

Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

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Client:	Aspire 108 London Street Limited			
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Opinions included herein are based on information gathered during the study and from our experience. If additional information becomes available which may affect our comments, conclusions or recommendations, Paragon Acoustic Consultants Ltd reserves the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

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Appendices

Appendix A: Insul Element Sound Insulation Calculations

Appendix B: Façade Sound Insulation Calculations

1.0 Introduction

It is proposed that 108 London Street, Reading RG1 4SJ, be converted from office to residential accommodation.

During the pre-application process, the Local Planning Authority has raised the following concern:

“A noise assessment should be submitted in support of applications for new residential proposed in noisy areas. The proposed development is next the After Dark night club which we have already received noise complaints about. The noise assessment would have to take this noise source into account by being carried out over a Friday and Saturday night when the club is at capacity.

The noise assessment will be assessed against the recommendations for internal noise levels within dwellings and external noise levels within gardens / balconies in accordance with BS 8233:2014 and WHO guidelines for Community Noise. The report should identify any mitigation measures that are necessary to ensure that the recommended standard is met.

Where appropriate, the noise assessment data should also include noise events (L_{AMax}) and the design should aim to prevent noise levels from noise events exceeding 45dB within bedrooms at night. Noise levels above 45dB are linked with sleep disturbance.

Internal noise criteria (taken from BS8233:2014)”

Room	Design criteria	Upper limit
Bedrooms (23:00 to 07:00)	<30dB LAeq, 8 hour	
Living rooms (07:00 – 23:00)	<35dB LAeq, 16 hour	
Gardens & Balconies	<50dB LAeq, T	<55dB LAeq, T

This assessment covers activity noise arising from the After Dark Club and general environmental noise, in the context of national and local planning policy and guidance and is based on the principles and recommendations contained within the following documents.

- National Policy Statement for England (NPSE) March 2010;
- National Planning Practice Guidance “Noise” August 2013;
- Reading Borough Local Development Framework Reading Central Area Action Plan (2009);
- Reading Borough Local Development Framework Sites and Detailed Policies Document (2012, 2015);
- World Health Organisation: 1999: “Guidelines for Community Noise”;
- BS 8233:2014 “Guidance on sound insulation and noise reduction for buildings”.

2.0 Site Description

The site and adjoining land uses is illustrated in Figure 1 below.

Figure 1: Site location



The site lies in an area which is characterised by mix of residential, commercial and retail premises. The eastern elevation of the scheme overlooks London Street, a moderately trafficked one-way route having a junction with London Road/Crown Street to the south and the A329 to the north.

The After Dark Club flanks the scheme to the south, with residential premises being evident to the north.

3.0 Planning Policy Guidance

3.1 Noise Policy Statement for England (NPSE) March 2010

The Government published the Noise Policy Statement for England (NPSE) in March 2010 with the aim of providing clarity regarding current policies and practices to enable noise management decisions to be made within the wider context, at the most appropriate level. The aims of the Government's noise policy are:

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

1. Avoid significant adverse impacts on health and quality of life;
2. Mitigate and minimise adverse impacts on health and quality of life; and
3. Where possible, contribute to the improvement of health and quality of life.

In its aims the Policy uses the key phrases "Significant adverse" and "adverse". In clarifying what these mean the Policy notes that "...there are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the WHO. They are:

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected."

The Policy extends these concepts to include:

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur."

It is further noted that NPSE should apply to all forms of noise including environmental noise, neighbour noise and neighbourhood noise.

The Policy notes that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is for a project to identify relevant SOAELs taking account the different sources of exposure and different receptors.

It can be seen that the test of significance in relation to government policy is a question of degree and that a significant noise level will be somewhere above a level where the onset of adverse effect might be expected - i.e. SOAELs will always be greater in magnitude than LOAELs and LOAELs are greater than NOELs. In other words, as exposure to a sound source increases there will start to be some level of effect on a receptor, and, as the exposure increases, the severity of the effect or effects increase with further increase in exposure to the level where the effect becomes significant.

It is also worth noting that the second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. The aim is that "all reasonable steps

should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.”

3.2 National Planning Practice Guidance – Noise (March 2014)

Noise needs to be considered when new developments would be sensitive to the prevailing acoustic environment. When determining impact, Local Authorities’ plan making and decision taking should account for the acoustic environment and in doing so consider:

- Whether or not a significant adverse effect is occurring or is likely to occur;
- Whether or not an adverse effect is occurring or is likely to occur; and
- Whether or not a good standard of amenity can be achieved

The subjective nature of noise means that there is not a simple relationship between noise levels and the impact of those affected. This will depend on how factors combine in any particular situation, including:

- The source and absolute level of the noise together with the time of day it occurs;
- For non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;
- The spectral content of the noise and its general character (whether the noise contains particular tonal characteristics or other particular features).

More specific factors to consider, when relevant, include:

- Where applicable, the cumulative effect of more than one noise source should be taken into account along with the extent to which the source of noise is intermittent and of limited duration;
- Consideration should also be given to whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time. In both cases, a suitable alternative means of ventilation is likely to be necessary.

In respect of mitigating noise, the approach to be adopted will depend on the nature of the development and the character of the location. For noise sensitive developments measures can include designing the development to reduce the impact of the noise from the local environment and optimising the sound insulation provided by the building envelope.

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

3.3 Reading Borough Local Development Framework Reading Central Area Action Plan (2009)

Clause 8.20 of the Local Development Framework Reading Central Area Action Plan makes the observation that:

“An increasing residential population in the centre raises the issue of conflict with alternative uses, particularly in the evening. Research suggests that, far from being conflicting uses, a busy evening economy is a major attractor of potential residents, who are often young and childless. Measures to maximise the mitigation of potential noise and disturbance should be built into the design of both the potential source, and of those developments, particularly housing developments, likely to be affected. However, where the

evening economy is at its strongest, the potential for noise and disturbance may be such that it cannot be mitigated through design and will make for an unacceptable living environment. In these cases, residential development adjacent to these areas should not take place, in line with the spatial strategy (paragraph 5.9)."

Policy RC9 advises that proposals for residential development within the central area will be assessed against the defined criteria, including:

- "ii *Proposals for new residential development within the central area will be required to demonstrate how the issue of potential noise disturbance from neighbouring land uses and other sources, and air quality implications of residential development, have been considered and if necessary, mitigated. New residential development should not be located next to existing town centre uses where those uses would give rise to unacceptable levels of noise and disturbance to the occupiers of the new scheme, unless this can be mitigated.*"

3.4 Reading Borough Local Development Framework Sites and Detailed Policies Document (2012, 2015);

Policy DM4: "SAFEGUARDING AMENITY" of the Local Development Framework makes specific recommendations in the context of development such that there will be no significant detrimental impact to the living environment of existing or new residential properties, in terms of:

- Noise and disturbance

Policy DM8: "RESIDENTIAL CONVERSIONS" goes on to say that:

"There are no unacceptable adverse impacts to other residential properties arising from noise and disturbance in terms of the number and layout of units proposed and the proximity to other properties"

4.0 General Guidance on the Assessment of Noise

4.1 World Health Organisation

The World Health Organisation (WHO) document "Guidelines for Community Noise" provided a review of the effects of noise and a description of the principles of health criteria.

Table 1 of the document presents guideline values arranged according to specific environments and critical health effects. Noise indices to be adopted and the accompanying time base to be used for the assessment are also presented.

The guideline values consider all health effects for a specific environment. An adverse health effect refers to any temporary or long-term impairment of physical, psychological or social functioning associated with noise exposure. The specific noise limits were set for each health "using the lowest noise level that produces an adverse health effect"

Table 1: WHO Guideline values for community noise in specific environments

Specific environment	Critical health effect(s)	L_{Aeq} [dB]	Time base [hours]	L_{Amax} fast [dB]
Outdoor living area	Serious annoyance, daytime and evening	50	16	
	Moderate annoyance, daytime and evening	55	16	
Dwelling, indoors	Speech intelligibility & moderate annoyance daytime & evening	35	16	45
	Sleep disturbance, night time	30	8	

For the daytime level, the WHO Guidelines for Community Noise identifies guideline values to assess typical community annoyance with 50 or 55 dB L_{Aeq} [outdoor noise level] representing "daytime levels below which a majority of the adult population will be protected from becoming moderately or seriously annoyed, respectively." On this last matter, page 144 of the Community Noise guidelines states that "Available data indicate that daytime sound pressure levels of less than 50 dB L_{Aeq} cause little or no serious annoyance in the community". The dose response curves on page 100 of the document suggest about 5% of the population is annoyed at 55 dB - i.e., the majority referred to in the annoyance guideline value is about 95% of the population.

For noise events, the guideline value was set at 45 dB L_{Amax} , with research cited in the text advising that this value should not be exceeded by more than 10 to 15 times per night to ensure "good sleep".

4.2 BS 8233:2014: Guidance on sound insulation and noise reduction for buildings

This British Standard came into effect on 28 February 2014 and supersedes BS 8233:1999, which is withdrawn.

The standard draws on the results of research and experience to provide information on the design of buildings that have internal acoustic environments appropriate to their functions. It deals with control of noise from outside the building, noise from plant and

services within it, and room acoustics for non-critical situations. It is applicable to the design of new buildings, or refurbished buildings undergoing a change of use, but does not provide guidance on assessing the effects of changes in the external noise levels to occupants of an existing building.

4.2.1 Dwellings

Indoor ambient noise levels for dwellings are set out at Section 7.7.2, Table 4, reproduced below.

Table 2: Indoor ambient noise levels for dwellings (from BS 8233:2014, Table 4)

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 $L_{Aeq,8hour}$

A series of notes provide context to the guideline values of Table 4. Note 1 advises that the indoor ambient noise levels are *“the sum total of structure-borne and airborne noise sources. Groundborne noise is assessed separately and is not included as part of these targets, as human response to groundborne noise varies with many factors such as level, character, timing, occupant expectation and sensitivity.”*

Note 3 states *“These levels are based on annual average data and do not have to be achieved in all circumstances. For example, it is normal to exclude occasional events, such as fireworks night or New Year’s Eve.”*

Note 4 deals with individual events and advises that *“Regular individual noise events (for example, scheduled aircraft or passing trains) can cause sleep disturbance. A guideline value may be set in terms of SEL or $L_{Amax,F}$, depending on the character and number of events per night. Sporadic noise events could require separate values”*.

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

4.3 Proposed Design Criteria

It is proposed that the design targets for indoor ambient noise follow the pre-application guidance reviewed above, which are consistent with Table 4 of BS 8233:2014.

Table 3: Proposed 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 $L_{Aeq,8hour}$

5.0 Noise Surveys

Environmental noise surveys were undertaken at site over the periods 09/03/18 to 19/03/18 and 09/03/2018 to 11/03/2018 at the following locations, respectively:

- **MP1:** Prince Regent House, 1m from façade at first floor level;
- **MP2:** London Road elevation, 1m from façade at first floor level.

Figure 2: Noise monitoring location



Measurements were made with instrumentation complying with Class 1 of IEC 61672-1, and IEC 61260 for octave and fractional octave filters and accuracy Type 1 as defined in IEC 60651 and IEC 60804. On-site calibrators complied with accuracy Class 1 as defined in IEC 60942.

The sound level meters have been calibrated by a competent laboratory within the last two years in accordance with BS 7580 Part 1, or to BS EN/IEC 61672 for meters manufactured to the BS EN/IEC 60651 or 60804 Standards as applicable.

At the beginning and end of a measurement session, the calibration of the measuring system was checked with a sound calibrator and no significant drift was encountered.

At each measurement position, the analyser was programmed to measure noise levels using continuous, consecutive 5 minute measurement periods.

The following equipment was used:

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Table 4: Schedule of instrumentation

Position	Manufacturer	Type	Serial Number	Calibration Due Date
MP1	SVANTEK	SVAN 971 Sound Level Meter	52614	2018-10-10
		SV18 preamplifier	57317	
		ACO 7025E microphone	65848	
		SA 271 outdoor microphone kit	n/a	n/a
MP2	SVANTEK	SVAN 958 sound level meter	14626	2019-08-02
		SV12L preamplifier	17309	
		SV22 microphone	4013039	
		SVAN outdoor microphone kit	n/a	
All	SVANTEK	SV33A sound level calibrator	58011	2018-10-25

6.0 Noise Monitoring Results

Results of noise monitoring are summarised in the following sections. For brevity the raw measurement data set is not reproduced herein due to its size, but is available upon request

6.1 Prince Regent House

The measurement data obtained at the Prince Regent House rear elevation, including noise emissions from the After Dark Club¹, are shown as a time series for the day and night periods in Figures 3 to 5 below.

Figure 3: Measured $L_{Aeq,5min}$ dB time series during daytime hours (façade values in dB re: 20 μ Pa)

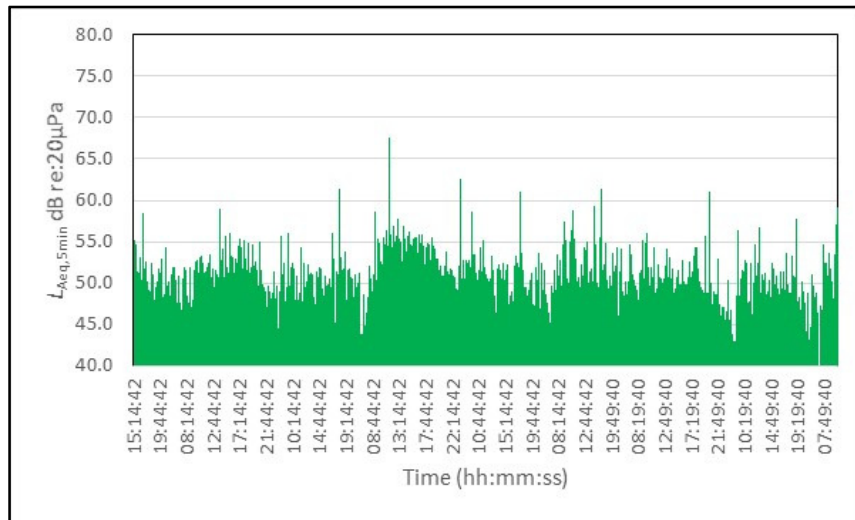
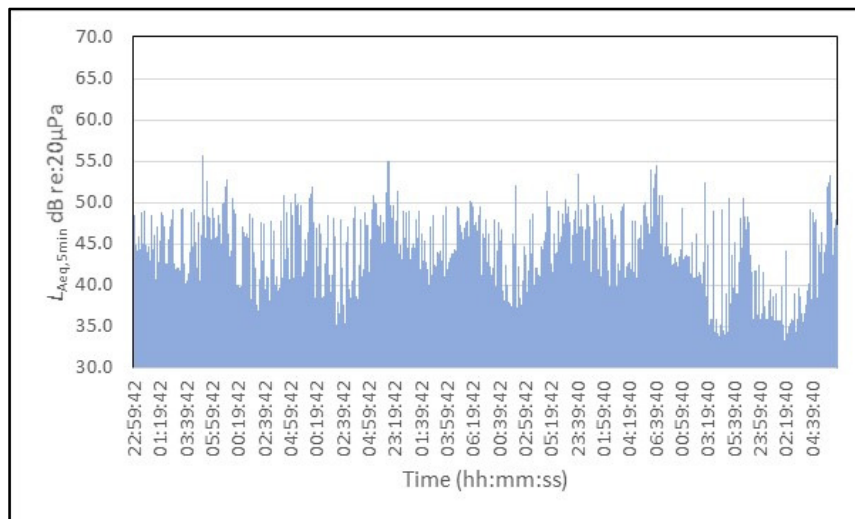
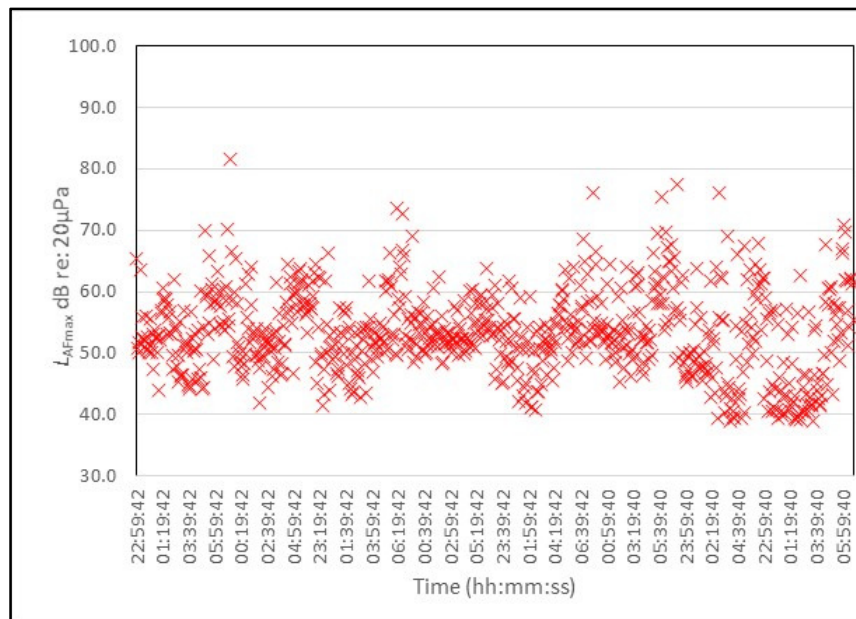


Figure 4: Measured $L_{Aeq,5min}$ dB time series during night hours (façade values in dB re: 20 μ Pa)



¹ Measurement results reported herein are relevant to the dates over which surveys were undertaken. Environmental noise levels may alter in the event that activity noise within the After Dark Club materially increases.

Figure 5: Measured L_{AFmax} dB noise levels during night hours (façade values in dB re: 20 μ Pa)



The measurement data have subsequently been processed to determine values of $L_{Aeq,16h}$ dB and $L_{Aeq,8h}$ dB for the day and night periods respectively. The range of night L_{AFmax} dB maximum noise levels is also included.

Table 5: Summary of broadband measurement data (all data façade values in dB re: 20 μ Pa)

Period	Start Date	$L_{Aeq,16h}$ dB	$L_{Aeq,8h}$ dB	Max. Noise Level L_{AFmax} dB	
				Min	Max
1	09-Feb	50.0	46.1	44.0	69.9
2	10-Feb	50.9	46.0	42.0	81.7
3	11-Feb	49.9	46.3	41.5	73.5
4	12-Feb	54.1	46.3	48.2	69.0
5	13-Feb	50.7	45.0	40.7	68.5
6	14-Feb	51.5			
7	16-Mar	51.1	47.4	45.3	76.1
8	17-Mar	50.2	44.1	39.0	77.4
9	18-Mar	48.6	43.2	38.9	70.8
10	19-Mar	51.7			

The measurement data have been processed to determine typical spectral $L_{eq,16h}$ and $L_{eq,8h}$ values for the day and night periods, as per Figures 6 and 7 below.

Figure 6: Daytime spectral $L_{eq,16h}$ dB noise levels (façade values in dB re: 20 μ Pa)

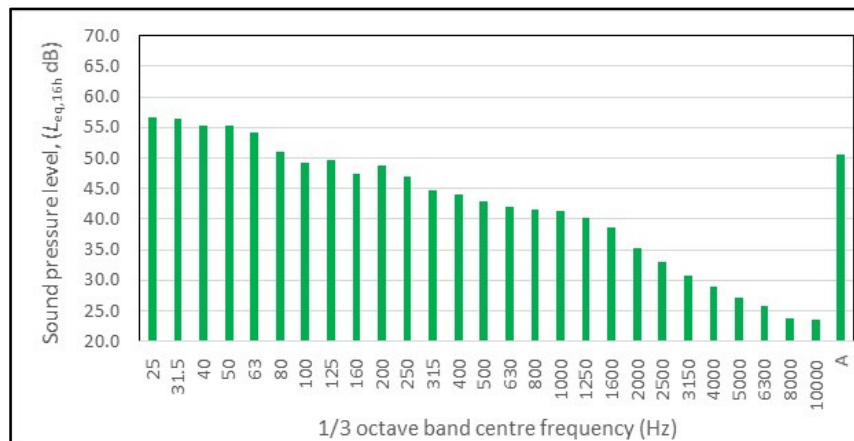
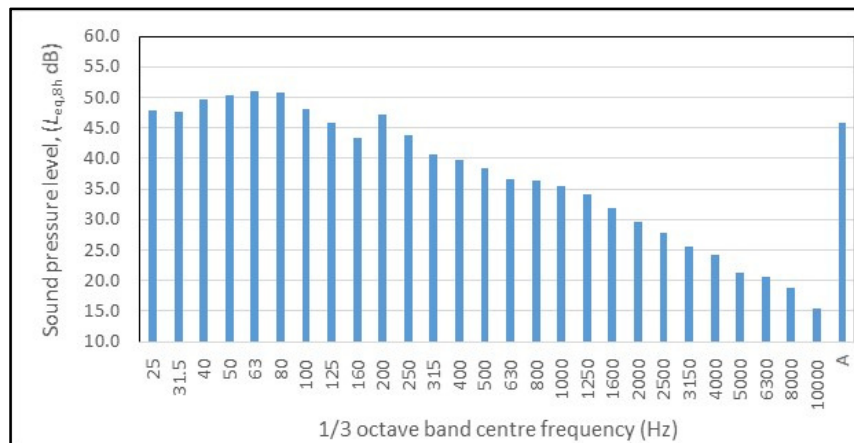


Figure 7: Night spectral $L_{eq,8h}$ dB noise levels (façade values in dB re: 20 μ Pa)

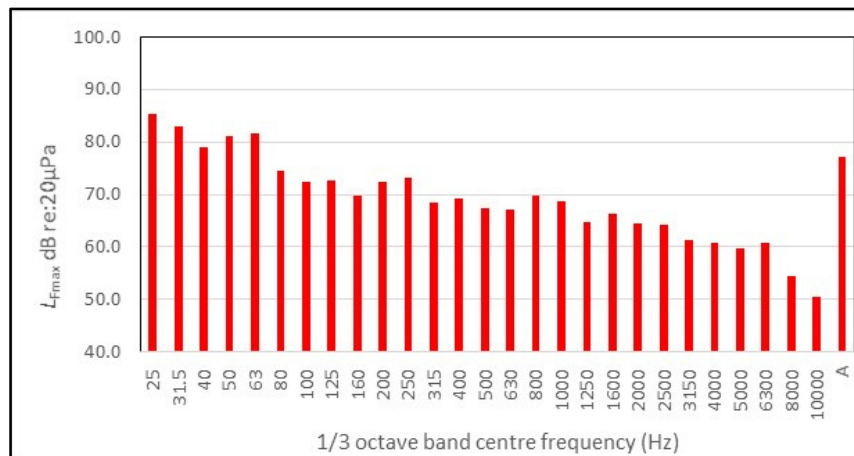


As regards maximum noise levels attributable to break out from the After Dark Club, it is considered that taking the single highest value of the pooled data set is not generally appropriate and moreover this wouldn't be widely supported by literature. The 10th or 15th highest maximum value could be potentially adopted following Valet² *et al.*, however a more stringent approach is advocated herein. The 5 minute L_{Fmax} measurements have been sorted by descending order of magnitude and the 99th percentile (the highest one percent) of the **individual** one-third octave band levels have then taken to produce a composite spectrum, as per Figure 8 below.

The equivalent broadband value that results from this process is numerically equal to the second highest measured L_{AFmax} value from the pooled data set and is therefore considered to represent the reasonably foreseeable worst-case basis for assessment.

² WHO Guidelines for Community Noise

Figure 8: Composite night L_{Fmax} spectrum (façade values in dB re: 20µPa)



6.2 London Road Elevation

The front elevation of the scheme is screened from the After Dark Club but subject to road traffic noise. The measurement data have been processed to determine typical day and night L_{eq} noise levels as per Table 4. As regards night maxima, for good sleep, page 46 of the WHO Guidelines for Community Noise cites research by Vallet & Vernet, 1991 who state that it is believed that indoor noise sound pressure levels should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night. The 10th highest L_{Amax} value has therefore been taken to represent the reasonably foreseeable worst-case basis for assessment.

Table 6: Summary of London Street environmental noise levels (façade values in dB re: 20µPa)

Quantity	1/1 Octave Band Centre Frequency (Hz)							A
	63	125	250	500	1k0	2k0	4k0	
Day $L_{eq,16h}$ (0700-2300 hrs)	76	72	71	70	70	69	67	75
Night $L_{eq,8h}$ (2300-0700 hrs)	68	68	66	63	60	58	55	66
Night L_{Fmax} (10 th highest)	86	81	82	79	76	73	71	82

7.0 External Building Fabric Assessment

The determination of facade sound insulation requirements has been undertaken in accordance with the more rigorous calculation method given in Annex G of BS 8233:2014, where:

$$L_{eq,2} = L_{eq,ff} + 10 \lg \left(\frac{A_0}{S} 10^{\frac{-D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{\frac{-R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{\frac{-R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{\frac{-R_{rr}}{10}} \right) + 10 \lg \left(\frac{S}{A} \right) + 3$$

$L_{eq,ff}$ is the equivalent continuous sound pressure level outside the room element under consideration. It is the free-field sound level, measured or calculated, at the intended position of the element under consideration;

A_0 is a reference absorption area of 10m² and is independent of frequency;

S_f is the total facade area of the room in question in square metres (m²);

S_{wi} is the area in square metres (m²) of the windows of the room;

S_{ew} is the area in square metres (m²) of the external wall of the room;

S_{rr} is the area in square metres (m²) of the ceiling of the room;

S is the total area of elements through which sound enters the room in square metres (m²), i.e. $S_f + S_{rr}$;

$D_{n,e}$ is the insulation of the ventilator measured according to BS EN 20140-10;

R_{wi} is the sound reduction index of the window;

R_{ew} is the sound reduction index of the external wall;

R_{rr} is the sound reduction index of the roof;

A is the equivalent absorption area of the receiving room.

The Annex G method is also considered to be applicable for the determination of indoor maximum noise levels.

It has been assumed that living rooms will be fitted out with hard floor finishes with bedrooms to have carpets. Reverberation times of 0.8s and 0.5s have been taken accordingly. It has further been taken that bedrooms will have a minimum volume of circa 30m³, while living rooms have been assumed to have a minimum volume of circa 50m³.

Annex G of the standard notes that estimated levels may differ from measured values and advises that the expected precision of the calculation is ± 2 dB L_{Aeq} .

7.2 Prince Regent House and London Street Rear Elevation

7.2.1 Cavity Masonry External Walls

Cavity masonry external walls generally comprise the following build-up:

Table 7: Cavity masonry external wall construction

Outer leaf:	100mm facing brickwork, nominal superficial mass 160 kgm ⁻²
Cavity:	50mm (nominal) clear
Wall ties:	Tie Type A or Type B as per Approved Document E:2003 unless otherwise confirmed
Inner leaf	100mm aggregate concrete blockwork, estimated minimum superficial mass 125 kgm ⁻²

The sound insulation performance has been determined using Insul v7.0.13 prediction software, Table 8 and Appendix A refer accordingly.

Table 8: Predicted External Wall Performance

Element	Sound Reduction Index (<i>R</i>) dB at 1/1 Octave Band Centre Frequency (Hz)							ISO 717-1 Rating <i>R_w</i> (<i>C</i> ; <i>C_{tr}</i>) dB
	63	125	250	500	1k0	2k0	4k0	
Cavity masonry external wall	38	41	37	45	54	63	71	50 (-1;-5)

7.2.2 Hung Tile Pitched Roof

The pitched roof is to be retained. It is suggested that it is configured as follows:

External finish:	Plain roof tiles on 50mm × 25mm treated soft wood battens on sarking felt
Framing:	Timber roof trusses (assumed minimum thickness 150mm × 50mm for 35° roof pitch)
Absorber:	Nominal 150mm thick mineral fibre insulation, minimum density 10 kgm ⁻³ , (<i>R_f</i> : 1000 Rayl/m)
Linings:	2 × 12.5mm Gypsum based board of nominal minimum mass 8.0 kgm ⁻² fixed to timber framing using any normal direct fix method
Internal finish:	Nominal 2.5mm plaster skim coat

The sound insulation performance of the pitched roof has been determined using Insul v9.0.3 prediction software thus:

Table 9: Predicted External Wall Performance

Element	Sound Reduction Index (<i>R</i>) dB at 1/1 Octave Band Centre Frequency (Hz)							ISO 717-1 Rating <i>R_w</i> (<i>C</i> ; <i>C_{tr}</i>) dB
	63	125	250	500	1k0	2k0	4k0	
Pitched roof	31	44	51	57	62	63	64	60 (-1;-5)

7.2.3 Glazing Specification

The glazing sound insulation performance and suggested corresponding configurations are set out below

Table 10: Glazing Sound Insulation Requirements

Room Type	Sound Reduction Index (<i>R</i>) dB at 1/1 Octave Band Centre Frequency (Hz)								ISO 717-1 Rating <i>R_w</i> (<i>C</i> ; <i>C_{tr}</i>) dB
	31.5	63	125	250	500	1k0	2k0	4k0	
K/L/D	n/a	10	17	24	26	28	26	22	24 (-1;-3)
Bed	20	25	30	27	28	39	44	41	40 (-2;-5)

Potential Glazing Configurations:

- **K/L/D:** Saint Gobain 6(15)4 double glazed unit;
- **Bedrooms:** Saint Gobain 6.8(12)8.8A double glazed unit.

7.3 London Street Front Elevation

7.3.1 Solid Masonry External Walls

Solid masonry external walls are generally understood to comprise the following build-up:

Table 11: Cavity masonry external wall construction

Outer leaf:	9" solid facing brickwork (approx.. 225mm), nominal superficial mass 360 kgm ⁻²
Inner leaf	12.5mm plasterboard on nominal 50mm timber battens or similar framing system

The sound insulation performance has been determined using Insul v7.0.13 prediction software, Table 12 and Appendix A refer accordingly.

Table 12: Predicted External Wall Performance

Element	Sound Reduction Index (<i>R</i>) dB at 1/1 Octave Band Centre Frequency (Hz)							ISO 717-1 Rating <i>R_w</i> (<i>C</i> ; <i>C_{tr}</i>) dB
	63	125	250	500	1k0	2k0	4k0	
Solid external wall and framed inner leaf	38	34	45	55	67	74	77	56 (-2;-8)

7.3.2 Hung Tile Pitched Roof

The pitched roof is to be retained. It is suggested that it is configured as follows:

External finish:	Plain roof tiles on 50mm × 25mm treated soft wood battens on sarking felt
Framing:	Timber roof trusses (assumed minimum thickness 150mm × 50mm for 35° roof pitch)
Absorber:	Nominal 150mm thick mineral fibre insulation, minimum density 10 kgm ⁻³ , (Rf: 1000 Rayl/m)
Linings:	2 × 12.5mm Gypsum based board of nominal minimum mass 8.0 kgm ⁻² fixed to timber framing using any normal direct fix method
Internal finish:	Nominal 2.5mm plaster skim coat

The sound insulation performance of the pitched roof has been determined using Insul v9.0.3 prediction software thus:

Table 13: Predicted Pitched Roof Performance

Element	Sound Reduction Index (<i>R</i>) dB at 1/1 Octave Band Centre Frequency (Hz)							ISO 717-1 Rating <i>R_w</i> (<i>C</i> ; <i>C_{tr}</i>) dB
	63	125	250	500	1k0	2k0	4k0	
Pitched roof	31	44	51	57	62	63	64	60 (-1;-5)

7.3.3 Glazing Specification

The glazing sound insulation performance and suggested corresponding configurations are set out below

Table 14: Glazing Sound Insulation Requirements

Room Type	Sound Reduction Index (R) dB at 1/1 Octave Band Centre Frequency (Hz)							ISO 717-1 Rating $R_w (C; C_{tr})$ dB
	63	125	250	500	1k0	2k0	4k0	
K/L/D	24	29	35	45	56	52	50	47 (-2;-7)
Bed	24	29	35	45	56	52	50	47 (-2;-7)

Potential Glazing Configurations:

- **K/L/D:** Retained sliding sash windows refurbished and fitted with good quality compression seals to the frame periphery, 150mm airgap, 6mm secondary pane;
- **Bedrooms:** Retained sliding sash windows refurbished and fitted with good quality compression seals to the frame periphery, 150mm airgap, 6mm secondary pane.

7.4 Product Verification

It is emphasised that Tables 10 and 14 form the specification to be complied with and is applicable to complete assemblies including glazed elements, frames, opening lights/doors and any other associated components. The accompanying glazing selections are provided for guidance purposes.

The relevant specialist trade contractor shall provide test data to demonstrate that the glazing performance values identified in Table 7 will be achieved. Tests shall be undertaken in a UKAS accredited laboratory (or technically equivalent) in full accordance with BS EN ISO 10140 Parts 1, 2, 4 and 5:2010 (Acoustics-Laboratory measurement of sound insulation of building elements – Part 1: Application rules for specific products. Part 2: Measurement of airborne sound insulation. Part 4: Measurement procedures and requirements. Part 5: Requirements for test facilities and equipment) or an equivalent series of standards.

For 1/3 octave bands below 100 Hz, the acoustic consultant reserves the right to require the contractor/system supplier to obtain further tests in accordance with ISO 15186-1:2000, Acoustics -- Measurement of sound insulation in buildings and of building elements using sound intensity -- Part 1: Laboratory measurements, so as to minimise low frequency measurement uncertainty as far as is practicable.

8.0 Ventilation

It is suggested that an appropriate ventilation solution would be to provide Mechanical Ventilation with Heat Recovery (Approved Document F System 4) which works as a whole house system, both extracting and supplying air which negates the need for either window or through-the-wall ventilators.

The system would comprise a central heat recovery unit ducted to atmosphere for the intake and discharge, ducted to habitable rooms on the supply side and ducted to bathrooms on the extract side. In addition, the kitchen extract hood may have a separate duct to atmosphere.

9.0 Conclusions

A detailed review of facade sound insulation requirements has been carried in respect of the proposed development located at 108 London Street, Reading. It is concluded that subject to adoption of the recommendations set out herein, external noise ingress should be controlled to values identified at the pre-planning stage and hence adequate residential amenity should prevail.

Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Appendix A: Insul Element Sound Insulation Calculations

Sound Insulation Prediction (v7.0.13)

Program copyright Marshall Day Acoustics 2012

- Key No. 1581

Margin of error is generally within $R_w \pm 3$ dB

Job Name:

Job No.:

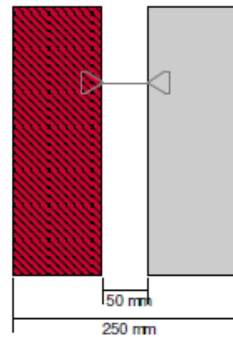
Date: 26 Mar 18

Page No.:

Initials: patricks

Notes:

File Name: 20180326_4184_Prince Regent Rear Elev_001.xl



R_w 50 dB

C -1 dB

C_{tr} -5 dB

System description

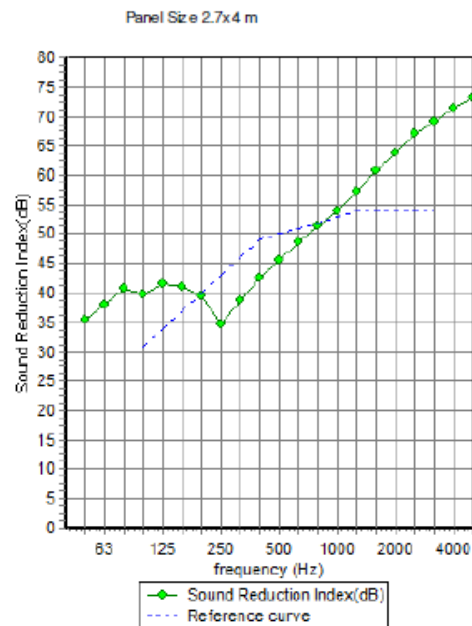
Panel 1 Outer layer: 1 x 100.0 mm Brick- ($m=160.0$ kg/m², $f_c=275$ Hz, Damping=0.00) Profile

Cavity: Butterfly Tie @ 600 mm

Panel 2 Inner layer: 1 x 100.0 mm Concrete Block- ($m=125.0$ kg/m², $f_c=252$ Hz, Damping=0.01) Profile

Mass-air-mass resonant frequency =32 Hz

frequency (Hz)	R(dB)	R(dB)
50	36	
63	38	38
80	41	
100	40	
125	41	41
160	41	
200	40	
250	35	37
315	39	
400	43	
500	46	45
630	49	
800	51	
1000	54	54
1250	57	
1600	61	
2000	64	63
2500	67	
3150	69	
4000	71	71
5000	73	



Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Sound Insulation Prediction (v7.0.13)

Program copyright Marshall Day Acoustics 2012

- Key No. 1581

Margin of error is generally within $R_w \pm 3$ dB

Job Name:

Job No.:

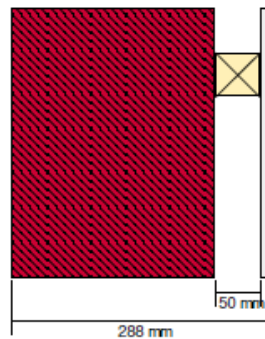
Page No.:

Notes:

Date: 26 Mar 18

Initials: patricks

File Name: 20180326_4184_London Rd Front Elev_001.xl



R_w 56 dB

C -2 dB

C_{tr} -8 dB

System description

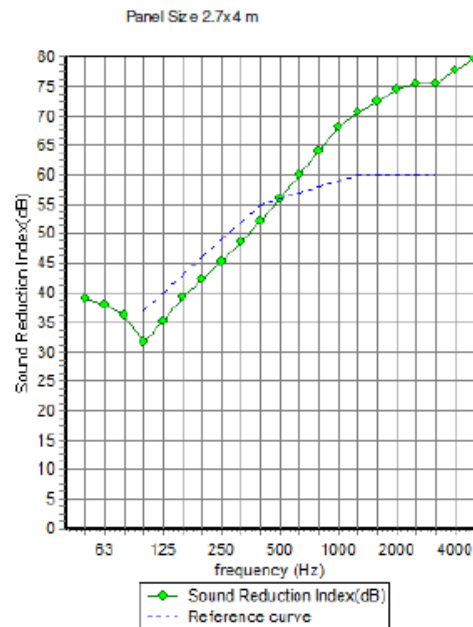
Panel 1 Outer layer: 1 x 225.0 mm Brick- ($m=360.0$ kg/m², $f_c=122$ Hz, Damping=0.00) Profile

Cavity: Timber stud @ 600 mm

Panel 2 Inner layer: 1 x 12.5 mm Gyproc Wallboard 12.5mm- ($m=8.0$ kg/m², $f_c=3263$ Hz, Damping=0.01) Profile

Mass-air-mass resonant frequency =96 Hz

frequency (Hz)	R(dB)	R(dB)
50	39	
63	38	38
80	36	
100	32	
125	35	34
160	39	
200	42	
250	45	45
315	49	
400	52	
500	56	55
630	60	
800	64	
1000	68	67
1250	71	
1600	73	
2000	74	74
2500	75	
3150	75	
4000	78	77
5000	80	



Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Sound Insulation Prediction (v9.0.3)

Program copyright Marshall Day Acoustics 2017

Paragon Acoustics - Key No. 1581

Job Name:

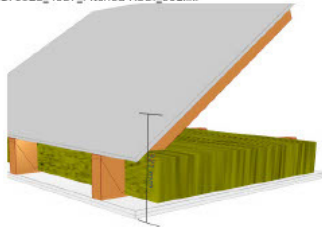
Job No.:

Date: 28/09/2017

File Name: 20170928_4087_Pitched Roof_001.lxl

Initials: patricks

Notes:



Rw 60 dB
C -1 dB
Ctr -5 dB
Dntw 62 dB
[V:50m3] [A:11m2]

Mass-air-mass resonant frequency = 90 Hz

Panel Size = 2.7 m x 4.0 m

Partition surface mass = 51 kg/m²

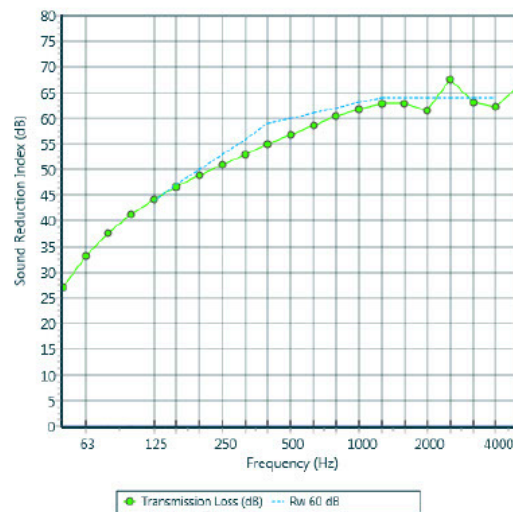
System description

Panel 1 : 1 x 14.0 mm Roofing tiles

Frame: Pitched Roof, Cavity Width 282 mm, Stud spacing 600 mm, 1 x Fibreglass (22kg/m³) Thickness 150 mm (p:10 kg/m³, Rt:10000 Rayl/m)

Panel 2 : 2 x 12.5 mm Gyproc Wallboard 12.5mm

freq.(Hz)	TL(dB)	TL(dB)
50	27	
63	33	31
80	38	
100	41	
125	44	44
160	47	
200	49	
250	51	51
315	53	
400	55	
500	57	57
630	59	
800	60	
1000	62	62
1250	63	
1600	63	
2000	61	63
2500	68	
3150	63	
4000	62	64
5000	66	



Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Appendix B: Façade Sound Insulation Calculations

Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Figure A1: Prince Regent House Day $L_{Aeq,16h}$ Calculation

Project	108 London Street
Building	
Elevation	Prince Regent House (Rear)
Floor	Upper
Receiver	Typical K/L/D

External Noise Input Data		1/1 Octave Band Centre Frequency Hz								A
Term	Description	32	63	125	250	500	1000	2000	4000	
L_p	Input Noise Level →	61	59	54	52	48	46	41	34	51
K	Input sound field correction →	0	0	0	0	0	0	0	0	
L_{pt}	Noise level at intended room position	61	59	54	52	48	46	41	34	51

Receive Room Dimensions		
Term	Derivation	Value
L	Input receive room length →	5.0
W	Input receive room width →	4.0
H	Input receive room height →	2.4
S_{floor}	Total Floor area	20.0
S_f	Input total façade area (including widow) →	9.6
S_{wi}	Input window area →	4.8
S_{ew}	$S_f - S_{wi}$	4.8
S_{tr}	Input roof area →	0.0
S	$S_f + S_{tr}$	9.6
V_{RR}	Input room volume →	48.0

X_L Length of source room in metres, m

Y_L Width of source room in metres, m

Z_L Height of source room in metres, m

S_{floor} Area of the floor, m²

S_f Façade area of the room, m²

S_{wi}

S_{ew} Area of the external wall of the room, m²

S_{tr} Area of the roof, m²

S Area of all elements, m², i.e. $S_f + S_{tr}$

V Volume of the receive room, m³

Design Noise Level for Receive Room		Octave Band Centre Frequency Hz								A
Term	Description	32	63	125	250	500	1000	2000	4000	
DI	Input starting NR →	23	71	54	42	33	27	23	20	17
Uv	Uncertainty	2	2	2	2	2	2	2	2	
DNL	DI + Uncertainty	69	52	40	31	25	21	18	15	33

DI Design Intent for receive room
SM Safety Margin to be applied to design
DNL Design Noise Level for receive room derived from Design Intent and Safety Margin

Calculations		Octave Band Centre Frequency Hz							
Term	Description	32	63	125	250	500	1000	2000	4000
T	Input receive room rev time →	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
A	Absorption in receive room	9.8	9.8	9.8	9.8	9.8	9.8	9.8	9.8
F_{SRI}	Target façade SRI	-8.2	6.9	13.5	20.4	23.1	24.8	23.1	18.5
Select external wall construction →		Parklex Timber Rain Screen on 2 x 18mm CPB on 150mm Metsec on 2 x 15mm Soundbl- 100mm Brick/100 Cavity/100mm Block							
R_{ew}	SRI of external wall	33	38	41	39	43	51	59	65
Select roof/ceiling construction →		User 1 User 2 User 3							
R_{tr}	SRI of roof/ceiling/cladding	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
$R_{wi req'd}$	Req'd SRI of window	-8.2	6.9	13.5	20.5	23.1	24.8	23.1	18.5
Select glazing configuration →		Saint Gobain 6 (15) 4 Saint Gobain 6 (20) 4 Saint Gobain 6 (24) 4							
R_{wi}	SRI of selected glazing	27.0	32.0	25.0	22.0	30.0	42.0	39.0	38.0
$L_{p,2}$	Receive room noise level	34.8	27.4	28.6	29.9	18.0	4.3	2.0	-4.0
A-weighting correction, dB		-31.5	-26	-16	-9	-3	0	1	1
$L_{p,2} + A\text{-weighting correction}$		3.3	1.4	12.6	20.9	15.0	4.3	3.0	-3.0
$L_{pA} (31.5-4000 \text{ Hz})$		23							
$L_{pA} (125-2000 \text{ Hz})$ BS 8233 Annex G.2		23							
Equivalent 1/1 Octave Band NR		-30	-10	8	19	14	4	5	2
Resultant receive room NR (31.5-4000 Hz)		19							
Resultant receive room NR (125-4000 Hz)		19							

T Reverberation time of the receive room

A Equivalent absorption area of the receive room

F_{SRI} Required SRI of the façade

R_{ew} SRI of the external wall

R_{tr} SRI of the roof/ceiling

$R_{wi req'd}$ Required SRI of the window

R_{wi} SRI of the selected window system

Data Source: Insul v7.0.4

Data Source: Insul v5.3

Data Source: TNO2003179

Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Figure A2: Prince Regent House Night L_{AFmax} Calculation

Project	108 London Street
Building	
Elevation	Prince Regent House (Rear)
Floor	Upper
Receiver	Typical Bedroom

External Noise Input Data										
Term	Description	1/1 Octave Band Centre Frequency Hz								A
		32	63	125	250	500	1000	2000	4000	
L_p	Input Noise Level →	88	85	77	77	73	73	70	65	77
K	Input sound field correction →	-3	-3	-3	-3	-3	-3	-3	-3	
L_{pt}	Noise level at intended room position	85	82	74	74	70	70	67	62	74

Receive Room Dimensions		
Term	Derivation	Value
L	Input receive room length →	4.0
W	Input receive room width →	3.0
H	Input receive room height →	2.4
S_{floor}	Total Floor area	12.0
S_f	Input total façade area (including widow) →	7.2
S_{wi}	Input window area →	3.6
S_{ew}	$S_f - S_{wi}$	3.6
S_{tr}	Input roof area →	12.0
S	$S_f + S_{tr}$	19.2
V_{RR}	Input room volume →	28.8

X_L Length of source room in metres, m

Y_L Width of source room in metres, m

Z_L Height of source room in metres, m

S_{floor} Area of the floor, m²

S_f Façade area of the room, m²

S_{wi}

S_{ew} Area of the external wall of the room, m²

S_{tr} Area of the roof, m²

S Area of all elements, m², i.e. $S_f + S_{tr}$

V Volume of the receive room, m³

Design Noise Level for Receive Room										
Term	Description	Octave Band Centre Frequency Hz								A
		32	63	125	250	500	1000	2000	4000	
DI	Input starting NR →	35	79	63	52	45	39	35	32	45
U_v	Uncertainty	5	5	5	5	5	5	5	5	
DNL	$DI + \text{Uncertainty}$	74	58	47	40	34	30	27	25	40

DI Design Intent for receive room

SM Safety Margin to be applied to design

DNL Design Noise Level for receive room derived from Design Intent and Safety Margin

Calculations										
Term	Description	Octave Band Centre Frequency Hz								
		32	63	125	250	500	1000	2000	4000	
T	Input receive room rev time →	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
A	Absorption in receive room	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	
F_{SRI}	Target façade SRI	13.8	26.8	29.2	37.2	39.4	43.0	43.0	40.7	
Select external wall construction →		Parklex Timber Rain Screen on 2 x 18mm CPB on 150mm Metsec on 2 x 15mm Soundb...								
R_{ew}	SRI of external wall	33	38	41	39	43	51	59	65	
Select roof/ceiling construction →		Hung Tiled Pitched Roof								
R_{tr}	SRI of roof/ceiling/cladding	26.0	31.0	44.0	51.0	57.0	62.0	63.0	64.0	
$R_{wi} \text{ req'd}$	Req'd SRI of window	9.7	23.8	25.1	33.6	35.5	38.9	38.8	36.5	
Select glazing configuration →		Saint Gobain 8.4A (16) 6.4								
R_{wi}	SRI of selected glazing	24.0	29.0	22.0	28.0	39.0	48.0	47.0	58.0	
$L_{p,2}$	Receive room noise level	64.8	56.6	50.5	44.9	31.2	22.9	19.3	6.3	
A-weighting correction, dB		-31.5	-26	-16	-9	-3	0	1	1	
$L_{p,2} + \text{A-weighting correction}$		33.3	30.6	34.5	35.9	28.2	22.9	20.3	7.3	
$L_{pA} (31.5-4000 \text{ Hz})$		39								
$L_{pA} (125-2000 \text{ Hz})$	BS 8233 Annex G.2	39								
Equivalent 1/1 Octave Band NR		14	27	33	35	28	23	22	12	
Resultant receive room NR (31.5-4000 Hz)		35								
Resultant receive room NR (125-4000 Hz)		35								

T Reverberation time of the receive room

A Equivalent absorption area of the receive room

F_{SRI} Required SRI of the façade

R_{ew} SRI of the external wall

R_{tr} SRI of the roof/ceiling

$R_{wi} \text{ req'd}$ Required SRI of the window

R_{wi} SRI of the selected window system

Data Source: Insul v7.0.4

Data Source: Insul v5.3

Data Source: 700224

Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Figure A3: 108 London Street Day $L_{Aeq,16h}$ Calculation

Project	108 London Street								
Building									
Elevation	108 London Street								
Floor	Upper								
Receiver	Typical K/L/D								

Intrusive Noise Input Data

Term	Description	Octave Band Centre Frequency Hz							A
		63	125	250	500	1000	2000	4000	
L_p	Input Noise Level →	76	72	71	70	70	69	67	75
K	Input sound field correction →	-3	-3	-3	-3	-3	-3	-3	
L_{p1}	Noise level at intended room position	73	69	68	67	67	66	64	72

Receive Room Dimensions

Term	Derivation	Value
L	Input receive room length →	5.0
W	Input receive room width →	4.0
H	Input receive room height →	2.4
S_{floor}	Total Floor area	20.0
S_f	Input total façade area (including widow) →	9.6
S_{wi}	Input window area →	7.2
S_{ew}	$S_f - S_{wi}$	2.4
S_{rr}	Input roof area →	20.0
S	$S_f + S_{rr}$	29.6
V_{RR}	Input room volume →	48.0

X_L Length of source room in metres, m
 Y_L Width of source room in metres, m
 Z_L Height of source room in metres, m
 S_{floor} Area of the floor, m²
 S_f Façade area of the room, m²
 S_{wi} Window area of the room, m²
 S_{ew} Area of the external wall of the room, m²
 S_{rr} Area of the roof, m²
 S Area of all elements, m², i.e. $S_f + S_{rr}$
 V Volume of the receive room, m³

Design Noise Level for Receive Room

Term	Description		Octave Band Centre Frequency Hz							A
			63	125	250	500	1000	2000	4000	
DI	Input starting NR →	25	55	44	35	29	25	22	20	35
Uv	Safety Margin		2	2	2	2	2	2	2	
DNL	DI + Uncertainty		53	42	33	27	23	20	18	33

DI Design Intent for receive room
SM Safety Margin to be applied to design
DNL Design Noise Level for receive room derived from Design Intent and Safety Margin

Calculations

Term	Description	Octave Band Centre Frequency Hz							R_w	C	C_v
		63	125	250	500	1000	2000	4000			
T	Input receive room rev time →	0.8	0.8	0.8	0.8	0.8	0.8	0.8			
A	Absorption in receive room	9.8	9.8	9.8	9.8	9.8	9.8	9.8			
F_{SRI}	Target facade SRI	24.7	32.1	39.6	45.1	48.8	50.9	51.3			
Select external wall construction →		225mm Brick, 50mm framing, 12.5mm Wallboard User 3 User 4									
R_{ew}	SRI of external wall	38.0	34.0	45.0	55.0	67.0	74.0	77.0	56	-2	-8
Select roof/ceiling construction →		Plywood deck on 300mm timber joists lined with 2 x 15mm Wallboard with Plywood deck on 300mm timber joists lined with 2 x 15mm Wallboard on f Hung Tiled Pitched Roof									
R_{rr}	SRI of roof/ceiling/cladding	26.0	31.0	44.0	51.0	57.0	62.0	63.0	64	60	-1
$R_{wi req'd}$	Req'd SRI of window	24.5	39.6	37.8	42.8	46.1	48.0	48.3			
Select glazing configuration →		Pilkington 6/100/4 Double Window Pilkington 6/150/4 Double Window Pilkington 10/200/6 Double Window									
R_{wi}	SRI of selected glazing	24.0	29.0	35.0	45.0	56.0	52.0	50.0	47	-2	-7
L_{p2}	Receive room noise level	55.1	46.2	36.1	26.1	17.8	16.7	16.2			
A-weighting correction, dB		-26	-16	-9	-3	0	1	1			
$L_{p2} + A\text{-weighting correction}$		29.1	30.2	27.1	23.1	17.8	17.7	17.2			
$L_{pA,2}$ (63-4000 Hz)		34									
$L_{pA,2}$ (125-2000 Hz) BS 8233 Annex G.2		33									
Equivalent 1/1 Octave Band NIR		25	28	26	22	18	20	22			
Resultant receive room NIR (63-4000 Hz)		28									
Resultant receive room NIR (125-4000 Hz)		28									

T Reverberation time of the receive room
 A Equivalent absorption area of the receive room
 F_{SRI} Required SRI of the façade
 R_{ew} SRI of the external wall
 R_{rr} SRI of the roof/ceiling
 $R_{wi req'd}$ Required SRI of the window
 R_{wi} SRI of the selected window system

Data Source: Insul v7.0.4
Data Source: Insul v5.3
Data Source: Pilkington Optilam 4pp data sheet March 2002

Project: 108 London Street, Reading RG1 4SJ
Client: Aspire 108 London Street Limited

Date: 10/07/2018
Reference: 20180710_4184_ENA_001.docx

Figure A4: 108 London Street Night L_{AFmax} Calculation

Project	108 London Street							
Building								
Elevation	108 London Street							
Floor	Upper							
Receiver	Typical Bed							

Intrusive Noise Input Data									
Term	Description	Octave Band Centre Frequency Hz							A
		63	125	250	500	1000	2000	4000	
L_p	Input Noise Level →	86	81	82	79	76	73	71	82
K	Input sound field correction →	-3	-3	-3	-3	-3	-3	-3	
L_{p1}	Noise level at intended room position	83	78	79	76	73	70	68	79

Receive Room Dimensions		
Term	Derivation	Value
L	Input receive room length →	4.0
W	Input receive room width →	3.0
H	Input receive room height →	2.4
S_{floor}	Total Floor area	12.0
S_f	Input total façade area (including widow) →	7.2
S_{wi}	Input window area →	5.4
S_{ew}	$S_f - S_{wi}$	1.8
S_{rr}	Input roof area →	12.0
S	$S_f + S_{rr}$	19.2
V_{RR}	Input room volume →	28.8

X_L Length of source room in metres, m
 Y_L Width of source room in metres, m
 Z_L Height of source room in metres, m
 S_{floor} Area of the floor, m²
 S_f Façade area of the room, m²
 S_{wi} Window area of the room, m²
 S_{ew} Area of the external wall of the room, m²
 S_{rr} Area of the roof, m²
S Area of all elements, m², i.e. $S_f + S_{rr}$
V Volume of the receive room, m³

Design Noise Level for Receive Room										
Term	Description		Octave Band Centre Frequency Hz							A
			63	125	250	500	1000	2000	4000	
DI	Input starting NR →	36	64	53	45	39	36	33	31	45
Uv	Uncertainty		2	2	2	2	2	2	2	
DNL	DI + Uncertainty		62	51	43	37	34	31	29	43

DI Design Intent for receive room
SM Safety Margin to be applied to design
DNL Design Noise Level for receive room derived from Design Intent and Safety Margin

Calculations											
Term	Description	Octave Band Centre Frequency Hz							R_w	C	C_{tr}
		63	125	250	500	1000	2000	4000			
T	Input receive room rev time →	0.5	0.5	0.5	0.5	0.5	0.5	0.5			
A	Absorption in receive room	9.9	9.9	9.9	9.9	9.9	9.9	9.9			
F_{SRI}	Target façade SRI	24.0	29.6	38.4	41.4	41.9	41.8	42.1			
Select external wall construction →		225mm Brick, 50mm framing, 12.5mm Wallboard User 3 User 4									
R_{ew}	SRI of external wall	38.0	34.0	45.0	55.0	67.0	74.0	77.0	56	-2	-8
Select roof/ceiling construction →		Plywood deck on 300mm timber joists lined with 2 x 15mm Wallboard with Plywood deck on 300mm timber joists lined with 2 x 15mm Wallboard on r Hung Tiled Pitched Roof									
R_{rr}	SRI of roof/ceiling/cladding	26.0	31.0	44.0	51.0	57.0	62.0	63.0	64	60	-1
$R_{wi req'd}$	Req'd SRI of window	23.8	29.9	36.8	39.2	39.5	39.4	39.6			
Select glazing configuration →		Pilkington 6/100/4 Double Window Pilkington 6/150/4 Double Window Pilkington 10/200/6 Double Window									
R_{wi}	SRI of selected glazing	24.0	29.0	35.0	45.0	56.0	52.0	50.0	47	-2	-7
$L_{p,2}$	Receive room noise level	63.2	53.4	45.6	33.4	21.8	19.3	18.8			
A-weighting correction, dB		-26	-16	-9	-3	0	1	1			
$L_{p,2} + A\text{-weighting correction}$		37.2	37.4	36.6	30.4	21.8	20.3	19.8			
$L_{pA,2}$ (63-4000 Hz)		42									
$L_{pA,2}$ (125-2000 Hz) BS 8233 Annex G.2		41									
Equivalent 1/1 Octave Band NR		35	36	36	30	22	22	24			
Resultant receive room NR (63-4000 Hz)		36									
Resultant receive room NR (125-4000 Hz)		36									

T Reverberation time of the receive room
A Equivalent absorption area of the receive room
 F_{SRI} Required SRI of the façade
 R_{ew} SRI of the external wall
 R_{rr} SRI of the roof/ceiling
 $R_{wi req'd}$ Required SRI of the window
 R_{wi} SRI of the selected window system

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Data Source: Insul v5.3
Data Source: Pilkington Optilam 4pp data sheet March 2002