RS Acoustic Engineering

61 King Street, Wrexham
Noise Assessment Report



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Client: Lee Chaloner

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1. Introduction

1.1 RS Acoustic Engineering Ltd has been appointed by Lee Chaloner to undertake a noise assessment with regard to a proposed change of use at No.61 King Street, Wrexham, LL11.

1.2 The former office accommodation is to be converted and refurbished to provide a single office at ground floor level and six rooms for residential purposes at first and second floor level (House of Multiple Occupation). The terraced property is a three storey, grade two listed building.

1.3 A planning application was recently submitted to Wrexham County Borough Council for listed building consent for internal and external alterations (ref: P/2024/0149).

1.4 The dominant source of noise at the site is road traffic on King Street and Rhosddu Road to the south. There is a bus station to the south west of the property and the town centre is located beyond the bus station.

1.5 The terraced properties along King Street generally consist of commercial units at ground floor level and residential dwellings at first and second floor level.

1.6 A noise assessment has been undertaken taking into consideration the guidance contained within British Standard 8233:2014 *Guidance on sound insulation and noise reduction for building,* ProPG's *Planning & Noise* and also Technical Advice Note (Wales) 11 *Noise*.

1.7 This assessment is based on the results of an environmental noise survey undertaken by RS Acoustic Engineering Ltd. Continuous sound level monitoring was conducted over a number of days in order to establish the ambient sound pressure levels during the daytime and night-time period.

1.8 The measured sound level data has been used to determine the acoustic performance requirements for the building envelope construction and to determine whether it will be suitable to naturally ventilate habitable rooms via opening windows alone.

1.9 An assessment of noise ingress through the building envelope with windows open and closed has been undertaken to determine the resulting sound levels.

1.10 The guidance given within Approved Document F (Ventilation) and Approved Document O (Overheating) has also been taken into consideration with regard to noise ingress and opening windows.

1.11 The survey and assessment was conducted by Mr Ryan Swales ($BSc_{(Hons)}$, MIOA), Principal Acoustic Consultant and Member of the Institute of Acoustics.

1.12 The results of the noise survey have been presented, along with the assessment criteria and a discussion of the results with respect to the appropriate guidance and targets.

1.13 Recommendations regarding internal sound insulation, ventilation and noise mitigation are also provided within this report.

2. Assessment Guidance & Acoustic Criteria

Wrexham County Borough Council Requirements

2.1 A planning application was submitted in February 2024 to Wrexham County Borough Council (WCBC) for listed building consent for internal and external alterations (ref: P/2024/0149).

2.2 WCBC subsequently provided the following comments:

ZP07A - Noise Survey

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 Note (TAN) 11 – Noise.

The report of the noise survey 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.

ZP09 - Soundproofing of a Building (between Floors/Walls)

No part of the development shall commence until a scheme of noise insulation and attenuation measures between the floors and with the walls of neighbouring commercial units 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.

Technical Advice Note (Wales) 11: Noise

2.3 Paragraph 10 of TAN 11 states the following:

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.

2.4 With regard to mitigating the impact of noise, Paragraph 11 states the following:

Measures introduced to control the source of, or limit exposure to, noise should be proportionate and reasonable, and may include:

i. engineering: reduction of noise at point of generation (e.g. using quiet machines and/or quiet methods of working); containment of noise generated (e.g. insulating buildings which house machinery and/or providing purpose-built barriers around sites); protection of surrounding noise-sensitive buildings (e.g. improving sound insulation in these buildings and/or screening them by purpose-built barriers);

ii. lay-out: adequate distance between noise source and noise-sensitive building or area; screening by natural barriers, other buildings, or non-critical rooms in a building;

iii. administrative: limiting operating time of noise source; restricting activities allowed on the site; specifying an acceptable noise limit.

2.5 When assessing a proposal for a new residential development near a source of noise, TAN 11 also states local planning authorities should determine into which of the four noise exposure categories (NECs) the proposed site falls, taking into account both daytime and night-time noise levels.

2.6 A recommended range of noise levels is given for each of the NECs for dwellings exposed to noise from road, rail, air and mixed sources. Based on the measured sound pressure levels, it is worth noting that the front elevation of the property falls within NEC B, whereas the rear elevation falls within NEC A.

2.7 The following guidance is given with regard to NEC 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.

2.8 The following guidance is given with regard to NEC B:

Noise should be taken into account when determining planning applications and, where appropriate, conditions imposed to ensure an adequate level of protection.

British Standard 8233:2014: Guidance on sound insulation and noise reduction for buildings

2.9 BS 8233 provides guidance regarding acoustic criteria and noise levels appropriate for various types of space that have different functions.

2.10 With regard to dwellings, appropriate internal ambient sound levels are given for bedrooms, living rooms and dining rooms (habitable rooms). The guidelines take into consideration the effect of internal noise on sleep and also the effect of noise on resting, listening and communicating.

2.11 The internal sound level targets presented in Table 2.1 have been reproduced directly from the standard.

Table 2.1 - Indoor ambient noise levels for dwellings

Activity	Location	07:00 to 23:00	23:00 to 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 $L_{Aeq,8hour}$

2.12 Note 7 of the standard also suggests that in some circumstances it may be appropriate to relax the indoor ambient noise level targets by up to 5 dB:

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.

2.13 Note 5 of the standard states *If relying on closed windows to meet the guide values, there needs to be appropriate alternative ventilation that does not compromise the facade insulation or the resulting noise level. If applicable, any room should have adequate ventilation (e.g. trickle ventilators should be open) during assessment*.

World Health Organisation: Guidelines for community noise (1999)

2.14 To help avoid sleep disturbance within bedrooms, this historical guidance document recommends that the night-time internal ambient sound level should not exceed 30 dB $L_{Aeq,T}$ and the maximum sound level should not typically exceed 45 dB $L_{AFmax,T}$.

2.15 The corresponding values directly outside of bedroom windows are therefore 45 dB $L_{Aeq,8hour}$ and 60 dB $L_{AFmax,T}$. This is based on the assumption that a partially open window provides approximately 15 dB of sound attenuation (from external noise).

2.16 With regard to sleep disturbance and maximum L_{AFmax} sound levels, the study undertaken by Vallet & Vernet (1991) suggests that for good sleep, indoor sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night.

Professional Practice Guidance on Planning & Noise (2017)

2.17 Professional Practice Guidance on Planning and Noise (ProPG) has been produced in order to provide practitioners with guidance on a recommended approach to the management of noise within the planning system in England.

2.18 The NPPF encourages improved standards of design. This guidance document encourages better acoustic design for new residential development and aims to protect people from the harmful effects of noise.

2.19 The scope of ProPG is restricted to the consideration of new residential development that will be exposed predominantly to airborne noise from transportation sources.

Internal noise level guidelines

2.20 The recommended ProPG internal noise level guidelines are presented in Table 2.2. The guidelines reflect and extend current practice contained within BS 8233:2014.

Table 2.2 - ProPG internal noise level guidelines

Activity	Location	07:00 to 23:00	23:00 to 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 $L_{Amax,F}$

2.21 Where the local planning authority accepts that there is a justification that the internal target noise levels can only be practically achieved with windows closed, which may be the case in urban areas and at sites adjacent to transportation noise sources, special care must be taken to design the accommodation so that it provides good standards of acoustics, ventilation and thermal comfort without unduly compromising other aspects of the living environment.

2.22 In such circumstances, internal noise levels can be assessed with windows closed but with any façade openings used to provide "*whole dwelling ventilation*" in accordance with Building Regulations Approved Document F (e.g. trickle ventilators) in the open position.

2.23 It should also be noted that the internal noise level guidelines are generally not applicable under "*purge ventilation*" conditions as defined by Building Regulations Approved Document F, as this should only occur occasionally (e.g. to remove odour from painting and decorating or from burnt food).

Building Regulations 2010 - Part E

2.24 The Building Regulations 2010, Approved Document E *Resistance to the passage of sound*, provides minimum sound insulation standards for separating wall and floor constructions between adjacent dwellings (houses, flats and rooms for residential purposes).

2.25 The current acoustic performance standards for new-build rooms for residential purposes and also those that have been formed by a material change of use are presented in Table 2.3.

Table 2.3 - Performance standards of Approved Document E

Rooms for residential purposes - performance standards for separating walls, separating floors, and stairs that have a separating function		
	Airborne sound insulation $D_{nT,w}+C_{tr}$ dB (Minimum values)	Impact sound insulation $L'_{nT,w}$ dB (Maximum values)
Purpose built rooms for residential purposes		
Walls	43	--
Floors and stairs	45	62
Rooms for residential purposes formed by material change of use		
Walls	43	--
Floors and stairs	43	64

2.26 In this instance, separating party floors and walls need to achieve a minimum airborne performance of 43 dB $D_{nT,w}+C_{tr}$. Party floors between dwellings must also achieve an impact performance of 64 dB $L'_{nT,w}$ or less.

3. Environmental Noise Survey

Survey methodology

3.1 Continuous sound level monitoring was conducted over a 50-hour period on the south east facing elevation overlooking King Street and Rhosddu Road. The equipment was installed at first floor level (position A).

3.2 Measurements were performed from 12:30 hours on Tuesday 25th through to 14:30 hours on Thursday 27th June 2024.

3.3 Continuous sound level monitoring was also conducted over a 49.5-hour period on the rear north west facing elevation. The equipment was again installed at first floor level (position B).

3.4 Measurements were performed from 13:00 hours on Tuesday 25th through to 14:30 hours on Thursday 27th June 2024.

3.5 A measurement interval of 5-minutes was used during the survey and measurements were considered to be subject to sound reflections from the façade (as opposed to free field). One-third octave band and A-weighted broadband sound pressure levels were recorded during the survey.

3.6 The site location, surrounding area and survey measurement positions are shown in Figure 3.1 and Figure 3.2 overleaf. The floor plans and elevations are presented in Appendix A.

Figure 3.1 - Site location and survey measurement positions (source: Google Earth)

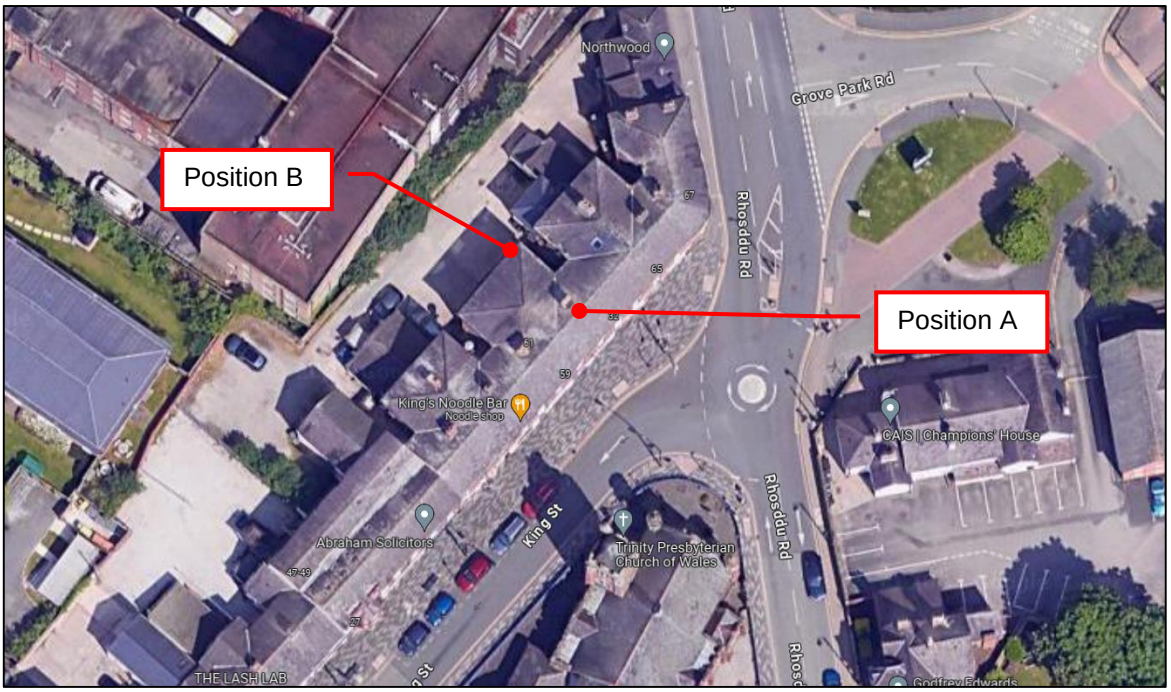


Figure 3.2 - Photographs showing continuous measurement positions



Survey equipment

3.7 The survey was conducted using the following Class-1 specification equipment:

- Brüel & Kjaer 2250-Light sound level meter, microphone type 4189, pre-amplifier type ZC0032.
- Brüel & Kjaer 2260 sound level meter, microphone type 4189, pre-amplifier type ZC0032.
- CEL-120/1 Acoustic calibrator.

3.8 Calibration of the sound level meter and microphone used for the measurements are traceable to UKAS accredited laboratories (calibration certificates are available upon request).

3.9 The calibration of both sound level meter and microphone was checked using a 1 kHz tone at 94 dB prior to and following the measurements performed. Calibration drift was less than 0.1 dB.

Weather conditions

3.10 The weather conditions during the survey were generally dry and fine with a light cloud cover. Wind speed measurements taken outside of the building were between 0.6 and 1.9 m/s^{-1}.

3.11 The air temperature during the survey ranged between 13°C and 25°C. The overall weather conditions were considered suitable to obtain representative measurements.

Subjective observations of the acoustic environment

3.12 The dominant source of noise at the site is road traffic on King Street and Rhosddu Road to the south. There is a bus station to the south west of the property and the town centre is located further south, beyond the bus station.

3.13 Passing buses and taxis were both a mixture of diesel powered engines and electric/hybrid powered.

3.14 Vehicle movements to the rear of the property were sporadic and the associated noise was negligible during the day. Neighbouring residents appear to use the land for parking.

3.15 Operational noise associated with the neighbouring commercial properties was negligible during the visits.

3.16 Other notable sources of noise include passing pedestrians and high altitude aircraft.

Measured indices

3.17 Although a wide range of statistical sound level data was recorded during the survey, the L_{Aeq} and L_{AFmax} indices are of most interest in this instance:

- $L_{Aeq,T}$ - The A-weighted equivalent continuous sound pressure level over a period of time, T. Representative of the 'average' sound pressure level over a given period (commonly used to describe the 'ambient' sound level).
- $L_{AFmax,T}$ - The A-weighted 'maximum' sound pressure level that occurred during a given period, T (commonly used for the assessment of occasional loud noises).

3.18 Sound pressure level measurements are taken with an A-weighting (denoted by a subscript 'A', e.g. L_{Aeq}) to approximate the frequency response of the human ear.

Results summary

3.19 Table 3.1 presents a summary of the continuously measured sound pressure levels at the front elevation (Position A). Measured values have been rounded to the nearest whole number.

Table 3.1 - Summary of continuously measured sound pressure levels, front elevation

Date	Period	Duration, T (hours)	$L_{Aeq,T}$ dB	10th Highest[1] $L_{AFmax,T}$ dB	15th Highest[2] $L_{AFmax,T}$ dB
Tuesday 25/06/2024	Daytime (12:30-23:00)	10.5	63	---	---
	Night-time (23:00-07:00)	8	56	76	74
Wednesday 26/06/2024	Daytime (07:00-23:00)	16	62	---	---
	Night-time (23:00-07:00)	8	56	77	75
Thursday 27/06/2024	Daytime (07:00-14:30)	7.5	63	---	---

[1]The 10th highest value from 96 measurement periods [2]The 15th highest value from 96 measurement periods (indoor sound pressure levels should ideally not exceed 45 dB L_{Amax} more than 10-15 times per night).

3.20 Table 3.2 presents a summary of the continuously measured sound pressure levels at the rear elevation (Position B). Measured values have been rounded to the nearest whole number.

Table 3.2 - Summary of continuously measured sound pressure levels, rear elevation

Date	Period	Duration, T (hours)	$L_{Aeq,T}$ dB	10th Highest[1] $L_{AFmax,T}$ dB	15th Highest[2] $L_{AFmax,T}$ dB
Tuesday 25/06/2024	Daytime (13:00-23:00)	10	46	---	---
	Night-time (23:00-07:00)	8	38	59	58
Wednesday 26/06/2024	Daytime (07:00-23:00)	16	48	---	---
	Night-time (23:00-07:00)	8	39	59	58
Thursday 27/06/2024	Daytime (07:00-14:30)	7.5	46	---	---

[1]The 10th highest value from 96 measurement periods [2]The 15th highest value from 96 measurement periods (indoor sound pressure levels should ideally not exceed 45 dB L_{Amax} more than 10-15 times per night).

3.21 At the rear elevation, the daytime ambient L_{Aeq} sound pressures levels are approximately 14 to 17 dB lower and the night-time sound pressure levels are approximately 17 to 18 dB lower (compared to the measured results at the front elevation).

3.22 The results of the sound level monitoring are presented graphically in Figure 3.3 and Figure 3.4 overleaf.

Figure 3.3 - Graph showing results of continuous sound level monitoring, front elevation

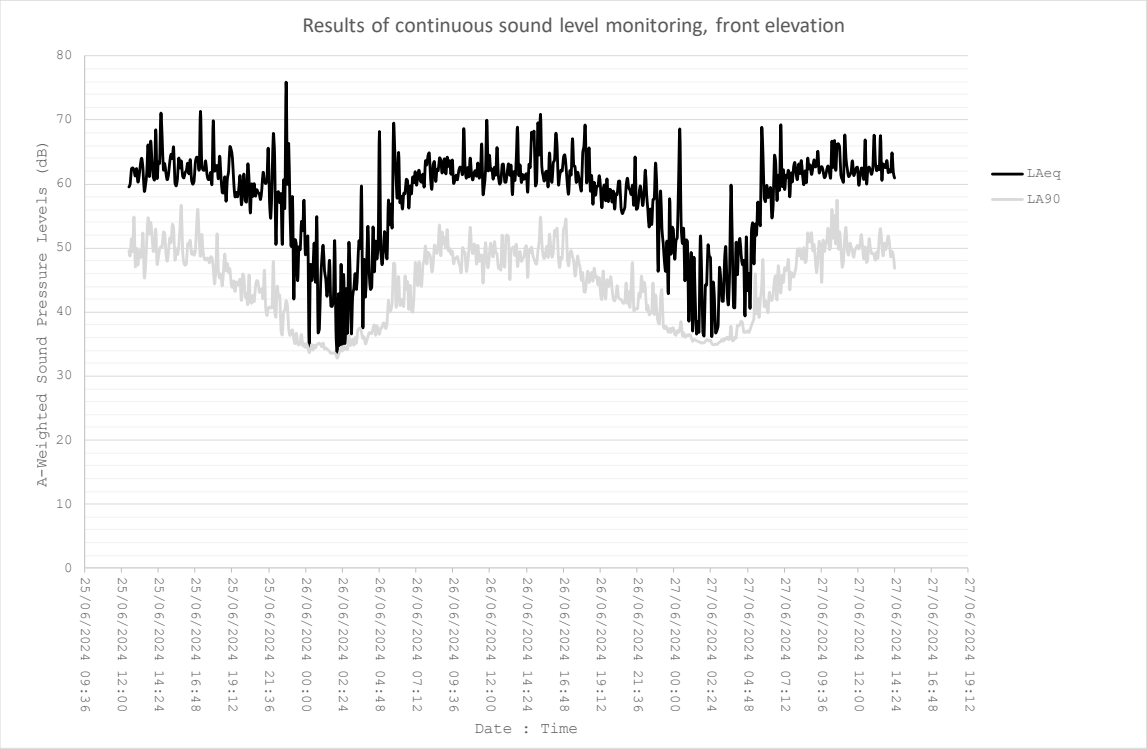
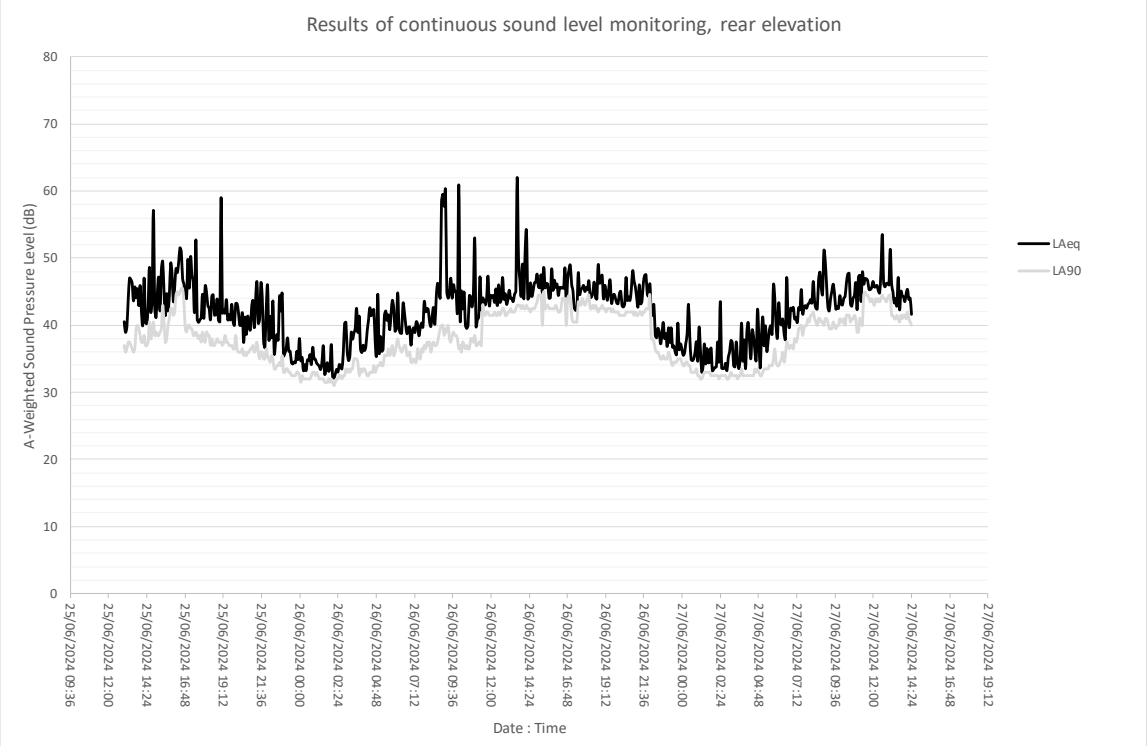


Figure 3.4 - Graph showing results of continuous sound level monitoring, rear elevation



4. Assessment & Discussion

Building envelope construction and acoustic performance

4.1 The external walls are of a traditional double-leaf brickwork construction. The sound insulation performance is expected to be approximately 50 to 60 dB R_w.

4.2 The roof and ceiling construction consists of a pitched tiled roof, mineral wool (loft) insulation and plasterboard ceiling. The roof and ceiling combination is expected to provide a sound insulation performance of approximately 40 to 50 dB R_w.

4.3 The windows to the front and rear elevation are timber framed, sash-style single glazed units with approximately 3 mm thick clear glass.

4.4 The sound insulation performance of the existing single glazing is estimated to be approximately 23 to 24 dB R_w.

4.5 Purge and background ventilation of the rooms is currently achieved via opening windows. There are no trickle vents within the timber frames or walls.

Noise ingress with windows closed

Front south east elevation

4.6 Table 4.1 and Table 4.2 present the noise ingress calculation results for two bedrooms on the front elevation facing King Street. The highest daytime sound pressure level has been used in the calculation (63 dB $L_{Aeq,16hour}$).

4.7 The calculations take into account the sound insulation performance of each building element, surface area and internal room dimensions. The proposed floor plans and elevations are presented in Appendix A.

4.8 The measured octave-band sound levels and typical reverberation time for a habitable room/bedroom have also been taken into consideration.

Table 4.1 - Noise ingress calculation results - 1st floor bedroom, front elevation

Title: 1st Floor Bedroom (Front Elevation) **Noise Break In (ISO 12354-3)**												
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C_{tr})***
				20.2	20.2	25.2	28.2	34.2	32.2			
L_{in}				47.8	40.8	34.8	29.8	19.8	15.8			
Materials												
3-4mm glass, timber sash window		2.2		14.0	14.0	19.0	22.0	28.0	26.0		**23**	**(-1,-3)**
Double-leaf brickwork wall		5.2		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
$L_{out,s}$												
$L_{out,2m}$	Add Element			68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{out,free\ field}$				65.0	58.0	57.0	55.0	51.0	45.0		**60**	
Element 1				20.2	20.2	25.2	28.2	34.2	32.2			
Plane façade	ΔL_{fs}	7.4		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	x_{fs}	0.0		20.2	20.2	25.2	28.2	34.2	32.2			
$L_{p,out,2m}$				68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{p,in}$				47.8	40.8	34.8	29.8	19.8	15.8		**38**	**dBA**

Table 4.2 - Noise ingress calculation results - 2nd floor bedroom, front elevation

Title: 2nd Floor Bedroom (Front Elevation) **Noise Break In (ISO 12354-3)**												
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C$_{tr}$)***
				21.0	21.9	26.9	30.0	35.9	34.1			
L_{in}				47.0	39.1	33.1	28.0	18.1	13.9			
Materials												
3-4mm glass, timber sash window		1.2		14.0	14.0	19.0	22.0	28.0	26.0		**23**	**(-1,-3)**
Double-leaf brickwork wall		3.9		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
Tiled roof, insulation, plasterboard ceiling		10.0		28.0	34.0	40.0	45.0	49.0	50.0		**44**	**(-2,-5)**
$L_{out,s}$												
$L_{out,2m}$	Add Element			68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{out,free\ field}$				65.0	58.0	57.0	55.0	51.0	45.0		**60**	
Element 1				21.0	21.9	26.9	30.0	35.9	34.1			
Plane façade	ΔL_{fs}	15.1		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	x_{fs}	0.0		21.0	21.9	26.9	30.0	35.9	34.1			
$L_{p,out,2m}$				68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{p,in}$				47.0	39.1	33.1	28.0	18.1	13.9		**36**	**dBA**

4.9 The calculation results indicate a daytime internal sound level of approximately 36 to 38 dB $L_{Aeq,16hour}$ with the existing single glazing.

4.10 The daytime sound level target of 35 dB $L_{Aeq,16hour}$ will therefore not be achieved with windows closed. The night-time target will also not be achieved.

4.11 Since the sound level targets will not be achieved, it is recommended that the glazing to the front elevation is acoustically enhanced as detailed below.

New secondary glazing to bedrooms

4.12 A suitable noise mitigation measure would be to install secondary glazing and retain the original timber sash windows. The new secondary glazed unit may be face-fixed to the primary (original) timber frame or reveal-fixed (i.e. not touching the original frame).

4.13 The window cill depths vary between approximately 150 and 190 mm and can therefore easily accommodate a secondary unit. The recommended gap/distance between the existing window frame and the frame of the new secondary glazing is 50 mm. The larger the air gap/spacing, the greater the acoustic performance.

4.14 For guidance, the following suppliers provide secondary glazed units that are suitable for residential conversions and listed buildings:

- https://www.selectaglaze.co.uk/
- https://clearviewsg.co.uk/diy-secondary-glazing/

4.15 Table 4.3 and Table 4.4 overleaf present the calculation results for a 4 mm thick secondary glazed unit installed alongside the existing single glazing. Slightly thicker 6 mm glass would also be appropriate and would provide a marginally improved acoustic performance (≈1 to 2 dB).

Table 4.3 - Noise ingress calculation results - 1st floor bedroom with secondary glazing

Title: 1st Floor Bedroom (Front Elevation) **Noise Break In (ISO 12354-3)**											
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C$_{tr}$)***
				22.2	34.0	41.9	47.1	51.3	50.0			
L_{in}				45.8	27.0	18.1	10.9	2.7	-2.0			
Materials												
Existing 3mm glass with 4mm secondary unit		2.2		16.0	28.0	37.0	42.0	46.0	44.0		**38**	**(-3,-9)**
Double-leaf brickwork wall		5.2		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
$L_{out,s}$												
$L_{out,2m}$	Add Element			68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{out,free\ field}$				65.0	58.0	57.0	55.0	51.0	45.0		**60**	
Element 1				22.2	34.0	41.9	47.1	51.3	50.0			
Plane façade	ΔL_{fs}	7.4		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	x_{fs}	0.0		22.2	34.0	41.9	47.1	51.3	50.0			
$L_{p,out,2m}$				68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{p,in}$				45.8	27.0	18.1	10.9	2.7	-2.0		**30**	**dBA**

Table 4.4 - Noise ingress calculation results - 2nd floor bedroom with secondary glazing

Title: 2nd Floor Bedroom (Front Elevation) **Noise Break In (ISO 12354-3)**											
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C$_{tr}$)***
				22.4	31.2	37.7	42.8	46.8	47.2			
L_{in}				45.6	29.8	22.3	15.2	7.2	0.8			
Materials												
Existing 3mm glass with 4mm secondary unit		1.2		16.0	28.0	37.0	42.0	46.0	44.0		**38**	**(-3,-9)**
Double-leaf brickwork wall		3.9		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
Tiled roof, insulation, plasterboard ceiling		10.0		28.0	34.0	40.0	45.0	49.0	50.0		**44**	**(-2,-5)**
$L_{out,s}$												
$L_{out,2m}$	Add Element			68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{out,free\ field}$				65.0	58.0	57.0	55.0	51.0	45.0		**60**	
Element 1				22.4	31.2	37.7	42.8	46.8	47.2			
Plane façade	ΔL_{fs}	15.1		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	x_{fs}	0.0		22.4	31.2	37.7	42.8	46.8	47.2			
$L_{p,out,2m}$				68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{p,in}$				45.6	29.8	22.3	15.2	7.2	0.8		**31**	**dBA**

4.16 The calculation results indicate a daytime internal sound level of approximately 30 to 31 dB $L_{Aeq,16hour}$ with secondary glazing installed.

4.17 The daytime sound level target of 35 dB $L_{Aeq,16hour}$ will therefore be easily achieved with windows closed.

4.18 Since the night-time sound level is at least 6 dB lower than the daytime sound level, the night-time sound level target of 30 dB $L_{Aeq,8hour}$ will also be easily achieved.

4.19 With regard to the maximum L_{AFmax} internal sound levels, the recommended target of 45 dB L_{AFmax} will also be achieved within bedrooms for the majority of the night-time period.

- 77 dB $L_{AFmax,5min}$ – 32 dB R_w+C_{tr} = 45 dB $L_{AFmax,5min}$

Replacement standard double glazing

4.20 Table 4.5 overleaf presents the calculation results for replacement glazing consisting of 4 mm thick glass / 12 mm cavity / 4 mm thick glass. The timber frames could be retained and the single glazed units replaced as necessary.

4.21 The frame should be checked for gaps/perimeter sealing during the refurbishment works.

Table 4.5 - Noise ingress calculation results - 2nd floor bedroom with double glazing

Title: 2nd Floor Bedroom (Front Elevation) **Noise Break In (ISO 12354-3)**												
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C$_{tr}$)***
				24.9	24.5	32.1	40.4	43.3	38.8			
L_{in}				43.1	36.5	27.9	17.6	10.7	9.2			
Materials												
4mm glass/12 - 20 mm cavity/4mm glass		1.2		21.0	17.0	25.0	35.0	37.0	31.0		**29**	**(-1,-4)**
Double-leaf brickwork wall		3.9		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
Tiled roof, insulation, plasterboard ceiling		10.0		28.0	34.0	40.0	45.0	49.0	50.0		**44**	**(-2,-5)**
$L_{out,s}$												
$L_{out,2m}$	**Add Element**			68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{out,free\ field}$				65.0	58.0	57.0	55.0	51.0	45.0		**60**	
Element 1				24.9	24.5	32.1	40.4	43.3	38.8			
Plane façade	ΔL_{fs}	15.1		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	x_{fs}	0.0		24.9	24.5	32.1	40.4	43.3	38.8			
$L_{p,out,2m}$				68.0	61.0	60.0	58.0	54.0	48.0		**63**	
$L_{p,in}$				43.1	36.5	27.9	17.6	10.7	9.2		**32**	**dBA**

4.22 The calculation results indicate a daytime internal sound level of approximately 32 dB $L_{Aeq,16hour}$ with replacement double glazing.

4.23 The daytime and night-time sound level targets will therefore be achieved with windows closed.

Rear north west elevation

4.24 Table 4.6 and Table 4.7 present the noise ingress calculation results for the two bedrooms on the rear elevation. The highest daytime sound pressure level measured on the rear elevation has been used in the calculation (48 dB $L_{Aeq,16hour}$).

Table 4.6 - Noise ingress calculation results - 1st floor bedroom, rear elevation

Title: 1st Floor Bedroom (Rear Elevation) **Noise Break In (ISO 12354-3)**												
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C$_{tr}$)***
				25.0	25.1	30.0	33.0	39.0	37.1			
L_{in}				28.0	20.9	15.0	10.0	0.0	-4.1			
Materials												
3-4mm glass, timber sash window		1.6		14.0	14.0	19.0	22.0	28.0	26.0		**23**	**(-1,-3)**
Double-leaf brickwork wall		11.3		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
$L_{out,s}$												
$L_{out,2m}$	**Add Element**			53.0	46.0	45.0	43.0	39.0	33.0		**48**	
$L_{out,free\ field}$				50.0	43.0	42.0	40.0	36.0	30.0		**45**	
Element 1				25.0	25.1	30.0	33.0	39.0	37.1			
Plane façade	ΔL_{fs}	12.9		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	x_{fs}	0.0		25.0	25.1	30.0	33.0	39.0	37.1			
$L_{p,out,2m}$				53.0	46.0	45.0	43.0	39.0	33.0		**48**	
$L_{p,in}$				28.0	20.9	15.0	10.0	0.0	-4.1		**18**	**dBA**

Table 4.7 - Noise ingress calculation results - 2nd floor bedroom, rear elevation

Title: 2nd Floor Bedroom (Rear Elevation) **Noise Break In (ISO 12354-3)**												
Formula/Comment	***Single Value***		***63***	***125***	***250***	***500***	***1000***	***2000***	***4000***	***8000***	***Rw***	***(C,C$_{tr}$)***
				23.2	24.5	29.6	32.8	38.6	36.9			
L_{in}				29.8	21.5	15.4	10.2	0.4	-3.9			
Materials												
3-4mm glass, timber sash window		1.6		14.0	14.0	19.0	22.0	28.0	26.0		**23**	**(-1,-3)**
Double-leaf brickwork wall		11.3		40.0	44.0	45.0	51.0	56.0	60.0		**51**	**(-1,-4)**
Tiled roof, insulation, plasterboard ceiling		20.9		28.0	34.0	40.0	45.0	49.0	50.0		**44**	**(-2,-5)**
$L_{out,s}$												
$L_{out,2m}$	Add Element			53.0	46.0	45.0	43.0	39.0	33.0		**48**	
$L_{out,free\ field}$				50.0	43.0	42.0	40.0	36.0	30.0		**45**	
Element 1				23.2	24.5	29.6	32.8	38.6	36.9			
Plane façade	ΔL_{fs}	33.8		0.0	0.0	0.0	0.0	0.0	0.0			
Visible	X_{fs}	0.0		23.2	24.5	29.6	32.8	38.6	36.9			
$L_{p,out,2m}$				53.0	46.0	45.0	43.0	39.0	33.0		**48**	
$L_{p,in}$				29.8	21.5	15.4	10.2	0.4	-3.9		**19**	**dBA**

4.25 The calculation results indicate a daytime internal sound level of approximately 18 to 19 dB $L_{Aeq,16hour}$ with the existing single glazing.

4.26 The daytime sound level target of 35 dB $L_{Aeq,16hour}$ will therefore be achieved with windows closed.

4.27 The night-time sound level targets of 30 dB $L_{Aeq,8hour}$ and 45 dB L_{AFmax} will also be achieved.

4.28 From a noise ingress perspective, no acoustic enhancement is required with regard to the existing glazed units. However, should either secondary glazing or replacement double glazing be installed (e.g. for thermal and/or security purposes), the internal sound level will be lower than the values given above (i.e. very quiet conditions internally).

Noise ingress with windows open

4.29 The level of sound attenuation through an open window is dependent on the type and size of window, the extent of opening, the angle of sound incidence and the characteristics of the noise source in question.

4.30 It is reasonable to assume a sound attenuation performance of approximately 15 dB for a partially open window. Partially open windows will provide background ventilation only, as opposed to rapid/purge ventilation.

4.31 BS 8233 provides the following guidance regarding the sound insulation from an open window:

If partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB[3]. [3)] Note that the level difference through a window partially open for ventilation can vary significantly depending on the window type and the frequency content of the external noise. If the specific details of the window and external noise are known the value for insulation may be adjusted accordingly.

Front elevation

4.32 Daytime façade sound pressure levels are approximately 62 to 63 dB $L_{Aeq,16hour}$ and night-time sound pressure levels are approximately 56 dB $L_{Aeq,8hour}$.

4.33 When assessing noise ingress through an open window, it is appropriate to correct the measured sound levels at the façade by approximately -3 dB to give an equivalent free-field sound level.

4.34 The corresponding 'free-field' sound pressure levels are therefore 59 to 60 dB $L_{Aeq,16hour}$ during the daytime and 53 dB $L_{Aeq,8hour}$ during the night-time.

4.35 Assuming a partially open window provides 15 dB of sound attenuation, the resulting internal sound level is approximately 44 to 45 dB $L_{Aeq,16hour}$ during the daytime and 38 dB $L_{Aeq,8hour}$ during the night-time.

Daytime

- 60 dB $L_{Aeq,16hour}$ – 15 dB = 45 dB $L_{Aeq,16hour}$

Night-time

- 53 dB $L_{Aeq,8hour}$ – 15 dB = 38 dB $L_{Aeq,8hour}$

4.36 The daytime sound level target of 35 dB $L_{Aeq,16hour}$ and the night-time target of 30 dB $L_{Aeq,8hour}$ will therefore not be achieved with windows open.

Alternative ventilation to habitable rooms

4.37 BS 8233 states where occupants rely on closed windows to meet the internal noise limits, there needs to be appropriate *alternative ventilation* that does not compromise the facade sound insulation or resulting internal sound level.

4.38 BS 8233 also provides the following comment with regard to ventilation:

The Building Regulations' supporting documents on ventilation recommend that habitable rooms in dwellings have background ventilation. Where openable windows cannot be relied upon for this ventilation, trickle ventilators can be used and sound attenuating types are available. However, windows may remain openable for rapid or purge ventilation, or at the occupant's choice.

4.39 Since the targets will not be achieved with windows open, it is recommended that an alternative means of ventilation is provided to the four habitable rooms/bedrooms on the front elevation (in addition to simply opening windows).

4.40 Taking into consideration the measured sound levels, it would be appropriate to install a good quality acoustic (sound attenuating) ventilator unit to the habitable room.

4.41 Installing a background ventilator directly through a wall that provides the equivalent areas described in Approved Document F can also be an acceptable route to compliance (as opposed to installing the ventilator unit within the window frame).

4.42 It is anticipated that installing a ventilator unit will be the simplest, least disruptive and the most cost effective noise mitigation measure (compared to installing mechanical ventilation).

4.43 Further guidance regarding ventilator types and acoustic performance is provided below.

4.44 It will still be appropriate to provide rapid or purge ventilation by fully opening the window (e.g. to remove odour from painting and decorating or from burnt food).

Rear elevation

4.45 Daytime façade sound pressure levels are approximately 46 to 48 dB $L_{Aeq,16hour}$ and night-time sound pressure levels are approximately 38 to 39 dB $L_{Aeq,8hour}$.

4.46 When assessing noise ingress through an open window, it is appropriate to correct the measured sound levels at the façade by approximately -3 dB to give an equivalent free-field sound level.

4.47 The corresponding 'free-field' sound pressure levels are therefore 43 to 45 dB $L_{Aeq,16hour}$ during the daytime and 35 to 36 dB $L_{Aeq,8hour}$ during the night-time.

4.48 Assuming a partially open window provides 15 dB of sound attenuation, the resulting internal sound level is approximately 28 to 30 dB $L_{Aeq,16hour}$ during the daytime and 20 to 21 dB $L_{Aeq,8hour}$ during the night-time.

Daytime

- 45 dB $L_{Aeq,16hour}$ – 15 dB = 30 dB $L_{Aeq,16hour}$

Night-time

- 36 dB $L_{Aeq,8hour}$ – 15 dB = 21 dB $L_{Aeq,8hour}$

4.49 The daytime sound level target of 35 dB $L_{Aeq,16hour}$ and the night-time target of 30 dB $L_{Aeq,8hour}$ will therefore be achieved with windows open.

4.50 The maximum sound level target of 45 dB L_{AFmax} will also be typically achieved during the night-time period.

4.51 Since the recommended targets will be achieved with the windows open, an alternative method of ventilation is considered unnecessary.

Overheating and opening windows

4.52 Approved Document O (Overheating) applies to new-build residential dwellings, however the guidance is also worth noting for existing dwellings and those undergoing a material change of use.

4.53 With regard to noise at night and opening windows, the document states the following:

In locations where external noise may be an issue (for example, where the local planning authority considered external noise to be an issue at the planning stage), the overheating mitigation strategy should take account of the likelihood that windows will be closed during sleeping hours (11pm to 7am).

Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits.

a. 40 dB $L_{Aeq,T}$, averaged over 8 hours (between 11pm and 7am).

b. 55 dB L_{AFmax}, more than 10 times a night (between 11pm and 7am).

4.54 On the rear elevation, the predicted internal sound levels are below the noise limits given within Approved Document O which indicates that occupants are likely to open bedroom windows during the night to help cool and remove excess heat from the room.

4.55 On the front elevation, the predicted internal sound levels are expected to be below or similar to the noise limits which again indicates that occupants are likely to open bedroom windows during the night to help cool and remove excess heat from the room.

Ventilation and noise mitigation

Acoustically rated ventilator units

4.56 Manually controlled trickle ventilators are the most common type of background ventilator and can be located over the window frames, in the frames, just above the glass or directly through the wall.

4.57 Sound attenuating (acoustically rated) ventilator units can be installed to habitable rooms, in order to allow background ventilation whilst maintaining a high acoustic performance from the facade.

4.58 The new ventilator unit should provide a sound insulation performance of at least **35 dB $D_{n,e,w}$** in the open position.

4.59 For guidance, example manufacturers of acoustically-rated ventilator units include:

- EHA² | Aereco
- https://www.greenwood.co.uk/acoustic-ventilation/aab
- https://brookvent.co.uk/wall-vents/

4.60 The minimum 'equivalent area' of background ventilators for natural ventilation should follow the guidance in Table 1.7 of Approved Document F for each room type.

Single room heat recovery ventilation unit

4.61 Heat recovery units are designed to improve indoor air quality and lower the risk of condensation. Single room heat recovery units tend to be more efficient than traditional extract ventilation systems, but are not as complex to install as the centralised packaged units for the whole building.

4.62 Example wall mounted systems include:

- Wall-Mounted Ventilation System | Mitsubishi Electric

Mechanically assisted ventilation

4.63 A further option with regard to ventilating and cooling habitable rooms whilst achieving a high facade sound insulation would be to use a mechanical ventilation system, such as a heat recovery system (MVHR) or positive input ventilation system (PIV).

4.64 Example suppliers of MVHR and PIV systems include:

- www.nuaire.co.uk/residential/positive-input-ventilation
- www.envirovent.com/specifier/products/heat-recovery-systems/

4.65 With a loft mounted motor and control unit, particular attention should be paid to the construction of bedroom ceilings and the mounting of the motor unit in order to minimise the noise transmission into adjacent rooms. It is commonplace for a double-boarded ceiling construction and acoustically enhanced loft-hatch to be used where there is a loft mounted motor/control unit.

Internal sound insulation and acoustic separation

Separating floors

4.66 The separating floor construction appears to consist of the original timber floor boards, 175 mm timber joists (no insulation between joists) and the original lath/plaster ceiling.

4.67 The typical airborne sound insulation performance of such a construction is approximately 36 to 41 dB $D_{nT,w}+C_{tr}$. The impact performance is typically 68 to 70 dB $L'_{nT,w}$.

4.68 The airborne and impact sound insulation performance of the existing floor is therefore expected to be below the minimum performance standards of Approved Document E.

4.69 It is assumed that significant acoustic enhancement to the upper side of the floor (such as a cradle-and-batten system) will be impractical due to creating issues with floor heights, staircase step-heights and door frame heights etc.

4.70 The following recommendations are therefore based on acoustically enhancing the underside of the floor (ceiling side).

Metal-frame suspended plasterboard ceiling

4.71 It is recommended that a suspended ceiling is installed to the underside of the ground and first floor consisting of 2 x 12.5 mm SoundBloc plasterboard on a metal-frame system.

4.72 Alternatively, FireLine plasterboard may be used or similar dense boards, e.g. Siniat's dB Board/Fire Board.

- Gyproc SoundBloc 12.5mm | Acoustic Plasterboard | British Gypsum (british-gypsum.com)
- Gyproc FireLine 12.5mm | Fire Resistant Plasterboard | British Gypsum (british-gypsum.com)

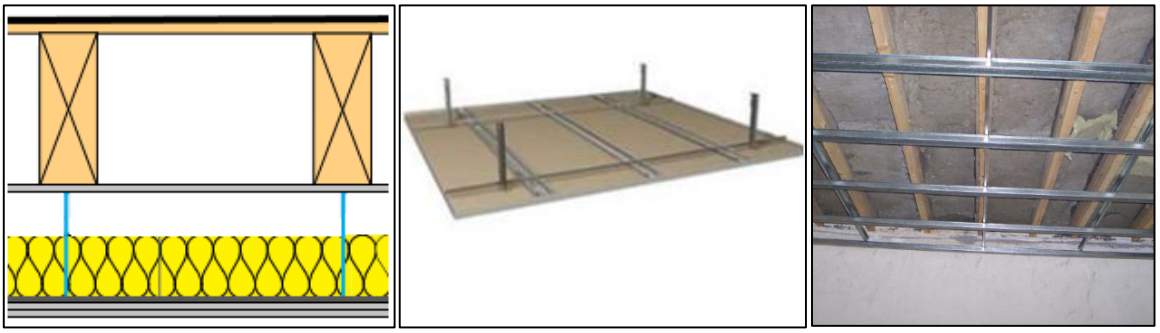
4.73 It is recommended that the existing lath/plaster ceilings are retained where possible, which will provide an additional mass layer within the overall floor build-up (which in turn will help with acoustic performance). Retention of the existing ceilings will also save on the costs associated with the removal and disposal of the existing plaster/wood and will preserve the original covings.

4.74 The new dense plasterboard should be installed with staggered joints. The joints to the outer board layer should be sealed with tape or caulked with sealant and the perimeter edge of the ceiling boards should also be sealed with flexible sealant. Ideally, a small perimeter gap (2 to 3 mm) should be maintained to ensure the new ceiling boards do not touch the surrounding walls.

4.75 A suitable suspension system would be the CasoLine metal frame (or similar):

- CasoLine MF Ceiling System | Gyproc

Figure 4.1 - Example metal-frame suspended ceilings



4.76 The suspension depth between the existing lath/plaster ceiling and the upper side of the new plasterboard should be at least 150 mm.

4.77 The measured floor-to-ceiling height was approximately 2.6 metres on the ground floor and 3 metres on the first floor and therefore suspended ceilings are a viable option.

4.78 It is also recommended that 100 mm thick mineral wool insulation is installed within the cavity (e.g. Knauf's acoustic partition roll or Isover's APR1200).

- Acoustic Roll Insulation | Glass Mineral Wool (knaufinsulation.co.uk)

4.79 Acoustic hangars can be used to help isolate the metal frame and plasterboard from the separating floor structure, which in turn notably increases the acoustic performance.

4.80 In this instance, where the lath/plaster ceilings are retained, it is anticipated that the performance standards will be achieved without acoustic hangars in the suspension system.

Acoustically resilient layer

4.81 To help with impact related noise (e.g. footsteps and chair movements), it is further recommended that an acoustically resilient layer is installed to the upper-side of the floor.

4.82 For guidance, the following acoustic layer would be appropriate:

- Regupol 3912 Acoustic Underlayment (REGUPOL sonus 3912) - CMS Danskin

4.83 Before the resilient layer is installed, the existing floorboards should be made good by replacing damaged/missing boards and filling gaps with flexible sealant as required.

4.84 Additional 'standard' underlay should not be required for the final floor finish (e.g. carpet or laminate) where a resilient layer is installed.

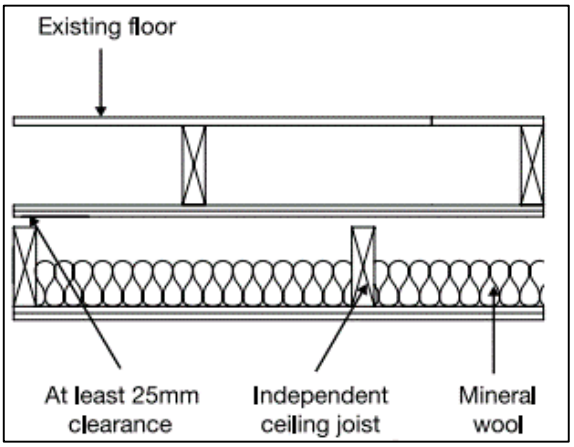
Independent timber frame (alternative option)

4.85 As an alternative to a metal frame system, a timber frame could be installed that is independent of the existing floor structure, as shown in the example diagram below.

4.86 A resilient foam tape/gasket can be used around the perimeter, in order to help acoustically isolate the timber frame from the surrounding masonry walls.

4.87 The suspension depth between the existing lath/plaster ceiling and the upper side of the new plasterboard should be at least 150 mm. It is recommended that 100 mm thick mineral wool insulation is installed within the cavity.

Figure 4.2 - Diagram showing independent timber frame/joists



Recessed downlights

4.88 Where recessed down-lighting is required, acoustic/fire-rated units should be installed throughout the property to help maintain the acoustic performance of the new ceiling.

Anticipated performance on completion

4.89 With the recommendations implemented, the airborne sound insulation performance is expected to be approximately 45 to 48 dB $D_{nT,w}+C_{tr}$. The impact performance is expected to be approximately 55 to 57 dB $L'_{nT,w}$.

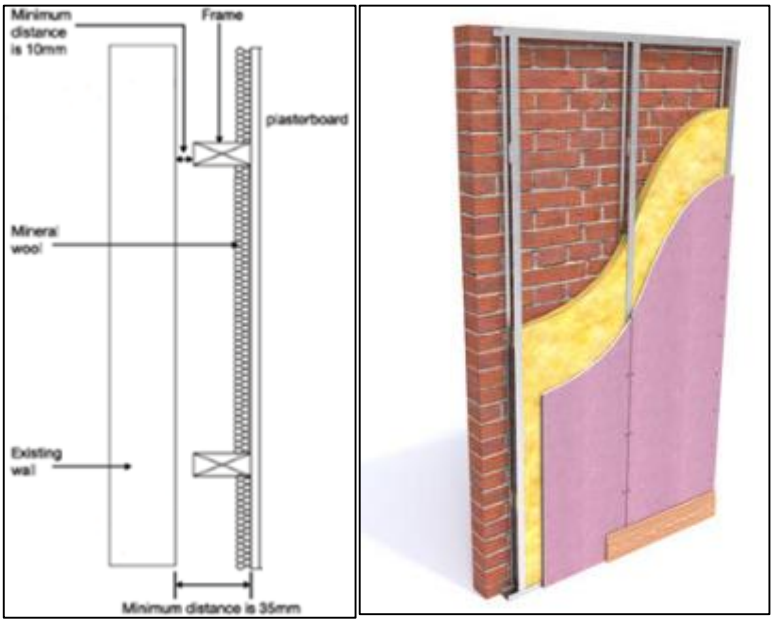
4.90 On completion, the airborne and impact sound insulation performance of the floor should therefore achieve the minimum performance standards of Approved Document E.

Acoustic wall linings and flanking noise attenuation

4.91 It is recommended that the party walls are appropriately lined in order to increase the airborne sound insulation of the separating construction. This measure will also help reduce vertical flanking sound transmission between floors (sound energy that radiates via the brickwork wall.

4.92 The walls can be lined with either a fully independent or virtually independent wall lining system. The diagram overleaf shows a fully independent wall lining in which the supporting frame does not touch the masonry wall.

Figure 4.3 - Diagram showing independent wall lining



4.93 The wall lining should ideally consist of 2 x 12.5 mm SoundBloc plasterboard (or FireLine plasterboard) with 50 mm thick mineral wool insulation/slabs fitted between studs.

4.94 The greatest level of flanking sound attenuation will be achieved via a fully independent wall lining system and it is therefore recommended that an independent lining is used where possible.

- GypLyner Independent Wall Lining System | British Gypsum (british-gypsum.com)

4.95 The supporting framework for the linings can be constructed from metal studs and floor/ceiling channels or alternatively from timber (e.g. 3” x 2” timber battens).

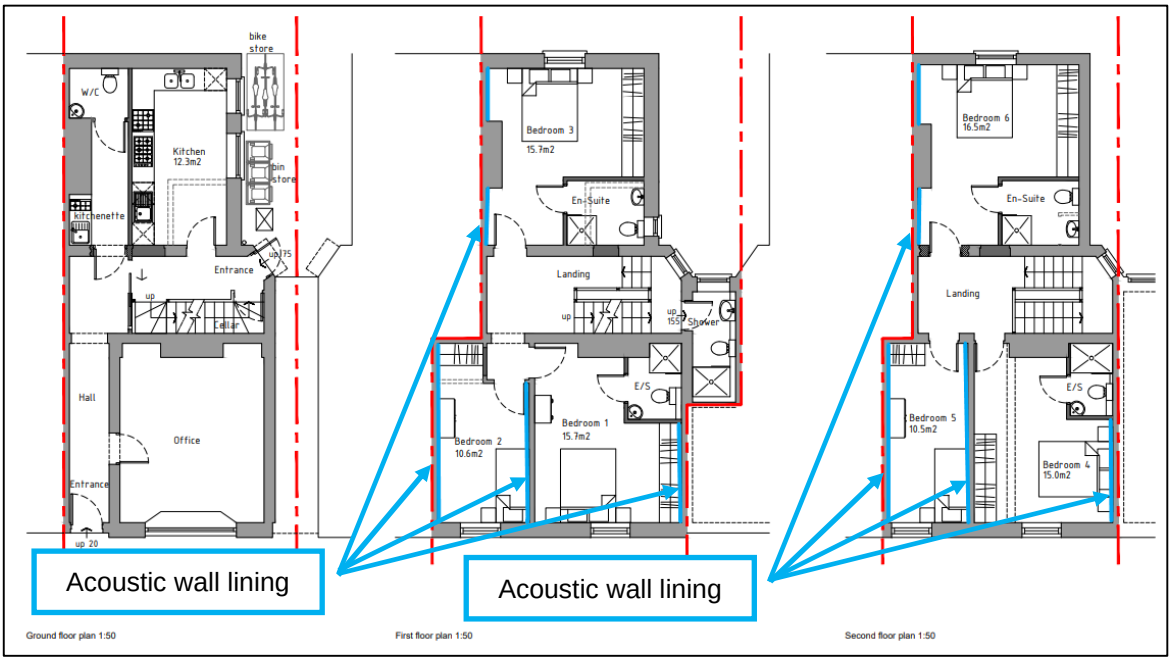
4.96 Where metal is preferred, the independent frame can be constructed from Gypframe floor and ceiling channels with Gypframe ‘I’ studs friction-fitted vertically within the channel sections to form the framework. There should be a gap of at least 10 mm between the metal frame and the existing masonry (to prevent acoustic bridging).

4.97 Where it is impractical to install independent wall linings, a virtually independent wall lining may be used, such as the GypLyner Single metal-framed lining system:

- GypLyner Single Wall Lining System | British Gypsum (british-gypsum.com)

4.98 Figure 4.4 overleaf shows the recommended wall linings highlighted in blue.

Figure 4.4 - Floor layouts showing independent wall linings



5. Conclusion

5.1 The external walls and roof construction will provide sufficient sound insulation from external noise and do not require acoustic enhancement.

5.2 The recommended sound level targets will not be achieved within the bedrooms on the front elevation with the existing single glazing.

5.3 Secondary glazing will be required to achieve the targets during the daytime and night-time period. Alternatively, the single glazing could be replaced with standard double glazed units. The timber sash frames could be retained.

5.4 An alternative means of ventilation should be provided to the bedrooms on the front elevation since the targets will not be achieved with windows open.

5.5 An appropriate noise mitigation measure would be to install good quality acoustic ventilator units to the external wall or window frame of the bedrooms.

5.6 An alternative approach would be to use mechanically assisted ventilation, as opposed to acoustically rated ventilator units.

5.7 The recommended sound level targets will be achieved within the bedrooms on the rear elevation with the existing single glazing.

5.8 An alternative method of ventilation is unnecessary for the bedrooms on the rear elevation since the daytime and night-time sound level targets will be achieved with windows open.

5.9 The separating floors and party walls should be acoustically enhanced in order to provide a sufficient airborne and impact sound insulation performance. Suspended ceilings and independent wall linings can be used to provide a significant improvement in sound insulation performance.

Appendix A
Floor plans and elevations

Figure A.1 - Site location plan

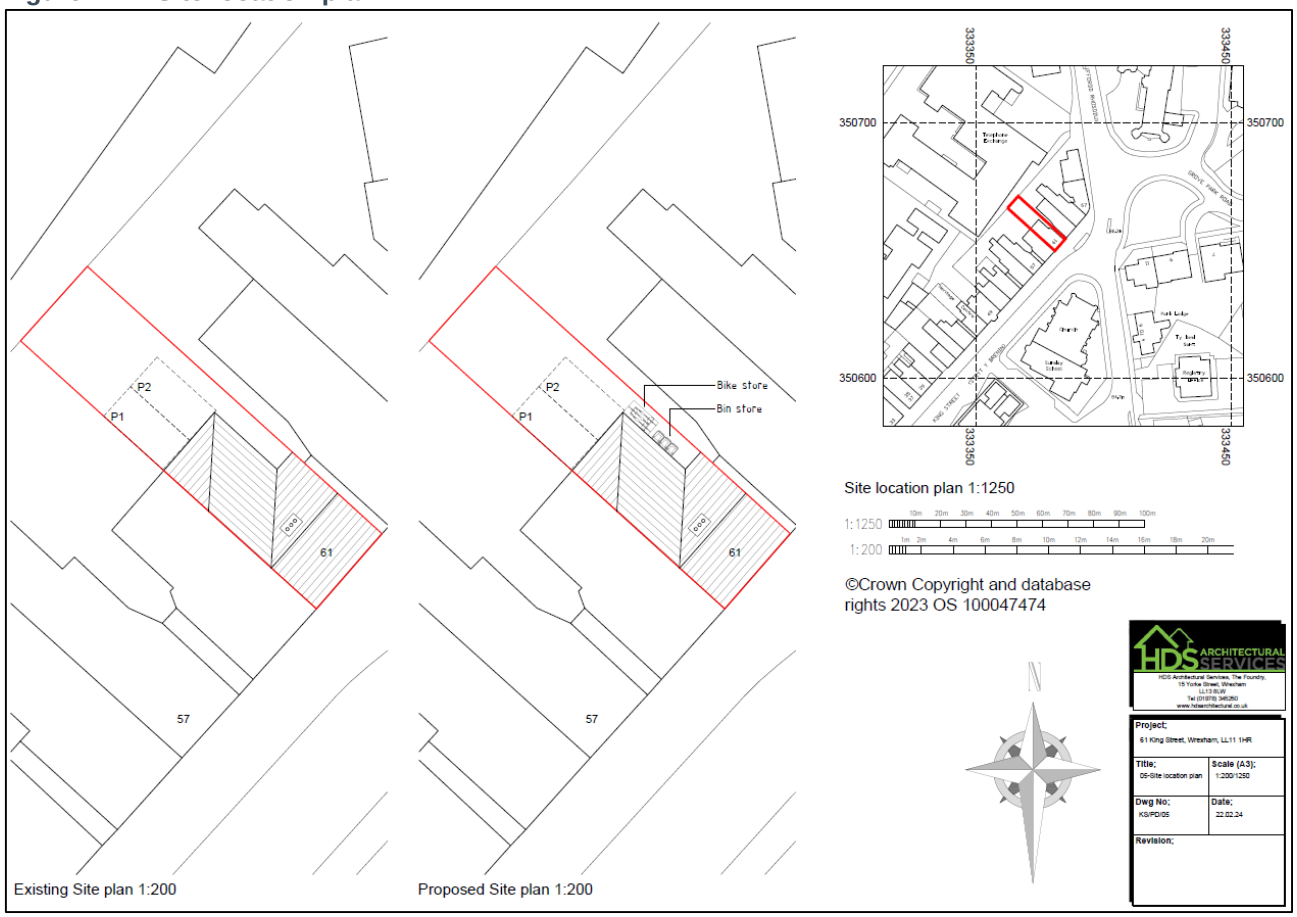
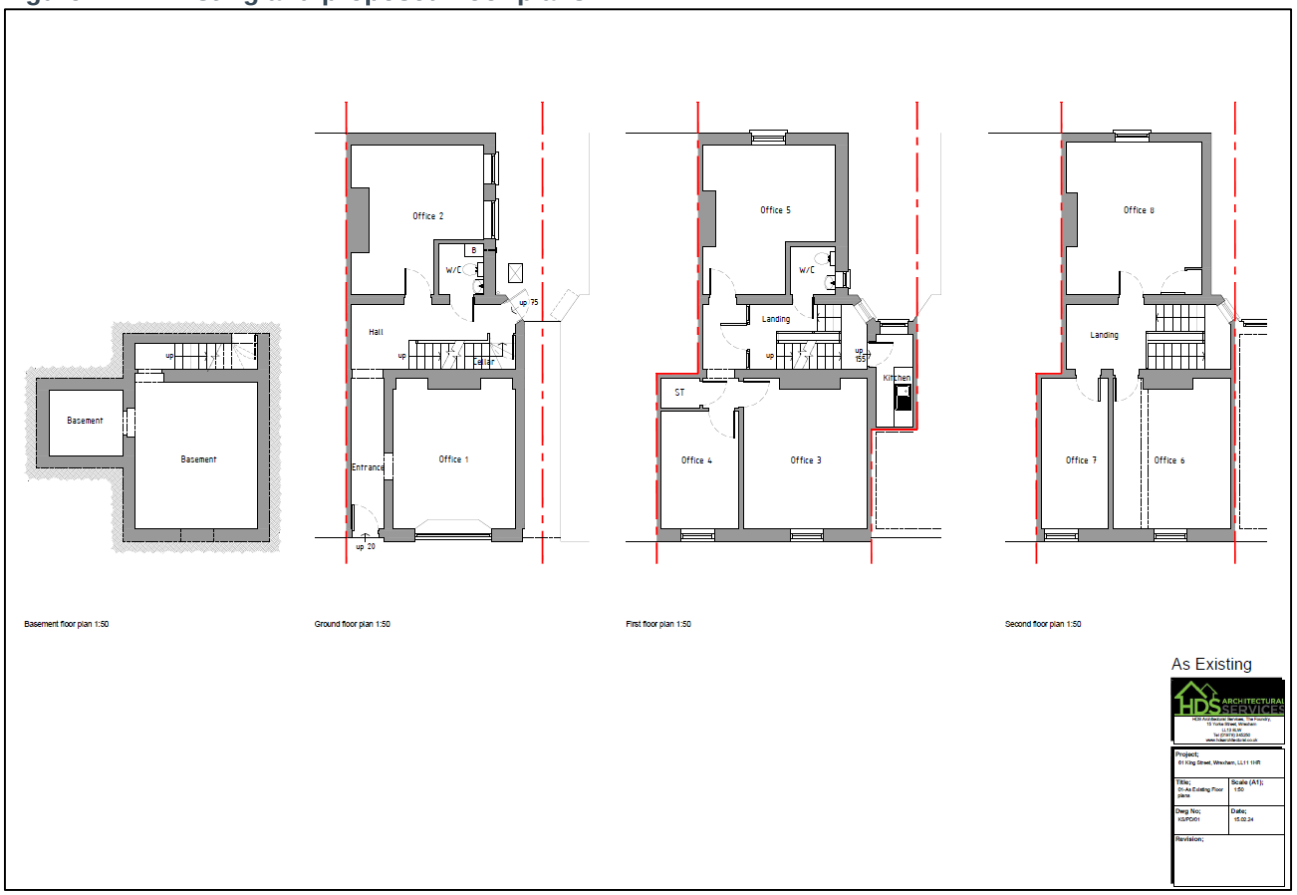


Figure A.2 - Existing and proposed floor plans



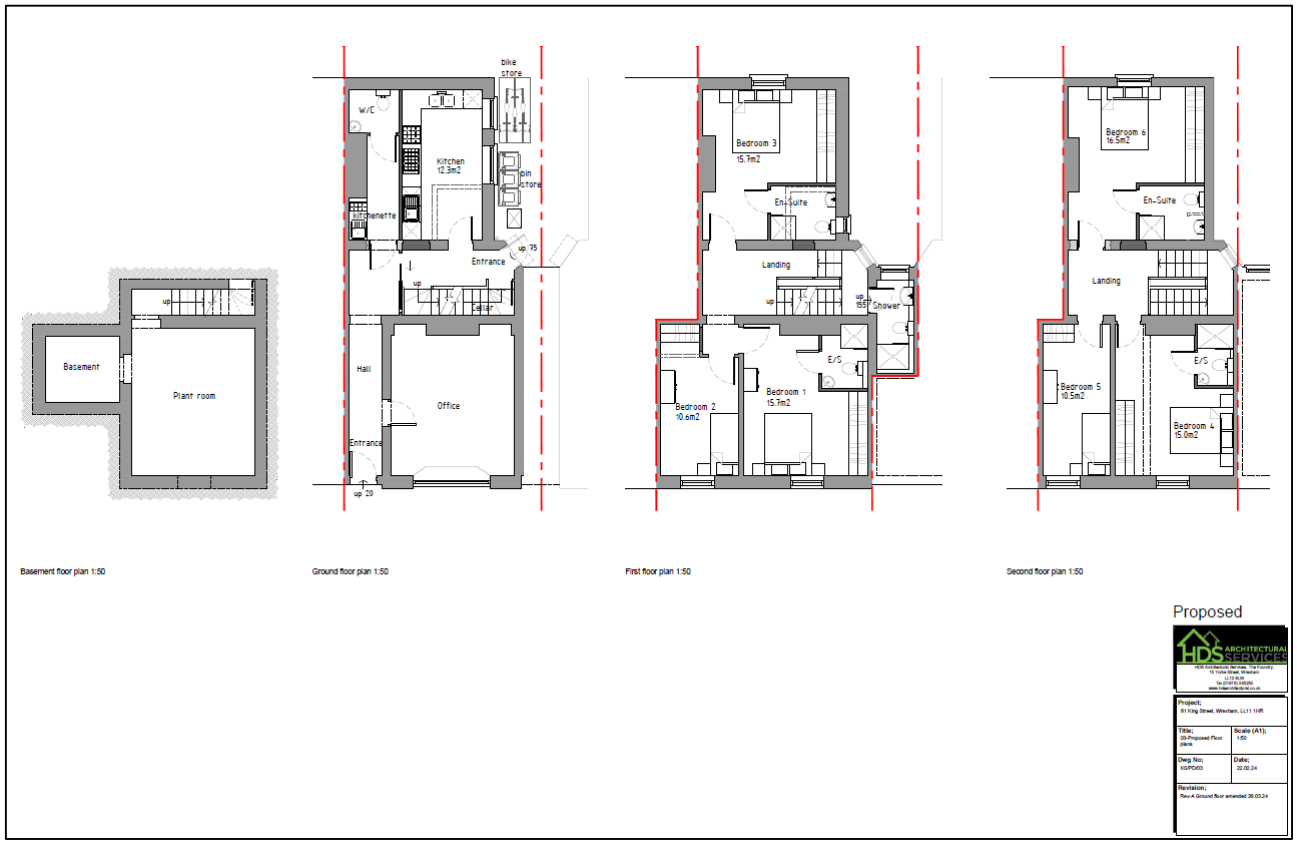


Figure A.3 - Existing and proposed elevations



Appendix B
Assessment terminology

Assessment terminology

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ($2x10^{-5}$Pa).
dB(A)	The most widely used weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc, according to the parameter being measured.
Acoustic environment	Sound from all sources as modified by the environment.
Ambient sound level	The totally encompassing sound in a given situation at a given time; it is usually composed of sound from many sources, near and far.
Equivalent continuous sound level - $L_{Aeq,T}$	The A-weighted equivalent continuous sound pressure level over a period of time, T. Representative of the 'average' sound pressure level over a given period (commonly used to describe the 'ambient' sound level).
Maximum sound level - $L_{AFmax,T}$	The A-weighted 'maximum' sound pressure level that occurred during a given period, T (commonly used for the assessment of intermittent loud noises).
Background sound level - $L_{A90,T}$	The sound pressure level that is exceeded for 90% of the measurement time interval, T. $L_{A90,T}$ is often used to describe the 'background' sound level.
Habitable room	Any room used or intended to be used for sleeping, cooking, living or eating purposes (enclosed spaces such as bath or toilet facilities, service rooms, corridors, laundries, hallways, utility rooms or similar spaces are excluded from this definition).
R_w	The weighted sound reduction index expressed in dB. A single number quantity for airborne sound insulation rating.
Free-field level	A sound field determined at a point away from reflective surfaces other than the ground with no significant contributions due to sound from other significant reflective surfaces. Generally as measured outside and away from buildings (>3.5metres).