Acoustic Associates Sussex Ltd

Planning Change of Use – Noise Assessment.

Site: **1 Windmill Parade, Southwick. BN42 4QB.**
Client: **Mr Arshadul Hoque**

Report by: Scott Castle BSc (Hons) CEnvH, MCIEH PGDip: Acoustics MIOA

Date: **14/07/2021**
Project: **J3212**
Issue 1

Acoustic Associates Sussex Ltd.

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Issue 1	14/07/2021	

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1 Introduction

Acoustic Associates have been appointed to undertake an acoustic assessment to support a change of use planning application. Specifically, the ground floor of the currently vacant restaurant premises is proposed for residential flats.

Standards and guidance referenced for this assessment include:

- World Health Organisation (WHO) - Guidelines for Community Noise 1999
- BS8233 (Sound insulation and noise reduction for buildings) 2014
- ISO9613 (Attenuation of sound during propagation outdoors) 1996
- ProPG2017: Planning & Noise – New Residential Development.
- Acoustics Ventilation and Overheating Guidance, January 2020

Two long term unattended class 1 sound level meters were used to measure the soundscape to the front and rear of the proposed three ground floor flats between 1st to 6th July 2021. The dates deliberately included a weekend to ensure that any change in the soundscape was properly measured.

The noisier façade is Windmill Parade which overlooks the A270 Old Shoreham Road (65dB $L_{Aeq,16\ hour}$ for daytime and 57dB $L_{Aeq,\ 8\ hour}$ for night time). The quieter façade looks to the North and measured 53dB $L_{Aeq,16\ hour}$ for the daytime period and 45dB $L_{Aeq,\ 8\ hour}$ for the night time period. The Western façade is predominantly wall, albeit two small windows which are proposed to be introduced to allow residents light and air into the flats. Attended readings were made to account for sounds from for the commercial workshop Brighton MG which is located on the opposite side of the road.

The proposed change of use seeks a smaller aspect of glazing on the A270 front façade and two newly introduced small windows on the Western façade.

The assessment has carried out rigorous calculations to determine the required glazing and ventilation for the three flats to ensure that BS8233:2014 table 4 values are capable of being achieved. The calculations made also ensure that the ProPG2017 criterion of no more than 10 events of 45dB L_{Amax} occur inside a bedroom during the night time period.

Sufficient data has been presented within the report to demonstrate that the change of use to flats is capable of being done on acoustic grounds with future occupants protected against road traffic and commercial sound sources. Planning permission should not therefore be withheld on noise grounds.

2 Context, Noise Criteria & Noise Assessment Methodology

2.1 Context and Location

The Rajah is a vacant Indian restaurant. It is proposed to carry out a change of use of the ground floor to 3 separate flats. For reference, the flat and existing layout at first floor are not proposed to change. The purpose of the report is to provide the local planning authority sufficient detail on noise and the current soundscape to be able to determine the current planning application.

The application is currently with Adur and Worthing Council planning department and may be viewed online at AWDM/0627/21

The property is set back from the Old Shoreham Road (A270) by approximately 20.5m.

The change of use seeks changes only to the ground floor. The first floor flat remains in terms of layout and occupation. The curved front windows as seen in Figure 2 will be reduced in size to a single smaller outlook and two new high-level windows will be placed into the West façade creating light for the kitchen/studio (flat 4) and bedroom 2 of Flat 2. The changes and comparisons can be made between Figure 2 and 3 below.

The site is located at the end of a row of terraced properties and includes a pharmacy (Harrison's)) and Londis. To the West is Brighton MG, a car show room which has an associated workshop which carries out MOT's.



Figure 1. Site Location and Block Plan

2.2 Current Ground Floor Layout



Figure 2. Current Ground Floor Layout

2.3 Proposed Ground Floor Layout

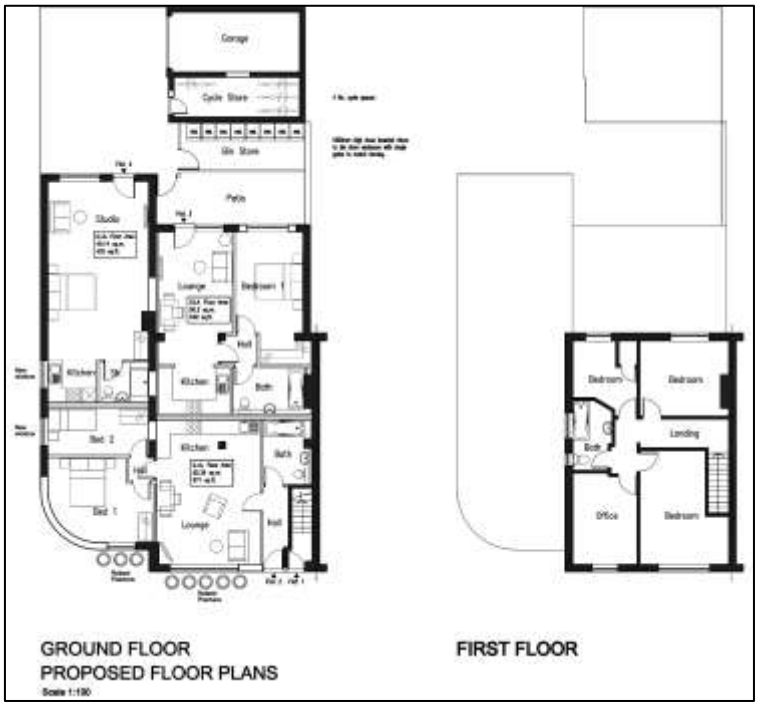


Figure 3. Proposed Ground Floor Layout

2.4 Soundscape

The soundscape noted on site was predominantly that of passing traffic on the A270 Old Shoreham Road. Birdsong (gull noise), aviation sounds from light aircraft and the bleeper of the pedestrian crossing were also noted. When stood opposite the MOT workshops, air tools could also be heard. It was noted that the closest Eastbound carriageway of the A270 is lower than the road immediately in front of the application site.

2.5 Commercial Setting

The Brighton MG car showroom were spoken to regarding their hours of use for the workshop and these were 08:30 to 17:30 Monday to Friday, 08:30 to midday Saturday and no workshop activities on Sundays. Harrison's pharmacy (adjacent) was noted to be open from 09:00 to 18:00 hours albeit with an hour closed for lunch for Monday to Friday and 09:00-13:00 Saturdays.

Londis were also spoken to regarding their commercial deliveries which occur three times a week (Tuesday, Thursday and Saturday) and are via the front layby and drop kerb. The deliveries last no more than 45minutes each.

2.6 ProPG2017

Planning guidance (ProPG2017) relates to new residential development and airborne transportation noise, which includes exposure to road traffic, railway and aviation noise. Whilst ProPG, 2017 generally mirrors the requirements of BS8233:2014 and the World Health Organisation Guidelines, 1999, it goes further in setting a limit for inside bedrooms for L_{Amax} events and specifically, no more than 10 L_{Amax} events per night time period above 45dB(A).

The internal bedroom L_{AMax} values will be used in accordance with ProPG2017, however, an initial site risk assessment is not necessary, as the site has already been granted planning permission.

2.6 BS8233:2014 Noise Criteria

Table 4 of BS8233:2014 provides the following guideline values:

Activity	Location	Time period of day	
		07:00-23:00	23:00-07:00
Resting	Living Rooms	35dB $L_{Aeq,16hour}$	-
Dining	Dining Room/Area	40dB $L_{Aeq,16hour}$	-
Sleeping (daytime resting)	Bedroom	35dB $L_{Aeq,16hour}$	30dB $L_{Aeq,8hour}$

Table 1. BS8233:2014 Criteria

3 Sound Survey Baseline Conditions & Results

A sound survey was carried out between Thursday 1st July 2021 and Tuesday 6th July 2021. The duration of the survey deliberately covered a weekend to ensure that the soundscape was properly understood. All measurements made are façade measurements due to proximity of reflective surfaces. For the purposes of the report, data has been converted to freefield conditions, with a subtraction of 3dB(A). All sound level meters used were calibrated before and after the survey without any significant drift having occurred. All data presented is freefield, A weighted and Fast time weighted.

The survey equipment is listed in Table 2 and in Figure 4 it is detailed where the equipment was located.

3.1 Sound Survey Details

Survey(s) carried out by	Scott Castle BSc(Hons) Env Health, MCIEH CEnvH PGDip Acoustics MIOA
Equipment Used	LT1 - 01dB Black Solo-Class 2 Sound Level Meter - Serial No. 60674
Equipment Used	LT2 - Castle/Svantek Mirus – Class 1 Sound Level Meter. Serial No. 96147
Equipment Used	1 July 2021 - ST1 and ST2- Norsonic 118(B) Class 1 Sound Level Meter- 31769 6th July 2021
Location	LT1- TQ24450/06030 – 2.6m above ground level LT2- TQ24463/06063 – 2.1m above ground level ST1 – TQ24448/06043 – Tripod Mounted 1.5m high
Duration	1st July 2021 to 6th July 2021

Table 2. Survey Equipment

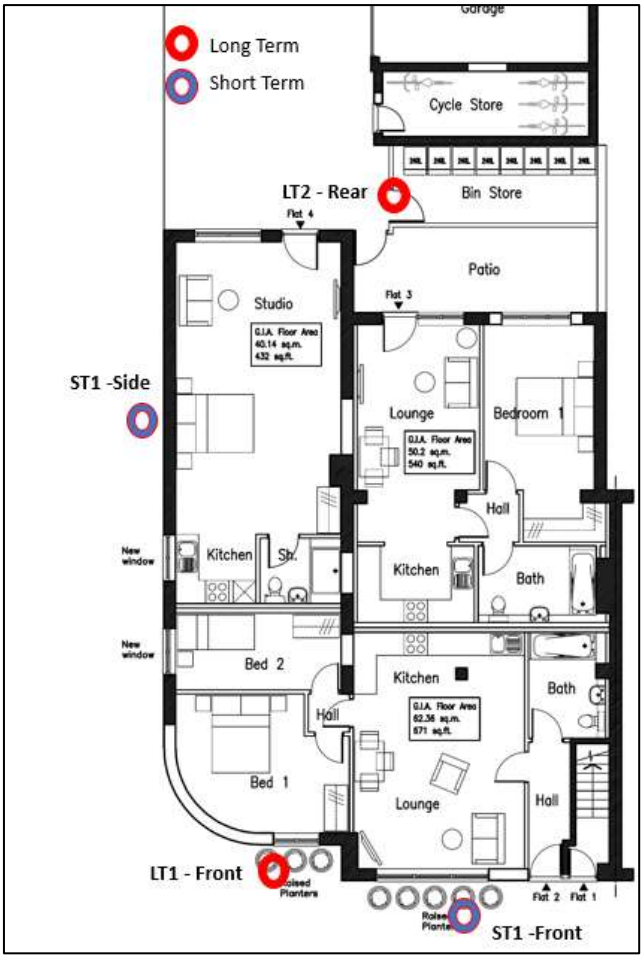


Figure 4. Survey Locations



Figure 5. Survey Locations LT1 and LT2



Figure 6. Survey Locations ST1 and ST2

3.2 Short Term Measured Data

Short term attended positions are useful for a number of reasons. They demonstrate how sound differs around a building shape and additionally, they can be used in combination with other sound level meters, either internal or external in order to determine how the soundscape differs.

3.3 Measured Sound Pressure Levels

3.3.1 Position LT1-Front External

Logarithmically Averaged Day and Night time Periods (External - Freefield)-dB(A)			
$L_{Aeq,\ 16\ hour\ -\ 07:00-23:00}$		$L_{Aeq,\ 8\ hour\ 23:00-07:00}$	
Day 1	64.5	Night 1	57.4
Day 2	64.3	Night 2	56.9
Day 3	63.5	Night 3	56.9
Day 4	65.4	Night 4	57.6
Day 5	65.2	Night 5	60.2
Arithmetic Average	**64.6**	**Arithmetic Average**	57.2

Figure 7. Measured Survey Data - LT1 (Front)

No. of Occurrences of L_{Amax} between 23:00-07:00 hours above 45dB L_{Amax} (SRI-13dB)				
Night 1	**Night 2**	**Night 3**	**Night 4**	**Night 5**
95	95	95	92	95

Figure 8. Number of L_{Amax} event over 45dB with an open window (SRI-13)

No. of Occurrences of L_{Amax} between 23:00-07:00 hours above 45dB L_{Amax} (SRI-30dB)				
Night 1	**Night 2**	**Night 3**	**Night 4**	**Night 5**
8	2	3	4	9

Figure 9. SRI Required to ensure L_{Amax} Events are below 10 per night measured internally

Figure 9 above details that an SRI of 30dB is needed at LT1 to ensure that L_{AMax} events are below 10 per night when measured inside a bedroom environment.

3.3.2 Position LT2-Rear External

Logarithmically Averaged Day and Night time Periods (External - Freefield)-dB(A)			
$L_{Aeq,\ 16\ hour}$ 07:00-23:00		$L_{Aeq,\ 8\ hour}$ 23:00-07:00	
Day 1	55.4	Night 1	46
Day 2	53.2	Night 2	43
Day 3	49.8	Night 3	43
Day 4	51.6	Night 4	44
Day 5	52.8	Night 5	46
Arithmetic Average	**52.6**	**Arithmetic Average**	44.5

Figure 10. Measured Survey Data, LT2 (Rear)

No. of Occurrences of L_{Amax} between 23:00-07:00 hours above 45dB L_{Amax} (SRI-13dB)				
Night 1	**Night 2**	**Night 3**	**Night 4**	**Night 5**
49	47	41	39	45

Figure 11. Number of L_{Amax} event over 45dB with an open window (SRI-13)

No. of Occurrences of L_{Amax} between 23:00-07:00 hours above 45dB L_{Amax} (SRI-22dB)				
Night 1	**Night 2**	**Night 3**	**Night 4**	**Night 5**
7	6	5	5	2

Figure 12. SRI Required to ensure L_{Amax} Events are below 10 per night measured internally

Figure 12 above details that an SRI of 30dB is needed at LT2 to ensure that L_{AMax} events are below 10 per night when measured inside a bedroom environment.

3.3.3 Position ST1-Side External

A number of 5-minute readings were taken adjacent to the Western elevation in front of the Brighton MG workshops. The survey position was tripod mounted at 1.5m and in façade conditions on the Western facade. Subjectively, air tools could be heard being used during the measurement period and these represent a worst-case scenario.

Time	dB $L_{Aeq, 5\ minutes}$
15:25	63.7
15:30	64.8
15:35	63.7

Figure 13. Short Term Measured Data -1 July 2021

3.3.4 Position ST2-Front External

A short reading was also taken closer to the current front entrance to determine, what, if any difference there is in the long term and short term measured data.

A single 5-minute reading was 66.6 dB $L_{Aeq, 5\ minutes.}$ This value correlated exactly with the data measured at LT1 for the same time period, so it is reasonable to assume that the LT1 data may be used for the front facades overlooking the A270.

3.3.5 Inside to Outside

On the day of collection, a sound level meter was tripod mounted internally at the rear and a 5-minute reading taken which allowed a direct comparison with the measured long-term meter outside to the rear. The internal sound level meter measured 39.4dB $L_{Aeq,5minutes.}$ The outside meter for the same time period measured 57.2dB $L_{Aeq,5minutes}$. The arithmetic subtraction of the two measured results would suggest that the rear glazed area (not the kitchen), would be an SRI of approximately 17.2dB.

3.3.6 Data Summary

Figure 14 below details a presentation of the worst case measured external freefield results.

Location	Day- dB $L_{Aeq, 16\ hour}$	Night- dB $L_{Aeq, 8\ hour}$
Worst Case Front (Long Term)	65	58
Worst Case Rear (Long Term)	55	46

Figure 14. Data Summary (Rounded to the Nearest Whole Number)

4 Discussion

4.1 Prediction of West Facing Façade Data

The short term measured data was timed to correlate specifically with the long-term meters at the front and rear and a like for like comparison was made. It is relevant to ensure that the West façade receives adequate protection due to the proximity of the vehicle workshop of Brighton MG.

The short term measured results at the Western facade were 3dB less than that measured at LT1. It is therefore reasonable and protective of the workshop area to simply subtract 3dB from the LT1 daytime and night time measured values, albeit it is recognised that the workshop would not operate during the night time period.

Given the changeable nature of sounds from the Brighton MG workshop, it would be relevant to consider a lower internal sound pressure level as the BS8233:2014 Table 4 values relate to continuous and anonymous sounds such as continued road traffic.

Therefore, with a side façade of 62dB, and the daytime BS8233:2014 criterion dropped by 5dB to 30dB $L_{Aeq, 16\ hour}$, this would provide a daytime SRI of 32dB.

4.2 Required Sound Reduction Index (SRI)

The calculated Sound Reduction Index (SRI) for the front, rear and side of the property is presented in Figure 15 below. As previously stated, all presented data values are freefield, A weighted and Fast time weighted.

1 Windmill Parade - Sound Reduction Index (SRI) Requirements						
Location	Highest Day - dB $L_{Aeq, 16\ hour}$	Highest Night- dB $L_{Aeq, 8\ hour}$	SRI Day	SRI Night	SRI L_{Amax}	SRI to be applied
Front Façade	65	58	30	28	30	30
Rear Façade	55	46	20	16	22	22
Side Façade	62	55	32	25	28	32

Figure 15. Required SRI for Facades

4.3 Predicted Internal Sound Pressure Levels

A number of rigorous calculations have been calculated to consider the different ground floor flats.

The rigorous calculations can be seen in Appendix A. The rigorous calculations use the worst case measured data to ensure a robust reporting process. It is noted that Flat 3 and Flat 2 lounge do not have an exposed ceiling, as these are below the existing first floor flat.

Where flat 4 has two definitive facades, ie a side and rear, these have been treated as separate facades for the calculation and subsequent logarithmic addition applied to sum the internal two sound pressure levels (which was calculated to be 29.5dB $L_{Aeq,\ 16\ hour}$) to ensure that these meet BS8233:2014 Table 4 values.

The results of the glazing and ventilation configuration can be seen below in Figure 16. It is relevant to note that the results achieved are with windows closed. Openable windows are discussed further in section 4.6 below.

The achieved internal sound pressure levels are all below the requirements of BS8233:2014, Table 4 values.

Whilst a trickle vent of 2500mm^2 has been applied to bedrooms, a larger Titon passive through the wall ventilator has been applied for the larger lounge spaces with a ventilation freespace of 9800mm^2. All rigorous calculations are made with the vents open.

Flat Number	Room	Total Façade Size (m^2)	Window (m^2)	Available Façade (m^2)	Suggested Window Specification	Suggested Vent	Internal Sound Pressure Level- dB $L_{Aeq,\ 16\ hour}$	SRI Achieved
2	Lounge	19.72	5.6	14.12	10\12\4	MA3051	34	32
2	Lounge	19.72	5.6	14.12	10\12\4	Titon	35	31
2	Bed 1	12.65	2.4	10.2	10\12\4	MA3051	31	34
2	Bed 2	6.8	0.6	6.2	4\12\4	MA3051	25	37
3	Lounge	10.54	1.8	8.74	4\12\4	Titon	23	32
3	Bedroom	9.28	2.7	6.58	4\12\4	31dB Vent	27	28
4	Side Wall	33.32	0.6	32.72	4\12\4	MA3051	28	34
4	Rear Wall	17	2.295	14.705	4\12\4	MA3051	24	31

Figure 16. Suggested Window Specification and Ventilation Schedule

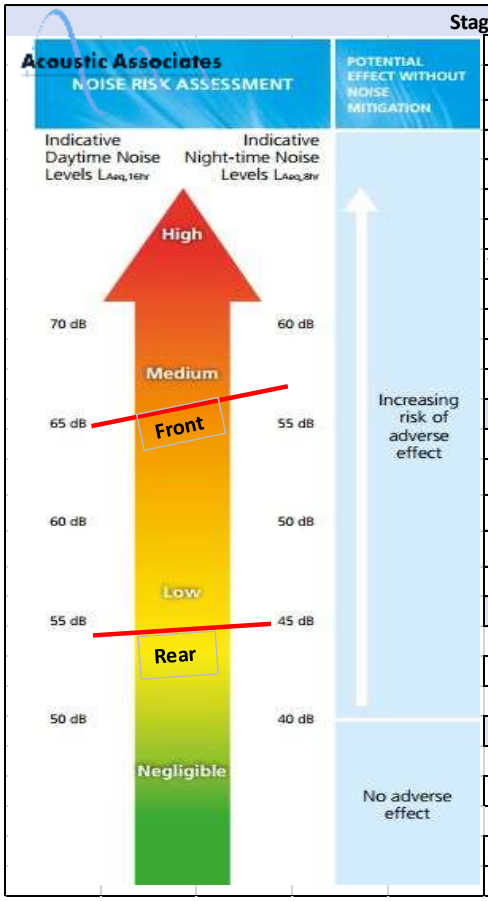
Whilst the window specifications have used Pilkington Glass, it is appropriate to provide the $R_{traffic}$ metric to allow the client to choose between different glazing providers. When comparing glazing performance, it is the $R_{traffic}$ (also known as $R_w + C_{tr}$) which must be compared, not the R_w value as the $R_{traffic}$ includes a suitable low frequency correction which is relevant for road traffic noise.

Sound Insulation Performace of Window Units			
Brand	Window Specification	R_w	$R_{traffic}$
Pilkington Double	4.12.4	31	25
Pilkington Double	10.12.4	36	29

Figure 17. $R_{traffic}$ Values for Suggested Glazing

4.4 ProPG2017

In accordance with ProPG, an initial site risk assessment has been produced which indicates to stakeholders the level of risk of developing the site with regards to noise. As anticipated, it is the front of the site which is just below medium risk, with the flats having a rear outlook falling into a much lower category.



Stage 1. Initial Site Risk Assessment	
Site:	1 Windmill Parade
Date:	1-6 July 2021
Individual	Scott Castle
Proposal	Proposed change of use to residential
Survey or Prediction	Survey
Freefield Survey	
Instrumentation used	Castle Mirus and 01dB Black Solo
Typical/Worst case 24 hour period	
Location Assessed(Grid Ref)	TQ24450/06030
Subjective Noise sources at site	Road traffic noise
Weather conditions	Mixed
Result	
No Mitigation Measures	
Daytime ($L_{Aeq,\ 16\ hour}$)	65/55/62 dB $L_{Aeq,16\ hour}$ (Front/Rear/Side)
Night ($L_{Aeq,\ 8\ hour}$)	58/46/55 B $L_{Aeq,\ 8\ hour}$ (Front/Rear/Side)
Night L_{AMax} Events above 45dB(A)	95 events assuming Rw13 @front
Outcome	
Level of Risk Posed	Low to Medium
Next Steps	
Stage 2 Full Assessment	No
Signed Off by	Peter Attwood
Date	07/06/2021

Figure 18. ProPG2017 Initial Site Risk Assessment - Summary

4.5 Openable Windows for Background Ventilation

Whether windows are openable to provide background ventilation will depend on the external soundscape, which if elevated externally, might mean the practice of opening windows will likely see an increase in the internal soundscape, above the criteria in Table 4, BS8233:2014 and ProPG2017.

In the Acoustics, Overheating and Ventilation Guidance dated Jan 2020, it is stated that the loss of sound energy through a partially open window is taken to be a reduction of 13dB from outside freefield sound pressure levels to inside sound pressure levels.

Figure 19 below shows the predicted internal noise levels with open windows using the survey data. Due to the external soundscape, residents whilst still having the freedom to open windows at will, the practice of opening the windows will cause an increase in the internal soundscape and have sound pressure levels internally which exceed Table 4 values of BS8233:2014.

Assessment of Opening Windows for Background Ventilation						
Location	**Worst Case Day -dB $L_{Aeq, 16\ hour}$**	**Worst Case Night- dB $L_{Aeq, 8\ hour}$**	**Open Window -Day**	**Open Window- Night**	**Within 5dB Tolerance - Day**	**Openable Windows**
Front	65	58	52	45	No	No
Rear	55	46	42	33	No	No
Side	62	55	49	42	No	No

Figure 19. Assessment of Opening Windows for Background Ventilation

As it was detailed earlier that opening windows may cause the internal soundscape to be elevated inside the property (above the requirements of BS8233:2014), then the Part F Building Regulations hierarchy would dictate that either a larger through the wall ventilator is possible, or mechanical extract ventilation (MEV) may be considered.

Through the wall passive ventilators are commercially available with high acoustic performance which the end resident may have open or closed and exercise a degree of control. The future occupants are also able to exercise control over whether they wish to open windows and it is relevant to note that there are not any criteria applied for short term purge ventilation such as removing odours of burnt toast for example.

It is strongly recommended that the Client's M+E consultant be liaised with to ensure that sufficient air changes in line with Building Regulations Approved Document F are achievable with the proposals made, as this is outside the scope of the current assessment.

5 Uncertainty

It is key to report where areas of uncertainty may arise in the reporting and assessment and what measures have been taken to minimise uncertainty to ensure that the report remains as robust as possible.

The sound level meters used in the site survey were calibrated before and after the survey in situ, without any significant drift having occurred, to ensure that the information and data being obtained was representative and that the sound level meters were operating correctly.

Given the outlook of the three flats, two sound level meters were used to cover both front and rear aspects, as well as using short term attended measurements to review the Western/side façade of Studio 4, to ensure that any commercial aspects from Brighton MG are captured within the survey.

The survey data has also only used whole data periods, ie whole days or nights.

The internal sound level criterion for the daytime for bedroom 2 of Flat 2 and the Studio of Flat 4 have also has been reduced to 30dB $L_{Aeq, 16\ hour}$ to ensure that the commercial sounds of the Brighton MG workshop have been accounted for.

6 Conclusion

Two long term unattended class 1 sound level meters were used to measure the soundscape to the front and rear of the proposed three ground floor flats between 1st to 6th July 2021. The dates deliberately included a weekend to ensure that any change in the soundscape was properly measured.

The noisier façade is Windmill Parade which overlooks the A270 Old Shoreham Road (65dB $L_{Aeq,16\ hour}$ for daytime and 57dB $L_{Aeq,\ 8\ hour}$ for night time). The quieter façade looks to the North and measured 53dB $L_{Aeq,16\ hour}$ for the daytime period and 45dB $L_{Aeq,\ 8\ hour}$ for the night time period. The Western façade is predominantly wall, albeit two small windows which are proposed to be introduced to allow residents light and air into the flats. Attended readings were made to account for sounds from for the commercial workshop Brighton MG which is located on the opposite side of the road.

The proposed change of use seeks a smaller aspect of glazing on the A270 front façade and two newly introduced small windows on the Western façade.

The assessment has carried out rigorous calculations to determine the required glazing and ventilation for the three flats to ensure that BS8233:2014 table 4 values are capable of being achieved. The calculations made also ensure that the ProPG2017 criterion of no more than 10 events of 45dB L_{Amax} occur inside a bedroom during the night time period.

Sufficient data has been presented within the report to demonstrate that the change of use to flats is capable of being done on acoustic grounds with future occupants protected against road traffic and commercial sound sources. Planning permission should not therefore be withheld on noise grounds.

7 Appendix A – Rigorous Calculations

7.1 Flat 2 Lounge

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	19.72
S_{wi}	Window Area (m^2)	5.6
S_{ew}	External Wall Area (m^2)	14.12
S_{rr}	Ceiling Area (m^2)	0.0001
S	Total Area sound enters the room (m^2)	19.72

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	67.3	63.3	61.3	61.3	58.3	51.3
$D_{n,e}$	MA3051-Greenwood	46.7	46.3	49	55.7	66.3	69.3
R_{wi}	10_12_4	25	22	33	40	43	44
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	67.3	63.3	61.3	61.3	58.3	51.3
Ao/S . 10^(-Dn,e/10)	1.084E-05	1.19E-05	6.38E-06	1.36488E-06	1.18876E-07	5.9579E-08
Swi/S . 10^(-Rwi/10)	0.000898	0.001792	0.000142	2.83976E-05	1.42325E-05	1.13053E-05
Sew/S . 10^(-Rew/10)	5.688E-05	9.01E-05	2.85E-05	4.51781E-06	7.16024E-07	2.26427E-07
Srr/S . 10^(-Rrr/10)	5.071E-16	5.07E-16	5.07E-16	5.07099E-16	5.07099E-16	5.07099E-16
10log10(S/A)+3	5.5351423	4.487789	3.907869	3.907869279	4.188156515	4.188156515
Leq,2	42.683687	40.56112	27.69286	20.55830905	14.26853899	6.129470627
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**26.583687**	**31.96112**	**24.49286**	**20.55830905**	**15.46853899**	**7.129470627**

A-Weigted Level Outside	**65**
BS8233 Predicted Internal A-Weigted Level	**34**
Prediced Building Envelope SRI	**32**

BS8233 Calculation can be seen below:

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

7.2 Flat 2 Lounge – Larger free Space vent (9800mm²)

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	19.72
S_{wi}	Window Area (m^2)	5.6
S_{ew}	External Wall Area (m^2)	14.12
S_{rr}	Ceiling Area (m^2)	0.0001
S	Total Area sound enters the room (m^2)	19.72

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	67.3	63.3	61.3	61.3	58.3	51.3
$D_{n,e}$	Titon (9800mm2)	39	35	36	41	50	57
R_{wi}	10_12_4	25	22	33	40	43	44
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	67.3	63.3	61.3	61.3	58.3	51.3
Ao/S . 10^(-Dn,e/10)	6.384E-05	0.00016	0.000127	4.02803E-05	5.07099E-06	1.0118E-06
Swi/S . 10^(-Rwi/10)	0.000898	0.001792	0.000142	2.83976E-05	1.42325E-05	1.13053E-05
Sew/S . 10^(-Rew/10)	5.688E-05	9.01E-05	2.85E-05	4.51781E-06	7.16024E-07	2.26427E-07
Srr/S . 10^(-Rrr/10)	5.071E-16	5.07E-16	5.07E-16	5.07099E-16	5.07099E-16	5.07099E-16
10log10(S/A)+3	5.5351423	4.487789	3.907869	3.907869279	4.188156515	4.188156515
Leq,2	42.915715	40.88891	29.95306	23.85272559	15.5026922	6.472343062
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**26.815715**	**32.28891**	**26.75306**	**23.85272559**	**16.7026922**	**7.472343062**

A-Weigted Level Outside	**65**
BS8233 Predicted Internal A-Weigted Level	**35**
Prediced Building Envelope SRI	**31**

BS8233 Calculation can be seen below:

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

7.3 Flat 2 Bedroom 1

Non Frequency Dependent Variables		
Term	Derivation	Value
Ao	Given in BS EN 20140-10 = 10 (m^2)	10
Sf	Total Facade Area (m^2)	12.7
Swi	Window Area (m^2)	2.4
Sew	External Wall Area (m^2)	10.2
Srr	Ceiling Area (m^2)	14.4
S	Total Area sound enters the room (m^2)	27.1

Key for Table Below	
Rwi	Sound Reduction of Window (Octave)
Rew	Sound Reduction Index of External Wall (Octave)
Rrr	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
Dn,e	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	Description	125	250	500	1000	2000	4000
Leq,ff	Free-Field External Noise Level	67.3	63.3	61.3	61.3	58.3	51.3
Dn,e	MA3051-Greenwood	46.7	46.3	49	55.7	66.3	69.3
Rwi	10_12_4	25	22	33	40	43	44
Rew	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
Rrr	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	125	250	500	1000	2000	4000
Leq,ff	67.3	63.3	61.3	61.3	58.3	51.3
Ao/S . 10^(-Dn,e/10)	7.889E-06	8.65E-06	4.65E-06	9.93186E-07	8.65029E-08	4.33542E-08
Swi/S . 10^(-Rwi/10)	0.0002801	0.000559	4.44E-05	8.85609E-06	4.43856E-06	3.52567E-06
Sew/S . 10^(-Rew/10)	2.99E-05	4.74E-05	1.5E-05	2.37482E-06	3.76384E-07	1.19023E-07
Srr/S . 10^(-Rrr/10)	1.68E-05	1.68E-05	1.68E-05	1.68032E-05	1.68032E-05	1.68032E-05
10log10(S/A)+3	6.9157661	5.868413	5.288493	5.288493082	5.568780318	5.568780318
Leq,2	39.461593	37.17296	25.6636	21.21656585	17.23431655	9.984474611
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**23.361593**	**28.57296**	**22.4636**	**21.21656585**	**18.43431655**	**10.98447461**

A-Weigted Level Outside	**65**
BS8233 Predicted Internal A-Weigted Level	**31**
Prediced Building Envelope SRI	**34**

BS8233 Calculation can be seen below:

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

7.4 Flat 2 Bedroom 2

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	6.8
S_{wi}	Window Area (m^2)	0.6
S_{ew}	External Wall Area (m^2)	6.2
S_{rr}	Ceiling Area (m^2)	8.4
S	Total Area sound enters the room (m^2)	15.2

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	63.7	59.7	57.7	57.7	54.7	47.7
$D_{n,e}$	MA3051-Greenwood	46.7	46.3	49	55.7	66.3	69.3
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	63.7	59.7	57.7	57.7	54.7	47.7
Ao/S . 10^(-Dn,e/10)	1.407E-05	1.54E-05	8.28E-06	1.77075E-06	1.54226E-07	7.72959E-08
Swi/S . 10^(-Rwi/10)	0.0001571	0.000395	0.000125	1.24827E-05	6.25616E-06	1.24827E-05
Sew/S . 10^(-Rew/10)	3.24E-05	5.14E-05	1.62E-05	2.57364E-06	4.07895E-07	1.28988E-07
Srr/S . 10^(-Rrr/10)	1.748E-05	1.75E-05	1.75E-05	1.74757E-05	1.74757E-05	1.74757E-05
10log10(S/A)+3	4.404509	3.357156	2.777236	2.777236053	3.057523289	3.057523289
Leq,2	31.550182	29.86038	22.69981	15.83053282	11.6125176	5.552513893
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**15.450182**	**21.26038**	**19.49981**	**15.83053282**	**12.8125176**	**6.552513893**

A-Weigted Level Outside	**62**
BS8233 Predicted Internal A-Weigted Level	**25**
Prediced Building Envelope SRI	**37**

BS8233 Calculation can be seen below:

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

7.5 Flat 4 Studio

Non Frequency Dependent Variables		
Term	Derivation	Value
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	33.3
S_{wi}	Window Area (m^2)	0.6
S_{ew}	External Wall Area (m^2)	32.7
S_{rr}	Ceiling Area (m^2)	40
S	Total Area sound enters the room (m^2)	73.72

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	Description	125	250	500	1000	2000	4000
$L_{eq,ff}$	Free-Field External Noise Level	63.7	59.7	57.7	57.7	54.7	47.7
$D_{n,e}$	MA3051-Greenwood	46.7	46.3	49	55.7	66.3	69.3
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	125	250	500	1000	2000	4000
$L_{eq,ff}$	63.7	59.7	57.7	57.7	54.7	47.7
Ao/S . 10^(-Dn,e/10)	2.9E-06	3.18E-06	1.71E-06	3.65102E-07	3.17991E-08	1.59373E-08
Swi/S . 10^(-Rwi/10)	3.24E-05	8.14E-05	2.57E-05	2.57375E-06	1.28993E-06	2.57375E-06
Sew/S . 10^(-Rew/10)	3.523E-05	5.58E-05	1.77E-05	2.79874E-06	4.4357E-07	1.40269E-07
Srr/S . 10^(-Rrr/10)	1.716E-05	1.72E-05	1.72E-05	1.71583E-05	1.71583E-05	1.71583E-05
10log10(S/A)+3	11.261926	10.21457	9.634653	9.634653439	9.914940675	9.914940675
Leq,2	34.391627	31.88929	25.27691	20.9322316	17.38498167	10.60091076
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**18.291627**	**23.28929**	**22.07691**	**20.9322316**	**18.58498167**	**11.60091076**

A-Weigted Level Outside	**62**
BS8233 Predicted Internal A-Weigted Level	**28**
Prediced Building Envelope SRI	**34**

BS8233 Calculation can be seen below:

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

Rear façade

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	17
S_{wi}	Window Area (m^2)	2.3
S_{ew}	External Wall Area (m^2)	14.7
S_{rr}	Ceiling Area (m^2)	40
S	Total Area sound enters the room (m^2)	57

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	56.7	52.7	50.7	50.7	47.7	40.7
$D_{n,e}$	MA3051-Greenwood	46.7	46.3	49	55.7	66.3	69.3
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	Flat timber joist roof, asphalt on boarding, 12mm plasterboard ceiling, thermal insuation	45	45	45	45	45	45
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	56.7	52.7	50.7	50.7	47.7	40.7
Ao/S . 10^(-Dn,e/10)	3.751E-06	4.11E-06	2.21E-06	4.72199E-07	4.11268E-08	2.06122E-08
Swi/S . 10^(-Rwi/10)	0.0001606	0.000404	0.000128	1.27601E-05	6.39518E-06	1.27601E-05
Sew/S . 10^(-Rew/10)	2.049E-05	3.25E-05	1.03E-05	1.62721E-06	2.57895E-07	8.15535E-08
Srr/S . 10^(-Rrr/10)	2.219E-05	2.22E-05	2.22E-05	2.21914E-05	2.21914E-05	2.21914E-05
10log10(S/A)+3	10.144822	9.097468	8.517549	8.51754873	8.797835966	8.797835966
Leq,2	30.005936	28.44652	21.31987	14.90553574	11.10465392	4.945169126
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**13.905936**	**19.84652**	**18.11987**	**14.90553574**	**12.30465392**	**5.945169126**

A-Weigted Level Outside	**55**
BS8233 Predicted Internal A-Weigted Level	**24**
Prediced Building Envelope SRI	**31**

BS8233 Calculation can be seen below:

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

Combined Internal SPL – 29.5dB

Acoustic Associates Sussex Ltd.

7.6 Flat 3 Lounge

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	10.5
S_{wi}	Window Area (m^2)	1.8
S_{ew}	External Wall Area (m^2)	8.7
S_{rr}	Ceiling Area (m^2)	0.0001
S	Total Area sound enters the room (m^2)	10.5

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	56.7	52.7	50.7	50.7	47.7	40.7
$D_{n,e}$	Titon (9800mm2)	39	35	36	41	50	57
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	56.7	52.7	50.7	50.7	47.7	40.7
Ao/S . 10^(-Dn,e/10)	0.0001199	0.000301	0.000239	7.56503E-05	9.52381E-06	1.90025E-06
Swi/S . 10^(-Rwi/10)	0.0006825	0.001714	0.000542	5.42105E-05	2.71696E-05	5.42105E-05
Sew/S . 10^(-Rew/10)	6.582E-05	0.000104	3.3E-05	5.22793E-06	8.28571E-07	2.62017E-07
Srr/S . 10^(-Rrr/10)	9.524E-16	9.52E-16	9.52E-16	9.52381E-16	9.52381E-16	9.52381E-16
10log10(S/A)+3	2.7979661	1.750613	1.170693	1.170693164	1.4509804	1.4509804
Leq,2	28.884078	27.71349	20.97863	13.17688385	4.893837707	-0.33832806
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**12.784078**	**19.11349**	**17.77863**	**13.17688385**	**6.093837707**	**0.661671942**

A-Weigted Level Outside	**55**
BS8233 Predicted Internal A-Weigted Level	**23**
Prediced Building Envelope SRI	**32**

BS8233 Calculation can be seen below:

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

7.7 Flat 3 Bedroom 1

Non Frequency Dependent Variables		
Term	**Derivation**	**Value**
A_o	Given in BS EN 20140-10 = 10 (m^2)	10
S_f	Total Facade Area (m^2)	9.3
S_{wi}	Window Area (m^2)	2.7
S_{ew}	External Wall Area (m^2)	6.6
S_{rr}	Ceiling Area (m^2)	0.0001
S	Total Area sound enters the room (m^2)	9.3

Key for Table Below	
R_{wi}	Sound Reduction of Window (Octave)
R_{ew}	Sound Reduction Index of External Wall (Octave)
R_{rr}	Sound Reduction Index of Roof/Ceiling (Octave)
A	Equivalent Absorbtion Area of Rx Room
$D_{n,e}$	Insulation of Trickle Vent (BS EN 20140-10)

Frequency Dependent Variables							
		Octave Band Centre Frequency					
Term	**Description**	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	Free-Field External Noise Level	56.7	52.7	50.7	50.7	47.7	40.7
$D_{n,e}$	31 dB Vent	31	31	31	31	31	31
R_{wi}	4_12_4	24	20	25	35	38	35
R_{ew}	Cavity Masonry (Brick Cavity with Insulation lightweight block)	41	39	44	52	60	65
R_{rr}	No Roof	100	100	100	100	100	100
A	Equivalent Absorbtion Area of Room (Copied from BS8233)	11.00	14.00	16.00	16.00	15.00	15.00

BS8233 Calculation Details						
	Octave Band Centre Frequency					
Term From Equation Below	**125**	**250**	**500**	**1000**	**2000**	**4000**
$L_{eq,ff}$	56.7	52.7	50.7	50.7	47.7	40.7
Ao/S . 10^(-Dn,e/10)	0.0008541	0.000854	0.000854	0.000854116	0.000854116	0.000854116
Swi/S . 10^(-Rwi/10)	0.0011558	0.002903	0.000918	9.18081E-05	4.6013E-05	9.18081E-05
Sew/S . 10^(-Rew/10)	5.637E-05	8.93E-05	2.83E-05	4.47776E-06	7.09677E-07	2.2442E-07
Srr/S . 10^(-Rrr/10)	1.075E-15	1.08E-15	1.08E-15	1.07527E-15	1.07527E-15	1.07527E-15
10log10(S/A)+3	2.2709026	1.223549	0.64363	0.643629659	0.923916895	0.923916895
Leq,2	32.122801	29.77442	23.89744	21.12270401	18.17038911	11.38351161
A-Weighting	-16.1	-8.6	-3.2	0	1.2	1
A-Weighted Leq	**16.022801**	**21.17442**	**20.69744**	**21.12270401**	**19.37038911**	**12.38351161**

A-Weigted Level Outside	**55**
BS8233 Predicted Internal A-Weigted Level	**27**
Prediced Building Envelope SRI	**28**

BS8233 Calculation can be seen below:

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