Guide (2020) seeks to determine the level of risk associated with overheating in a new residential development based on the existing noise climate. The AVO risk categories are detailed in the table below with clearer categorisation.

AVO Guide (2020) Level 1 Risk Assessment			
Daytime (07:00 – 23:00)	**Night-time (23:00 – 07:00)**	**Risk Category**	**Mitigation**
≥63 dB $L_{Aeq,16hour}$	≥55 dB $L_{Aeq,8hour}$	High Risk	Level 2 assessment recommended. Windows which are unopenable on grounds of noise will inevitably create issues for the overheating strategy.
57 – 62 dB $L_{Aeq,16hour}$	52 – 54 dB $L_{Aeq,8hour}$	Medium Risk	Level 2 assessment optional to give more confidence regarding the suitability of internal noise conditions.
54 – 56 dB $L_{Aeq,16hour}$	49 – 51 dB $L_{Aeq,8hour}$	Low Risk	
≤53 dB $L_{Aeq,16hour}$	≤48 dB $L_{Aeq,8hour}$	Negligible Risk	None required – openable windows suitable for ventilation

Table 17 – AVO Guide (2020) Level 1 Risk Assessment

Level 2 Risk Assessment:

A 'Level 2' assessment of noise is recommended where a dwelling using purge ventilation (e.g., open windows) reaches Level 1 'High Risk' or 'Medium Risk'. The Level 2 assessment guidance comments that where internal ambient noise levels are >50 dB $L_{Aeq,16hr}$ (day) or >42 dB $L_{Aeq,8hr}$ (night) then the outcome might be that the noise causes a material change in behaviour, e.g., having to keep windows closed for the majority of the time, or there is the potential for sleep disturbance.

To conduct a Level 2 assessment, the following minimum information is required:

- Statement of the overheating criteria being applied.
- Description of the provisions for meeting the stated overheating criteria. This should include, where relevant, the area of façade opening.
- Details of the likely internal ambient noise levels whilst using provisions for mitigating overheating, and the method used to predict these.
- Estimation of how frequently and for what duration such provisions are required to mitigate overheating.
- Consideration of the effect of individual noise events.

- Assessment of the adverse effect on occupants.

The figure below outlines the AVO Guide (2020) guidance for a Level 2 assessment of noise from transport sources relating to the Overheating Condition.

Internal ambient noise level [Note 2]			Examples of Outcomes [Note 5]	
$L_{Aeq,T}$ [Note 3] during 07:00 – 23:00 [Note 6]	$L_{Aeq,8h}$ during 23:00 – 07:00	Individual noise events during 23:00 – 07:00 [Note 4]		
> 50 dB	> 42 dB	Normally exceeds 65 dB $L_{AF,max}$	Noise causes a material change in behaviour e.g. having to keep windows closed most of the time	Avoiding certain activities during periods of intrusion. 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.
			Increasing likelihood of impact on reliable speech communication during the day or sleep disturbance at night	At higher noise levels, more significant behavioural change is expected and may only be considered suitable if occurring for limited periods. As noise levels increase, small behaviour changes are expected e.g. turning up the volume on the television; speaking a little more loudly; having to close windows for certain activities, for example ones which require a high level of concentration. Potential for some reported sleep disturbance. Affects the acoustic environment inside the dwelling such that there is a perceived change in quality of life. At lower noise levels, limited behavioural change is expected unless conditions are prevalent for most of the time. [Note 8]
≤ 35 dB	≤ 30 dB	Do not normally exceed $L_{AF,max}$ 45 dB more than 10 times a night	Noise can be heard, but does not cause any change in behaviour	Noise can be heard, but does not cause any change in behaviour, attitude, or other physiological response[Note 9]. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.

Note 1 The noise levels suggested in Tables 3-2 and 3-3 assume a steady road traffic noise source but may be adapted for other types of transport.

Table 3-3 of AVO Guide (2020)

Figure 6 – AVO Guide Level 2 Internal Ambient Noise Levels

Appendix C – Environmental Survey

C.1 – Time History Noise Data

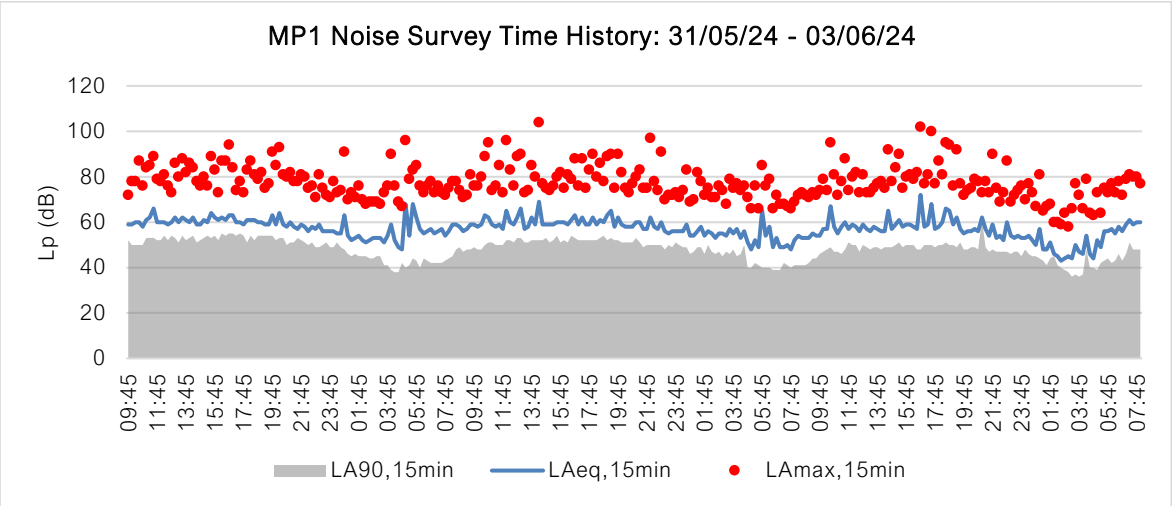


Figure 7 – MP1 Noise Survey Time History

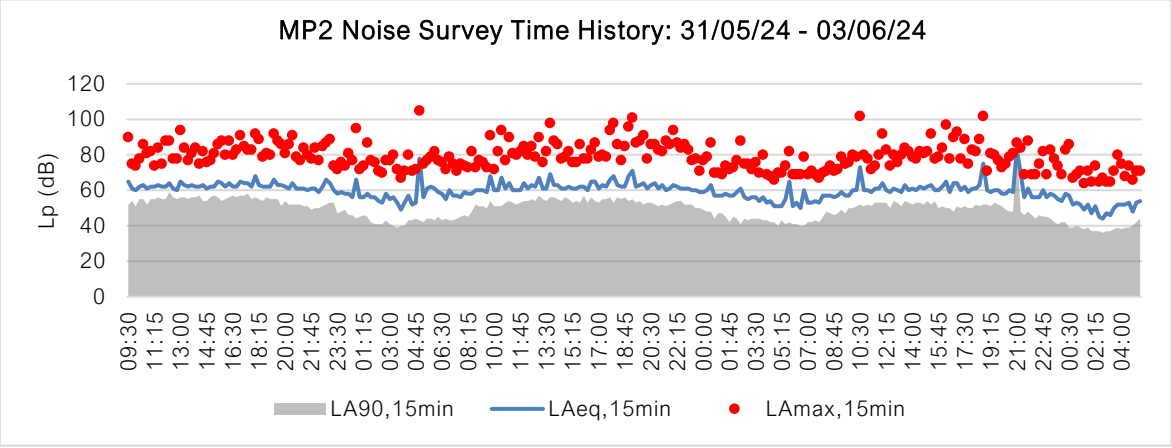


Figure 8 – MP2 Noise Survey Time History

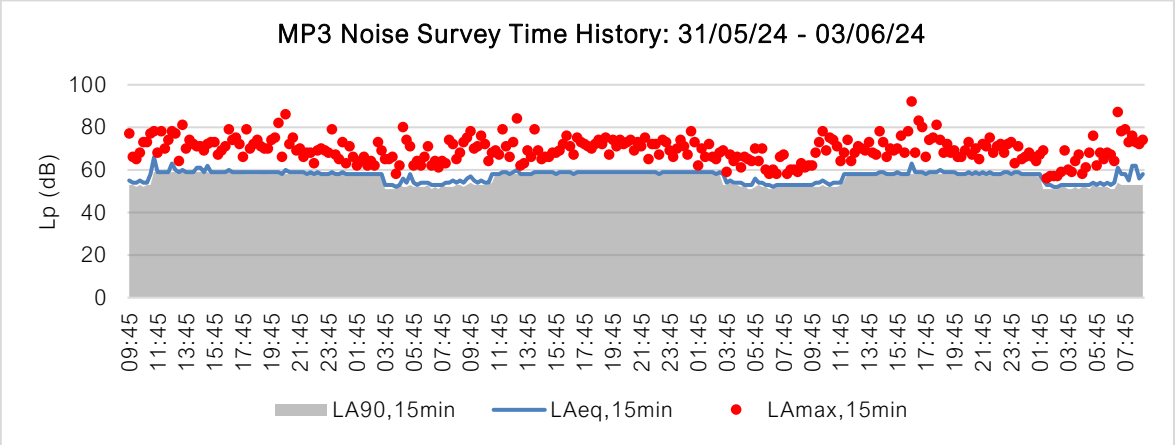


Figure 9 – MP3 Noise Survey Time History

C.2 – Background Sound Level Analysis

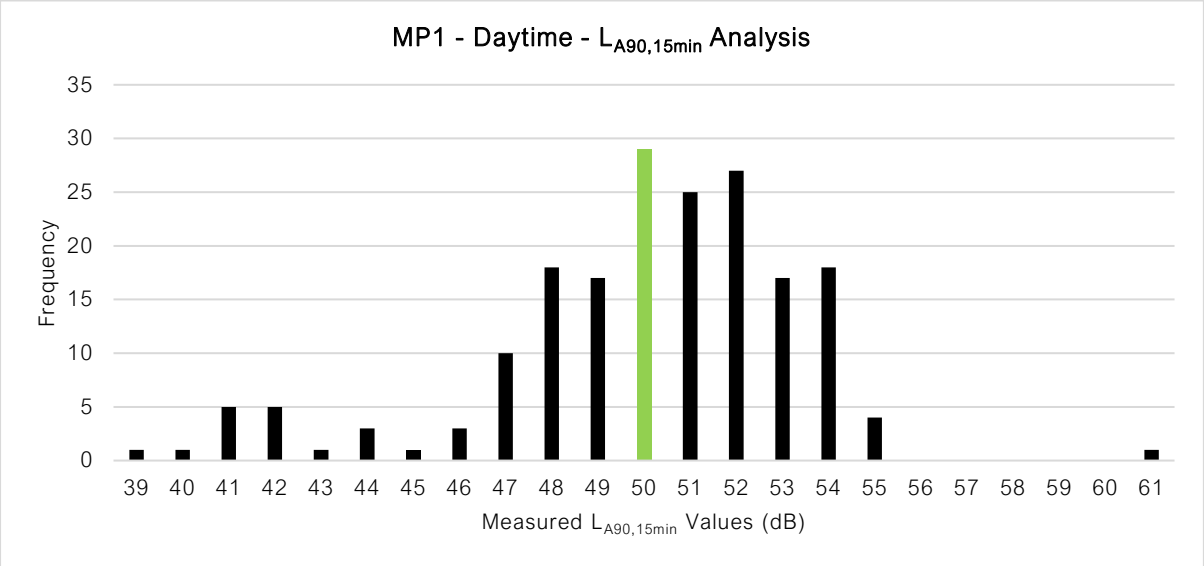


Figure 10 – MP1 Background Sound Level Analysis - Day

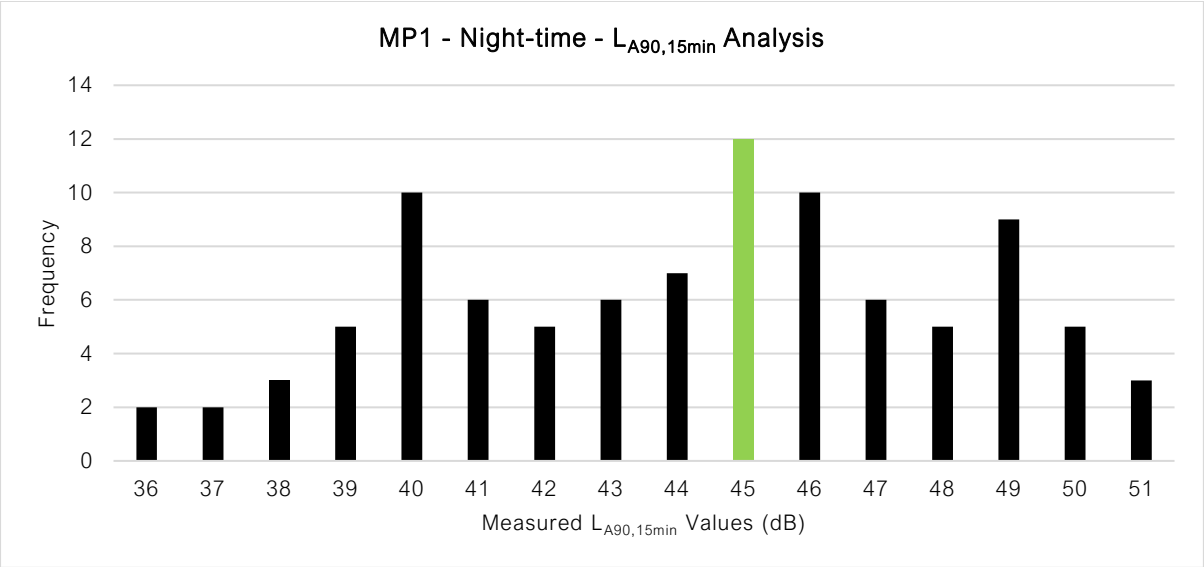


Figure 11 – MP1 Background Sound Level Analysis – Night

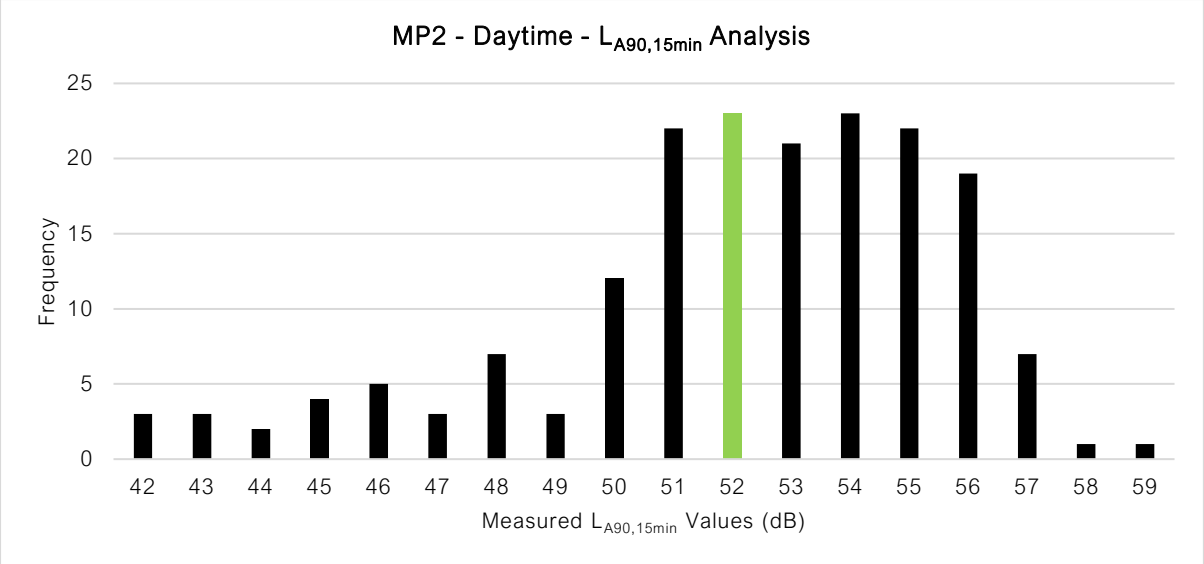


Figure 12 – MP2 Background Sound Level Analysis - Day

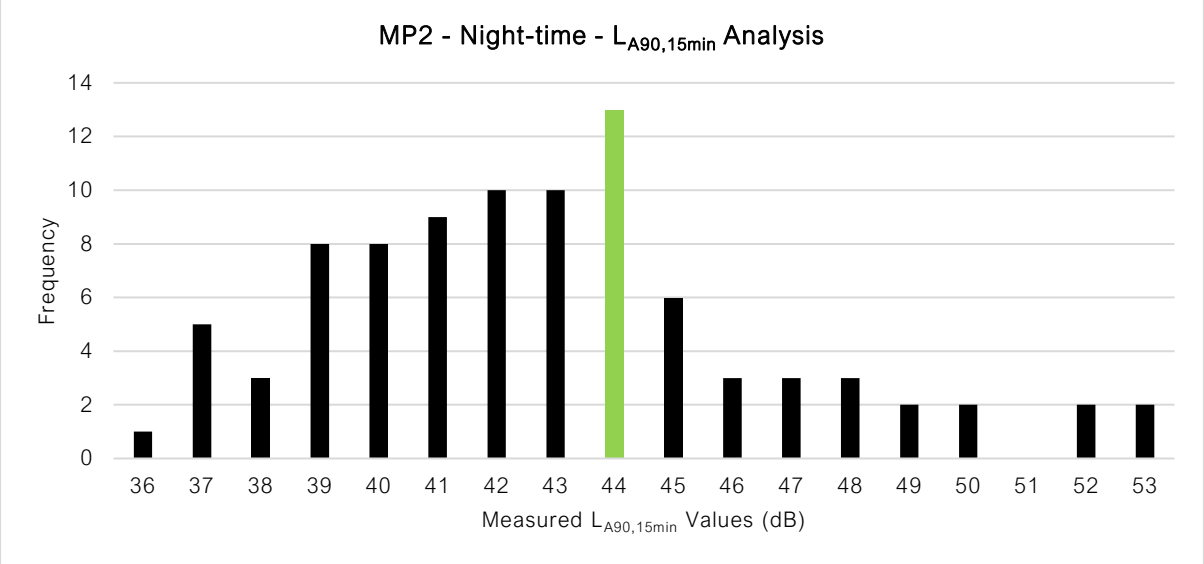


Figure 13 – MP2 Background Sound Level Analysis – Night

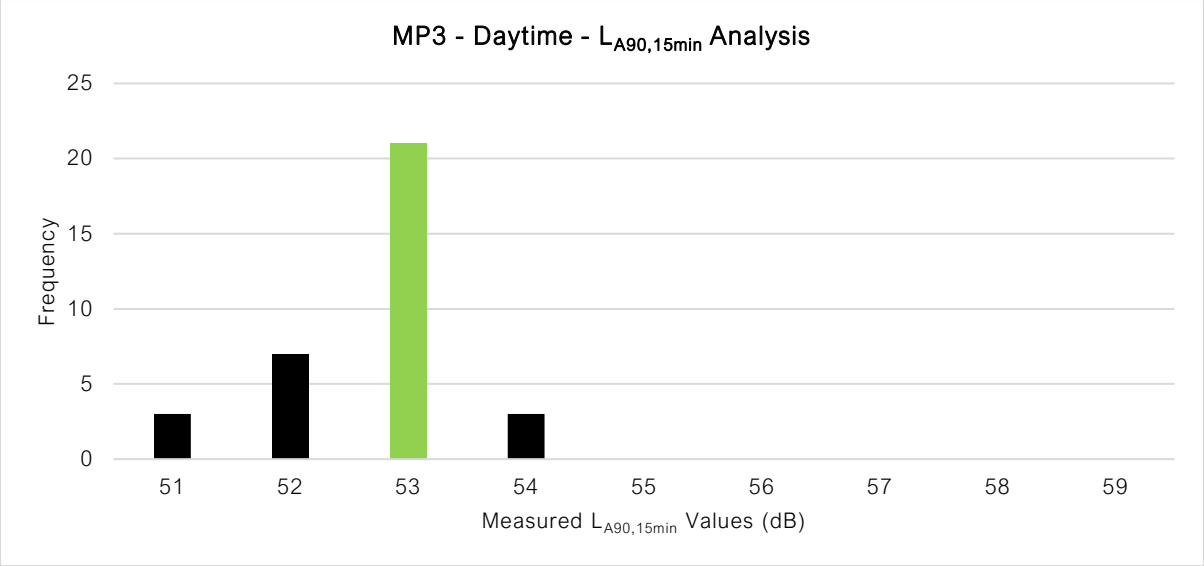


Figure 14 – MP2 Background Sound Level Analysis - Day

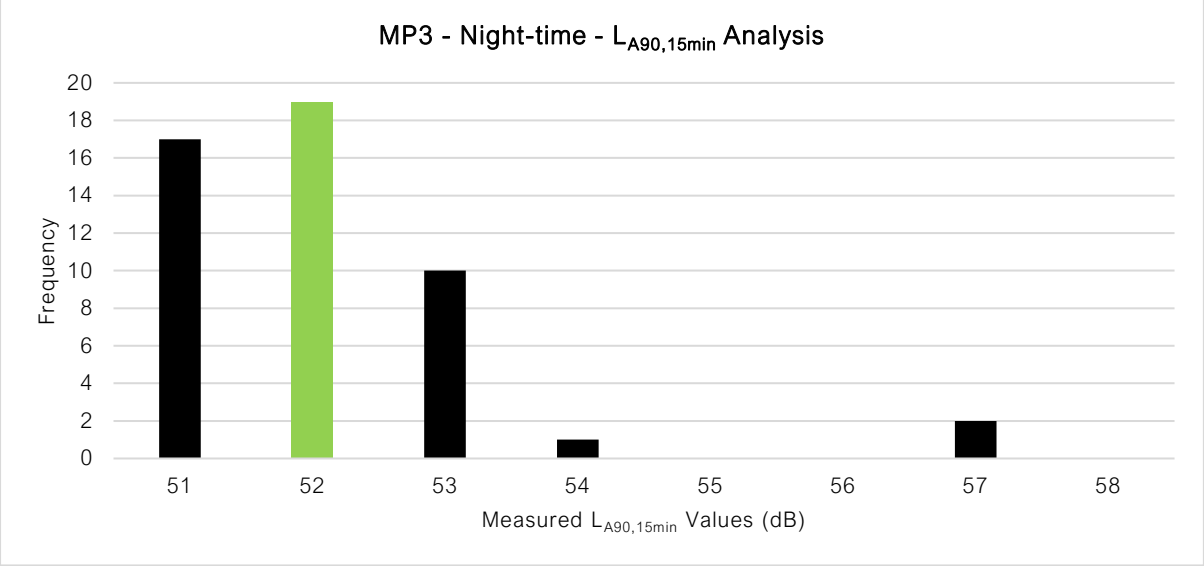


Figure 15 – MP2 Background Sound Level Analysis – Night

C.3 – Surveying Equipment

Piece of Equipment	Serial No.	Calibration Deviation
Svantek 971 Class 1 Sound Level Meter	44018	≤0.1
CESVA SC250 Class 1 Calibrator	T252860	≤0.2
Svantek 971 Class 1 Sound Level Meter	127628	≤0.2
CESVA CB006 Class 1 Calibrator	901625	≤0.1

Table 18 – Surveying Equipment

All equipment used during the survey was field calibrated at the start and end of the measurement period with a negligible deviation of ≤0.2 dB. All sound level meters are calibrated every 24 months and all calibrators are calibrated every 12 months, by a third-party calibration laboratory. All microphones were fitted with a protective windshield for the entire measurements period. Calibration certificates can be provided upon request.

C.4 – Meteorological Conditions

As the environmental noise survey was carried out over a long un-manned period no localised records of weather conditions were taken. However, all measurements have been compared with met office weather data of the area, specifically the closest weather station, and the data from the weather station is outlined in the table below. When reviewing the time history of the noise measurements, any scenarios that were considered potentially to be affected by the local weather conditions have been omitted. The analysis of the noise data includes statistical and percentile analysis and review of minimum and maximum values, which aids in the preclusion of any periods of undesirable weather conditions. The weather conditions were deemed suitable for the measurement of environmental noise in accordance with BS7445 Description and Measurement of Environmental Noise. The table below presents the average temperature, wind speed and rainfall range for each 24-hour period during the entire measurement.

Weather Conditions – Erbistock (Approx. 7.5km S of Site)				
Time Period	Air Temp (°C)	Rainfall (mm/h)	Prevailing Wind Direction	Wind Speed (m/s)
31/05/2024 – 00:00 – 23:59	11.7 – 17.7	0.0	WSW	0.0 - 6.7
01/06/2024 – 00:00 – 23:59	8.6 – 18.5	0.0	SSW	0.0 – 4.6
02/06/2024 – 00:00 – 23:59	8.7 – 21.0	0.0	W	0.0 – 5.4
03/06/2024 – 00:00 – 23:59	11.4 – 17.9	0.0	WNW	0.0 – 4.4

Table 19 – Weather Conditions

Appendix D – Noise Break-in Calculations

The façade sound reduction and predicted internal noise levels are calculated assuming the following:

- The calculation method for façade sound reduction is in accordance with BS8233:2014 and BS EN 12354-3.
- The reverberation time is typically 0.5 seconds and 0.3 seconds across the relevant frequency range for a furnished living room and bedroom in the UK respectively..
- Based on the technical drawings provided to NOVA Acoustics, window areas of 3.7m^2 and room volumes of 57.6m^3 are used in the calculations for bedrooms as a worst-case scenario. For living rooms, the calculations are based on a window area of 3.7m^2 and room volume of 57.6m^3 as a worst-case scenario.
- The acoustic performance of the façade elements are taken from the relevant manufacturers technical information or the sound reduction has been predicted using INSUL 9.0.
- For background trickle ventilation a total Equivalent Area of 5000mm^2 per habitable room has been used in the calculations, which equates to 2 No. trickle vents (2500mm^2 each). No trickle vents have been included for Studio 6, 7 and 14 due to them directly overlooking the rear plant area.

Living Room (Studio 1) Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Measured Leq,T	61	67	61	58	57	56	53	47	47
Glazing Noise Ingress	22	41	35	25	15	3	0	-12	-12
Ventilation Noise Ingress	22	38	22	20	22	11	12	3	3
Wall Noise Ingress	4	23	12	7	-4	-6	-9	-15	-15
Roof Noise Ingress									
Room Absorption Correction		0	0	-1	-1	-1	-2	-3	-4
Total Noise Ingress	**27**	**46**	**38**	**29**	**25**	**14**	**14**	**4**	**2**
NR30	35	59	48	39	33	30	26	24	22
Exceedance of Criteria	-8	-13	-10	-10	-8	-16	-12	-20	-20

Bedroom (Studio 1) Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Measured Leq,T	61	67	61	58	57	56	53	47	47
Glazing Noise Ingress	24	42	36	26	16	4	1	-11	-11
Ventilation Noise Ingress	23	40	24	22	24	13	14	5	5
Wall Noise Ingress	3	23	12	7	-4	-6	-9	-15	-15
Roof Noise Ingress									
Room Absorption Correction		-1	-1	-2	-2	-2	-3	-4	-5
Total Noise Ingress	**28**	**46**	**38**	**29**	**25**	**14**	**14**	**4**	**3**
NR30	35	59	48	39	33	30	26	24	22
Exceedance of Criteria	-7	-13	-10	-10	-8	-16	-12	-20	-19

Bedroom (Studio 1) Night Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Measured Leq,T	57	62	55	56	54	53	49	44	44
Glazing Noise Ingress	20	37	30	24	13	1	-3	-14	-14
Ventilation Noise Ingress	20	35	18	20	21	10	10	2	2
Wall Noise Ingress	0	18	6	5	-7	-9	-13	-18	-18
Roof Noise Ingress									
Room Absorption Correction		-1	-1	-2	-2	-2	-3	-4	-5
Total Noise Ingress	**24**	**41**	**32**	**27**	**22**	**11**	**10**	**1**	**0**
NR25	30	55	43	35	28	25	21	19	17
Exceedance of Criteria	-6	-14	-11	-8	-6	-14	-11	-18	-17

Bedroom (Studio 1) Night Time Max

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Corrected Lmax Spectrum	78	83	76	77	75	74	70	65	65
Glazing Noise Ingress	40	58	51	45	34	22	18	7	7
Ventilation Noise Ingress	41	55	38	40	41	30	30	22	22
Wall Noise Ingress	20	38	26	25	13	11	7	2	2
Roof Noise Ingress									
Room Absorption Correction		-1	-1	-2	-2	-2	-3	-4	-5
Total Noise Ingress	**45**	**62**	**53**	**48**	**43**	**32**	**31**	**22**	**20**
NR40	45	67	56	49	43	40	37	34	33
Exceedance of Criteria	0	-5	-3	-1	0	-8	-6	-12	-13

Figure 16 – Studio 1 Calculations

Living Room (Studio 3) Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Glazing Noise Ingress	26	44	39	29	18	7	6	-2	-2
Ventilation Noise Ingress	27	42	27	25	26	16	19	14	14
Wall Noise Ingress	9	28	18	13	1	0	-1	-3	-3
Roof Noise Ingress									
Room Absorption Correction									
Total Noise Ingress	**31**	**49**	**41**	**32**	**28**	**18**	**20**	**14**	**13**
NR30	35	59	48	39	33	30	26	24	22
Exceednce of Criteria	-4	-10	-7	-7	-5	-12	-6	-10	-9

Bedroom (Studio 3) Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Glazing Noise Ingress	26	44	39	29	18	7	6	-2	-2
Ventilation Noise Ingress	27	42	27	25	26	16	19	14	14
Wall Noise Ingress	9	28	18	13	1	0	-1	-3	-3
Roof Noise Ingress									
Room Absorption Correction									
Total Noise Ingress	**29**	**47**	**39**	**30**	**26**	**16**	**18**	**12**	**11**
NR30	35	59	48	39	33	30	26	24	22
Exceednce of Criteria	-6	-12	-9	-9	-7	-14	-8	-12	-11

Bedroom (Studio 3) Night Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
	6	0	0	0	0	0	0	0	0
Glazing Noise Ingress	21	38	33	26	15	5	0	-11	-11
Ventilation Noise Ingress	23	36	21	22	23	14	13	5	5
Wall Noise Ingress	5	22	12	9	-3	-2	-7	-12	-12
Roof Noise Ingress									
Room Absorption Correction									
Total Noise Ingress	**24**	**40**	**33**	**27**	**22**	**14**	**12**	**3**	**1**
NR25	30	55	43	35	28	25	21	19	17
Exceednce of Criteria	-6	-15	-10	-8	-6	-11	-9	-16	-16

Bedroom (Studio 3) Night Time Max

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Glazing Noise Ingress	41	58	52	45	34	25	20	8	8
Ventilation Noise Ingress	43	57	41	42	43	34	33	25	25
Wall Noise Ingress	25	42	31	29	17	17	13	7	7
Roof Noise Ingress									
Room Absorption Correction									
Total Noise Ingress	**44**	**60**	**53**	**46**	**42**	**33**	**32**	**22**	**21**
NR40	45	67	56	49	43	40	37	34	33
Exceednce of Criteria	-1	-7	-3	-3	-1	-7	-5	-12	-12

Figure 17 – Studio 3 Calculations

Living Room (Studio 14) Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Measured Leq,T	66	69	64	61	59	59	59	58	58
Glazing Noise Ingress	25	43	38	28	17	6	6	-1	-1
Ventilation Noise Ingress	25	40	25	23	24	14	18	14	14
Wall Noise Ingress	8	25	15	10	-2	-3	-3	-4	-4
Roof Noise Ingress									
Room Absorption Correction		-1	-1	-1	-2	-2	-2	-3	-5
Total Noise Ingress	**29**	**47**	**40**	**31**	**26**	**16**	**19**	**14**	**12**
NR30	35	59	48	39	33	30	26	24	22
Exceednce of Criteria	-6	-12	-8	-8	-7	-14	-7	-10	-10

Bedroom (Studio 14) Day Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Measured Leq,T	62	70	69	63	57	55	54	52	52
Glazing Noise Ingress	18	35	31	22	5	0	-6	-16	-16
Ventilation Noise Ingress									
Wall Noise Ingress	4	22	16	8	-8	-11	-12	-14	-14
Roof Noise Ingress	18	37	31	19	8	-2	-11	-19	-19
Room Absorption Correction		2	2	1	1	1	1	-1	-2
Total Noise Ingress	**26**	**44**	**39**	**28**	**14**	**6**	**0**	**-8**	**-10**
NR30	35	59	48	39	33	30	26	24	22
Exceednce of Criteria	-9	-15	-9	-11	-19	-24	-26	-32	-32

Bedroom (Studio 14) Night Time Leq

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Measured Leq,T	60	69	69	62	57	52	49	45	45
Glazing Noise Ingress	18	34	31	21	5	-3	-11	-23	-23
Ventilation Noise Ingress									
Wall Noise Ingress	4	21	16	7	-8	-14	-17	-21	-21
Roof Noise Ingress	17	36	31	18	8	-5	-16	-26	-26
Room Absorption Correction		2	2	1	1	1	1	-1	-2
Total Noise Ingress	**25**	**43**	**39**	**27**	**14**	**3**	**-5**	**-15**	**-17**
NR25	30	55	43	35	28	25	21	19	17
Exceednce of Criteria	-5	-12	-4	-8	-14	-22	-26	-34	-34

Bedroom (Studio 14) Night Time Max

Item / Description	dB(A)	63	125	250	500	1k	2k	4k	8k
Corrected Lmax Spectrum	71	80	80	73	68	63	60	56	56
Glazing Noise Ingress	29	45	42	32	16	8	0	-12	-12
Ventilation Noise Ingress									
Wall Noise Ingress	15	32	27	18	3	-3	-6	-10	-10
Roof Noise Ingress	28	47	42	29	19	6	-5	-15	-15
Room Absorption Correction		2	2	1	1	1	1	-1	-2
Total Noise Ingress	**36**	**54**	**50**	**38**	**25**	**14**	**6**	**-4**	**-6**
NR40	45	67	56	49	43	40	37	34	33
Exceednce of Criteria	-9	-13	-6	-11	-18	-26	-31	-38	-39

Figure 18 – Studio 14 Calculations


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