Environmental Noise Assessment

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68 – 70 High Street and 2 Turner Street, Manchester, M4 1DZ.

Project Consultant
T. Hegan BSc (Hons) AMIOA
Acoustic Consultant
info@acousticsurveys.co.uk

Proofing Consultant
L. Hatton BSc (Hons) AMIOA
Acoustic Consultant
info@acousticsurveys.co.uk

Peak Acoustics Ltd
Fernbank House
Springwood Way
Macclesfield
SK10 2XA

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1. Summary

1.1. Proposal

A development of residential dwellings is proposed at first and second floor level at 68 – 70 High Street and 2 Turner Street, Manchester, M1 4DZ.

1.2. Reason for Assessment

The development is to be situated in close proximity of busy roads, the Manchester metro-link and A1 / A3 licensed premises. An assessment is required in order to identify and mitigate against noise affecting future residents of the proposed dwellings.

1.3. Planning Conditions & Criteria

Internal noise levels are to be within the target criteria of Manchester City Council, based on BS8233:2014 and defined as:

- 35dB $L_{Aeq,16hr}$ within living rooms (07:00 – 23:00)
- 30dB $L_{Aeq,\ 8hr}$ within bedrooms (23:00 – 07:00)
- 45dB L_{Amax} not normally exceeded by more than 15 times (23:00 – 07:00)

1.4. Assessment Standards & Justification

'Planning & Noise: Technical Guidance' – Manchester City Council (2015) contains criteria for internal noise levels within noise-sensitive dwellings.

'BS8233:2014 – Guidance on sound insulation and noise reduction for buildings' is a recognised standard for assessing and mitigating environmental noise levels upon a proposed noise sensitive development. The standard gives a rigorous calculation method for determining interior noise levels based on measured environmental noise levels.

1.5. Measurements

To assess noise emissions, measurements were undertaken over a weekend period from Friday 5th – Monday 8th April 2017. For the purposes of the assessment, noise levels over the 24-hour period beginning 07:00 Saturday 6th April were used as this period included all noise sources under investigation including high activity from nearby licensed premises. Measured noise levels are summarised below.

Measurement Summary				
Measurement	**Date**	**Period**	**L_{Aeq} (dB)**	**L_{AFmax} (dB)**
M1 (Zone 1)	6th-7th May 2017	Day (16hr)	**61.2**	-
		Night (8hr)	**59.9**	**85.3**
M2 (Zone 2)	6th-7th May 2017	Day (16hr)	**65.0**	-
		Night (8hr)	**62.6**	**85.5**

Note: The results are inclusive of a -3 dB façade correction due to measurements being taken within 1m of a hard reflective surface.

1.6. Noise Assessment Outcome

It is determined that by using mitigation as specified below for the building façade, the outcome summarised in the following table is achieved.

Zone	Internal Space	Noise Parameter	Internal Noise Level	Within Desirable Limit (BS8233)
Zone 1 Turner St	Living Room	Daytime $L_{Aeq, 16hr}$	27.5	Yes
	Bedrooms	Night-time $L_{Aeq, 8hr}$	21.9	Yes
	Bedrooms	Night-time, L_{AFmax}	39.4	Yes
Zone 2 High St.	Living Room	Daytime $L_{Aeq, 16hr}$	31.2	Yes
	Bedrooms	Night-time $L_{Aeq, 8hr}$	24.7	Yes
	Bedrooms	Night-time, L_{AFmax}	38.5	Yes

1.7. Mitigation Recommendations

1.7.1. Glazing and Ventilation Scheme

Glazing and ventilation requirements for habitable rooms in Zones 1 and 2 are shown in the table below.

Zone	Room Type	Glazing Specification	Ventilation Specification
1	Living Rooms	Existing 4mm Glazing, 150mm Gap and 4mm Secondary Panel	Mechanical Ventilation
	Bedrooms	Existing 4mm Glazing, 150mm Gap and 4mm Secondary Panel	Mechanical Ventilation
2	Living Rooms	Existing 4mm Glazing, 150mm Gap and 4mm Secondary Panel	Mechanical Ventilation
	Bedrooms	Existing 4mm Glazing, 150mm Gap and 6mm Secondary Panel	Mechanical Ventilation

Zones:



1.7.2. Additional Notes and Requirements

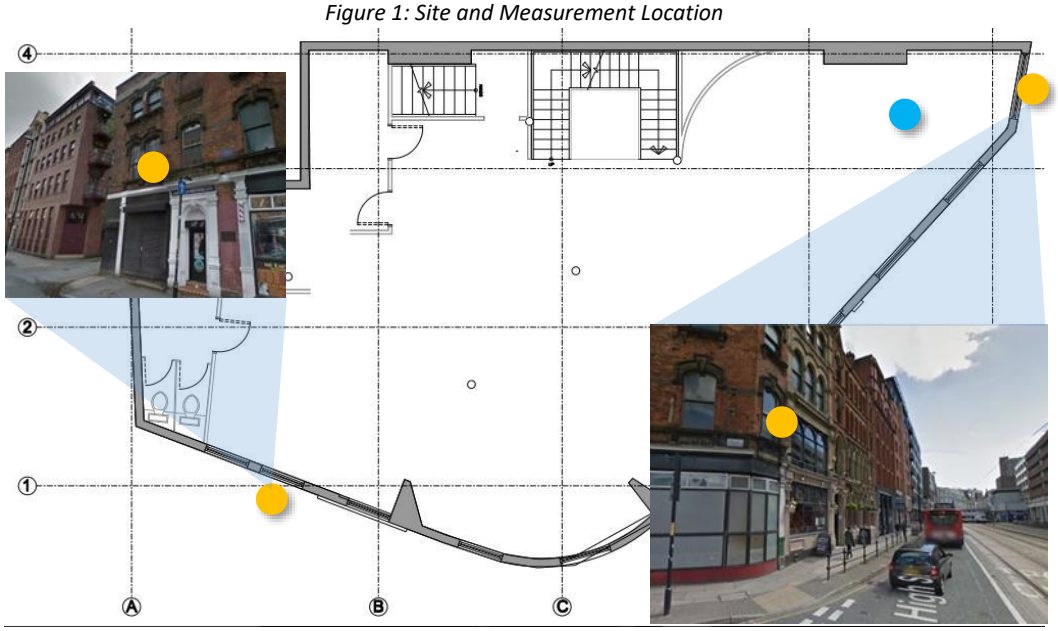
- Any alternative secondary glazing system may be used provided that the performance of the whole system (Existing Glazing + Secondary Panel) is rated at a minimum of **38 dB R_w+C_{tr}** (Bedrooms in Zone 2) or **34 dB R_w+C_{tr}** (All other areas).

- Inlet and outlets to the mechanical ventilation system should not be located in habitable rooms and any self-noise generated by the system should be designed not to exceed 30 dB L_{Aeq} in bedrooms / 35 dB L_{Aeq} in living rooms.

1.8. Site & Measurement Location

The site and measurement locations are shown in Figure 1 below.

Figure 1: Site and Measurement Location



External Measurement Locations

Internal Measurement Location

2. Environmental Noise Survey

2.1. Source Under Investigation

The primary noise sources identified on-site were vehicle traffic along High street, which included regular passing of buses and trams. Raised voices and activity due to passing members of the public, assumed to be visiting licenced premises within the locality was evident during the attended measurement period (20:46-21:41 on 05/05/17).

3.1. Measurement location

Noise levels were measured outside of open windows at two locations at first-floor level. Measurement M1 overlooked Turner Street and measurement M2 overlooked High Street. Measurement M2 was chosen to be representative of the room within the development likely to be worst-affected by noise, with a clear line of sight to traffic on High Street and patrons entering and leaving The English Lounge.

3.2. Weather Conditions

Weather conditions were deemed acceptable for environmental noise measurements; detailed weather conditions are given in **Appendix C**.

3.3. Measurement Equipment

Measurement equipment used complies with accuracy requirements for common environmental noise measurement standards. A detailed equipment list is given in **Appendix B** with calibration information in **Appendix D**.

3.4. Measurement Results

The results from the measurement intervals are summarised in the tables below. Full measurement details and information can be found in **Appendix E**.

Measured Levels 6th - 7th April 2017

Measurement Summary				
Measurement	**Date**	**Period**	**L_{Aeq} (dB)**	**L_{AFmax} (dB)**
M1 (Zone 1)	6th - 7th May 2017	Day (16hr)	61.2	N/A
		Night (8hr)	59.9	85.3
M2 (Zone 2)	6th - 7th May 2017	Day (16hr)	65.0	N/A
		Night (8hr)	62.6	85.5

Noise maxima selected for the assessment are representative of regularly occurring individual noise events during night-time hours (23:00 – 07:00).

4. BS8233:2014 / MCC Noise Assessment

4.1. Criteria

Internal noise levels are to be within the target criteria of Manchester City Council, based on BS8233:2014 and defined as:

- 35dB $L_{Aeq,16hr}$ within living rooms (07:00 – 23:00)
- 30dB $L_{Aeq,\ 8hr}$ within bedrooms (23:00 – 07:00)
- 45dB L_{Amax} not normally to be exceeded by more than 15 times (23:00 – 07:00)

4.2. External Noise Analysis

Measured noise levels are shown graphically in **Appendix E** and are typical of a city-centre location, characterised by high L_{Aeq} noise levels continuing late into the evening on Friday and Saturday night.

4.3. Internal Noise Levels – Assumed Insulation

Internal noise levels have been calculated to demonstrate that the proposed development can achieve suitable internal noise levels inside rooms, when appropriate glazing and ventilation systems are used.

To describe the likely internal exposure to environmental noise at the site, Peak Acoustics, Ltd. use suggested data from BS8233:2014 on standard construction. This will include all elements of the exposed living room and bedroom façades closest to the noise sources.

The calculations have been adjusted to account for the larger glazing area than at of standard dwellings. It can be seen from the proposed plans that living rooms incorporate up to three windows whilst bedrooms have a single window each. The following glazing areas are considered in the calculations:

Bedrooms: 1.75 m^2 Glazed Area

Living Rooms: 5.25 m^2 Glazed Area

A summary of assumed construction details is provided within **Appendix F.**

4.4. Daytime Internal Noise Levels

4.4.1. Living Rooms – Zone 1

Considering the insulation with the addition of 4/150/4mm secondary glazing and mechanical ventilation, daytime environmental external noise in living rooms in Zone 1 would be reduced from 61.2 dB $L_{Aeq,16hr}$ to internal levels of 27.5 dB $L_{Aeq,16hr}$.

4.4.2. Living Rooms – Zone 2

Considering the insulation with the addition of 4/150/4mm secondary glazing and mechanical ventilation, daytime environmental noise in living rooms in Zone 2 would be reduced from 65.0 dB $L_{Aeq,16hr}$ to internal levels of 31.2 dB $L_{Aeq,16hr}$.

The specified glazing and ventilation scheme would therefore place internal noise levels in living rooms in all zones below 35 dB $L_{Aeq,16hr}$ and therefore within the target criteria of Manchester City Council.

4.5. Night-time Internal Noise Levels

4.5.1. Bedrooms – Zone 1

Considering the insulation with the addition of 4/150/4mm secondary glazing and mechanical ventilation, night-time environmental noise in bedrooms in Zone 1 would be reduced from 59.9 dB $L_{Aeq,8hr}$ to internal levels of 21.9 dB $L_{Aeq,8hr}$. Regularly occurring noise maxima would be reduced from 85.3 dB L_{AFmax} to 39.4 dB L_{AFmax}.

4.5.2. Bedrooms – Zone 2

Considering the insulation with the addition of 4/150/6mm secondary glazing and mechanical ventilation, night-time environmental noise in bedrooms in Zone 2 would be reduced from 62.6 dB $L_{Aeq,8hr}$ to internal levels of 24.7 dB $L_{Aeq,8hr}$. Regularly occurring noise maxima would be reduced from 85.5 dB L_{AFmax} to 38.5 dB L_{AFmax}.

The specified glazing and ventilation scheme would therefore place internal noise levels in bedrooms in all zones below 30 dB $L_{Aeq,8hr}$, with regularly occurring noise maxima below 45 dB L_{AFmax} and therefore within the target criteria of Manchester City Council.

4.6. Effect Level and Exposure Outcomes

A summary of internal noise levels and their respective BS8233 classifications can be found below:

Zone	Internal Space	Noise Parameter	Internal Noise Level	Within Desirable Limit (BS8233)
Zone 1 Turner St	Living Room	Daytime $L_{Aeq, 16hr}$	27.5	**Yes**
	Bedrooms	Night-time $L_{Aeq, 8hr}$	21.9	**Yes**
	Bedrooms	Night-time, L_{AFmax}	39.4	**Yes**
Zone 2 High St.	Living Room	Daytime $L_{Aeq, 16hr}$	31.2	**Yes**
	Bedrooms	Night-time $L_{Aeq, 8hr}$	24.7	**Yes**
	Bedrooms	Night-time, L_{AFmax}	38.5	**Yes**

5. Internal Noise Ingress

5.1. English Lounge Public House

Investigations have been made to determine the potential for adverse noise impact arising from the adjacent English Lounge restaurant and public house at 64 – 66 High Street.

In reference to the most recent planning approval 073604/FO/2004/C1 it is understood that the premises is A3 licensed for use at first-floor level as a restaurant only with background music.

5.1.1. Internal Noise Measurements

A 1-hour attended measurement was conducted on Friday 8th April from 20:45 – 21:45 in order to assess noise ingress from the adjoining English Lounge restaurant and public house during a period of high activity.

The microphone was placed 1.5m from floor level approximately 2m from the partition wall with the public house and windows were closed during measurements.

5.1.2. Subjective Impressions

During the attended measurement, the primary source of noise was vehicle traffic from High Street and people stood outside The English Lounge. The existing windows are basic and it was determined on-site that noise ingress through the windows was the primary transmission path for sound. No sound transmission through the wall was audible above the residual level of noise break-in through the closed windows.

5.1.3. Existing Insulation

The partition wall is of a masonry construction. Though the exact thickness is unknown, a wall of this type would typically provide a weighted Sound Reduction Index in the order of 50 dB R_W.

5.1.4. Results and Outcome

A noise level of 45.6 dB $L_{Aeq,1hr}$ was recorded during the attended measurement, although the main contributory factor was noise through the existing windows.

Since the public house is not understood to be licensed for any activities at first floor level that would produce high noise levels of a low-frequency nature, and the existing wall can be expected to provide high level of sound insulation against broadband noise, no mitigation is deemed necessary.

The likelihood of adverse impact arising from internal noise ingress from the public house is therefore deemed to be low, whilst external noise is addressed separately in the report with suitable glazing specifications provided.

APPENDIX A - Measurement Details

Measurement	Kit	Start Date	Start Time	End Date	End Time
M1 (Zone 1)	A1	05/05/17	22:00	08/05/17	10:25
M2 (Zone 2)	A3	05/05/17	21:53	08/05/17	10:28
M3 (Internal)	A3	05/05/17	20:46	05/05/17	21:46

APPENDIX B - Equipment Details

Kit	Equipment	Make	Model	Class	Serial Number
A1	Sound Meter	Svantek	958	1	34525
A1	Pre-Amp	Svantek	SV12L	1	41651
A1	Calibrator	Svantek	SV31	1	32507
A3	Sound Meter	Svantek	971	1	41980
A3	Pre-Amp	Svantek	SV18	1	44331
A3	Calibrator	Svantek	SV31	1	32507

APPENDIX C - Meteorology Details

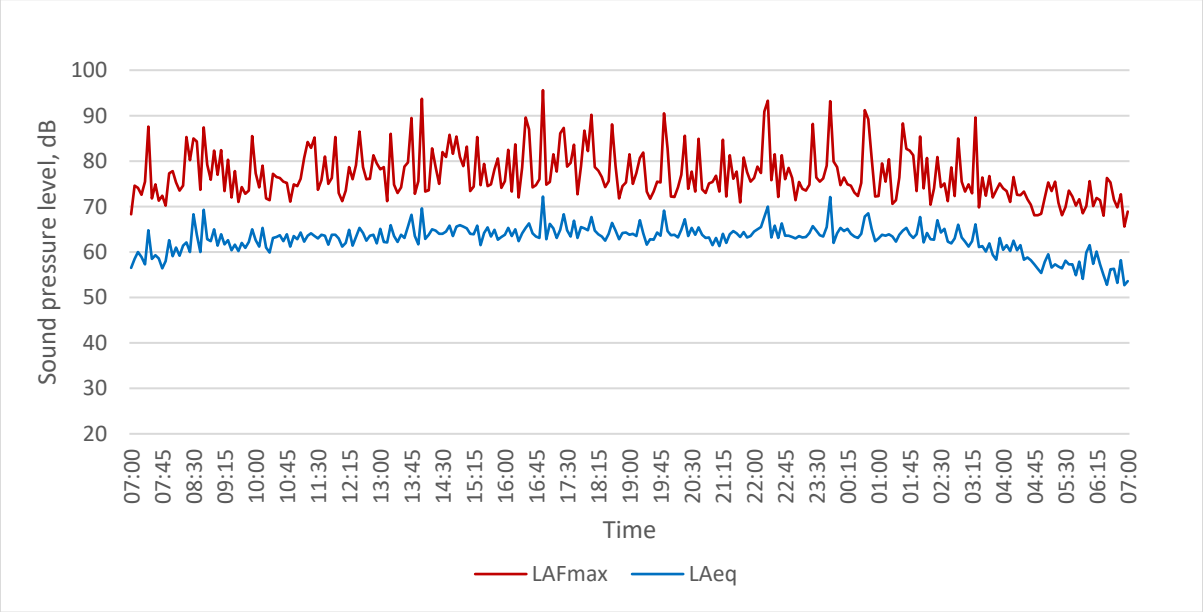
Measurement	Date	Temp C	Wind Speed m/s	Wind Direction	Humidity %	Precipitation mm	Cloud Cover (Oktas)
M1 – M3	05/06/17	11	3.8	NE	62	0.0	5/8
	06/05/17	10	4.1	NE	75	0.0	8/8

APPENDIX D - Calibration Details

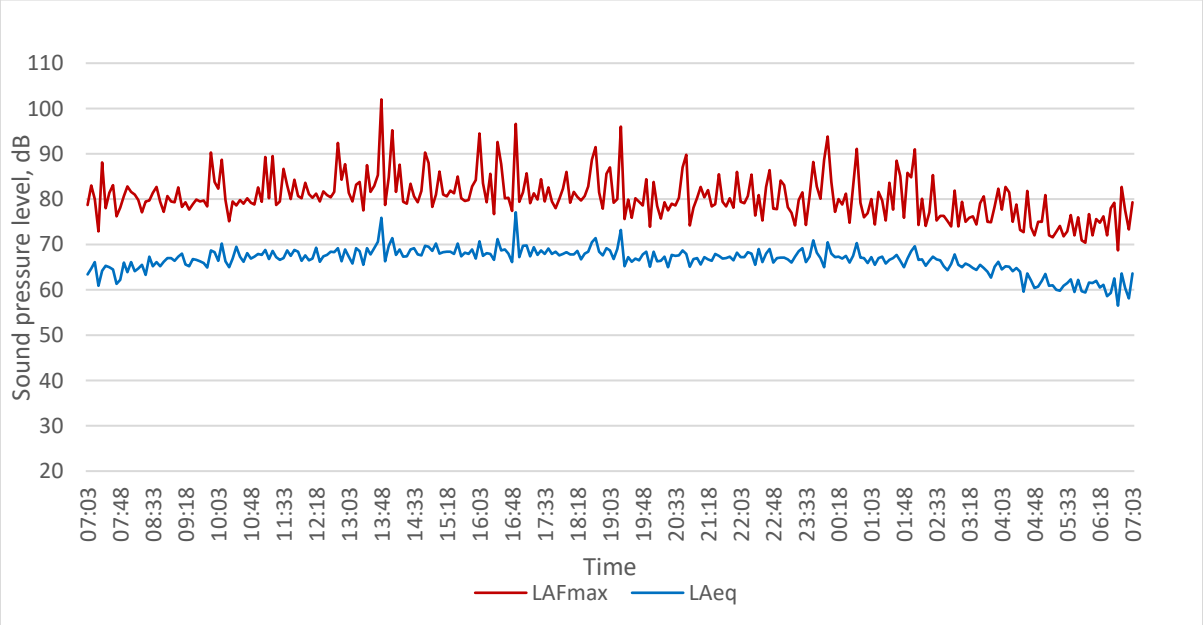
Measurement	Calibrator Ref Level (dB)	Level Before (dB)	Deviation Before (dB)	Level After (dB)	Deviation After (dB)
M1	114.0	113.9	0.1	114.7	-0.7
M2 / M3	114.0	113.44	-0.56	113.40	-0.60

APPENDIX E – Noise Survey Results

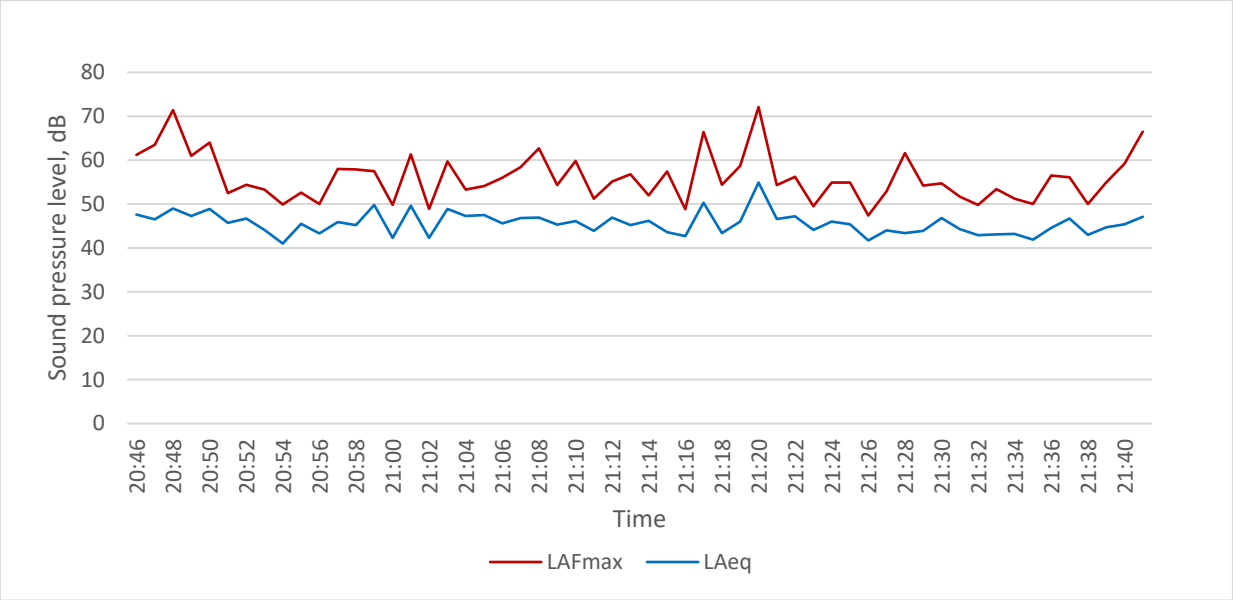
Environmental Noise Measurements, 6th - 7th May 2017, Measurement M1



Environmental Noise Measurements, 6th - 7th May 2017, Measurement M2



Environmental Noise Measurements, 6th May 2017, Attended Measurement M3



APPENDIX F – Assumed Construction Details

Values are given in accordance with two key areas covered by BS8233:2014, which are listed as the following:

- Living rooms between hours of 07:00 and 23:00;
- Bedrooms between hours of 23:00 and 07:00.

For the purposes of this assessment, daytime levels are assessed in living room spaces, night-time levels are assessed in bedrooms. Sizes are nominally given as:

- Living room 5m x 4m x 2.4m
- Bedroom 3m x 4m x 2.4m

The building envelope is assumed as having standard construction, with façade materials and elements, such as:

- External wall, concrete block & brickwork leaves with >75mm cavity
- Pitched roof with mineral wool and plaster ceiling
- 4/150/4mm Secondary glazing
- 4/150/6mm Secondary glazing

Glazing areas are adjusted to reflect the plans as follows:

- Bedrooms: 1.75 m^2 Glazed Area
- Living Rooms: 5.25 m^2 Glazed Area

The following are Sound Reduction Indices of the specifications identified previously:

Sound Reduction Index of the external wall, dB (R_w)

Frequency Band (Hz)	125	250	500	1000	2000
R_w of External wall	41	45	45	54	58

Sound Reduction Index of the roof, dB (R_w)

Frequency Band (Hz)	125	250	500	1000	2000
R_w of Roof	27	37	43	48	52

Sound Reduction Index of 4/150/4mm secondary glazing, dB (R_w)

Frequency Band (Hz)	125	250	500	1000	2000
R_w of Glazing	20	36	42	49	53

Sound Reduction Index of 4/150/6mm glazing, dB (R_w)

Frequency Band (Hz)	125	250	500	1000	2000
R_w of Glazing	24	39	45	50	51

This report determines values based on the assumption that ventilation is **NOT from open windows**, but from auxiliary methods of external ventilation.

Summary calculations are made following the BS8233:2014 Rigorous Design Calculation shown in **Appendix G**.

APPENDIX G – Attenuation Calculation Sheets

BS8233 Rigorous Design Calculation – Internal Daytime Noise Zone 1

	125	250	500	1000	2000
Leq1	62.9	59.7	56.2	56.9	53.7
Dne	50	48	51	63	85
Rwi	20	36	42	49	53
Rew	41	45	45	54	58
Rrr	27	37	43	48	52
A	11	14	20	20	15
Sf	9.6		S	10	
Sw1	5.3		A0	10	
Sew	4.4				
Srr	20.0				

	125	250	500	1000	2000
A	63	60	56	57	54
B	0.00001	0.00002	0.00001	0.00000	0.00000
C	0.00547	0.00014	0.00003	0.00001	0.00000
D	0.00004	0.00001	0.00001	0.00000	0.00000
E	0.00017	0.00007	0.00007	0.00001	0.00000
F	-22.45602	-36.30621	-39.10132	-47.56847	-51.69785
G	-0.59121	-1.63857	-3.09098	-3.09098	-1.93820
leq2	42.9	24.8	17.0	9.2	3.1
A weight	-16	-9	-3	0	1
LAeq2	26.9	15.8	14.0	9.2	4.1
Leq2 (SN)	42.9				
LAeq2 (SN)	27.5				

BS8233 Rigorous Design Calculation – Internal Night-time Noise Zone 1

	125	250	500	1000	2000
Leq1	61.1	58.6	54.8	55.5	52.3
Dne	50	48	51	63	85
Rwi	20	36	42	49	53
Rew	41	45	45	54	58
Rrr	27	37	43	48	52
A	11	14	16	16	15
Sf	9.6		S	10	
Sw1	1.8		A0	10	
Sew	7.8				
Srr	12.0				

	125	250	500	1000	2000
A	61	59	55	56	52
B	0.00001	0.00002	0.00001	0.00000	0.00000
C	0.00188	0.00005	0.00001	0.00000	0.00000
D	0.00006	0.00003	0.00003	0.00000	0.00000
E	0.00010	0.00004	0.00004	0.00000	0.00000
F	-26.88406	-38.89986	-40.68915	-49.54931	-53.75526
G	-0.59121	-1.63857	-2.12188	-2.12188	-1.93820
leq2	36.6	21.1	15.0	6.8	-0.4
A weight	-16	-9	-3	0	1
LAeq2	20.6	12.1	12.0	6.8	0.6
Leq2 (SN)	36.8				
LAeq2 (SN)	21.9				

BS8233 Rigorous Design Calculation – Internal Night-time Noise, Maxima Zone 1

	125	250	500	1000	2000
Lmax1	77.0	65.8	72.5	81.8	82.5
Dne	50	48	51	63	85
Rwi	20	36	42	49	53
Rew	41	45	45	54	58
Rrr	27	37	43	48	52
A	11	14	16	16	15
Sf	9.6		S	10	
Sw1	1.8		A0	10	
Sew	7.9				
Srr	12.0				

	125	250	500	1000	2000
A	77	66	73	82	83
B	0.00001	0.00002	0.00001	0.00000	0.00000
C	0.00182	0.00005	0.00001	0.00000	0.00000
D	0.00006	0.00003	0.00003	0.00000	0.00000
E	0.00010	0.00004	0.00004	0.00000	0.00000
F	-26.99496	-38.93858	-40.69750	-49.56690	-53.77370
G	-0.59121	-1.63857	-2.12188	-2.12188	-1.93820
lmaxq2	52.4	28.2	32.7	33.1	29.8
A weight	-16	-9	-3	0	1
LAmax2	36.4	19.2	29.7	33.1	30.8
LAmax2 (SN)	52.5				
LAmax2 (SN)	39.4				

BS8233 Rigorous Design Calculation – Internal Daytime Noise Zone 2

	125	250	500	1000	2000
Leq1	66.6	61.8	61.4	60.4	57.6
Dne	50	48	51	63	85
Rwi	20	36	42	49	53
Rew	41	45	45	54	58
Rrr	27	37	43	48	52
A	11	14	20	20	15
Sf	9.6		S	10	
Sw1	5.3		A0	10	
Sew	4.4				
Srr	20.0				

	125	250	500	1000	2000
A	67	62	61	60	58
B	0.00001	0.00002	0.00001	0.00000	0.00000
C	0.00547	0.00014	0.00003	0.00001	0.00000
D	0.00004	0.00001	0.00001	0.00000	0.00000
E	0.00017	0.00007	0.00007	0.00001	0.00000
F	-22.45602	-36.30621	-39.10132	-47.56847	-51.69785
G	-0.59121	-1.63857	-3.09098	-3.09098	-1.93820
leq2	46.6	26.9	22.2	12.7	7.0
A weight	-16	-9	-3	0	1
LAeq2	30.6	17.9	19.2	12.7	8.0
Leq2 (SN)	46.6				
LAeq2 (SN)	31.2				

BS8233 Rigorous Design Calculation – Internal Night-time Noise Zone 2

	125	250	500	1000	2000
Leq1	66.6	61.8	61.4	60.4	57.6
Dne	50	48	51	63	85
Rwi	24	39	45	50	51
Rew	41	45	45	54	58
Rrr	27	37	43	48	52
A	11	14	16	16	15
Sf	9.6		S	10	
Sw1	1.8		A0	10	
Sew	7.8				
Srr	12.0				

	125	250	500	1000	2000
A	67	62	61	60	58
B	0.00001	0.00002	0.00001	0.00000	0.00000
C	0.00075	0.00002	0.00001	0.00000	0.00000
D	0.00006	0.00003	0.00003	0.00000	0.00000
E	0.00010	0.00004	0.00004	0.00000	0.00000
F	-30.35883	-39.77423	-41.00040	-49.74365	-53.22256
G	-0.59121	-1.63857	-2.12188	-2.12188	-1.93820
leq2	38.6	23.4	21.3	11.5	5.4
A weight	-16	-9	-3	0	1
LAeq2	22.6	14.4	18.3	11.5	6.4
Leq2 (SN)	38.9				
LAeq2 (SN)	24.7				

BS8233 Rigorous Design Calculation – Internal Night-time Noise, Maxima Zone 2

	125	250	500	1000	2000
Lmax1	71.5	68.2	78.4	87.0	78.7
Dne	50	48	51	63	85
Rwi	24	39	45	50	51
Rew	41	45	45	54	58
Rrr	27	37	43	48	52
A	11	14	16	16	15
Sf	9.6		S	10	
Sw1	1.8		A0	10	
Sew	7.8				
Srr	12.0				

	125	250	500	1000	2000
A	81.1	68.8	74.6	72.4	74.1
B	0.00001	0.00002	0.00001	0.00000	0.00000
C	0.00075	0.00002	0.00001	0.00000	0.00000
D	0.00006	0.00003	0.00003	0.00000	0.00000
E	0.00010	0.00004	0.00004	0.00000	0.00000
F	-30.35883	-39.77423	-41.00040	-49.74365	-53.22256
G	-0.59121	-1.63857	-2.12188	-2.12188	-1.93820
lmaxq2	53.1	30.4	34.5	23.5	21.9
A weight	-16	-9	-3	0	1
LAmax2	37.1	21.4	31.5	23.5	22.9
LAmax2 (SN)	53.2				
LAmax2 (SN)	38.5				

APPENDIX H – Glazing Performance Models

Existing 4mm Glazing, 150mm Air Gap + Secondary 4mm Panel

Sound Insulation Prediction (v8.0.4)

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- Key No. 2539

Margin of error is generally within Rw +/- 3 dB

Job Name:

Job No.: Page No.:

Date: 15 May 17 Initials:tim

File Name: Insul 4 150 4 Secondary.ixl

Notes:



Rw	44 dB
C	-3 dB
C_{tr}	-10 dB
D_{nTw}	46 dB [V:50m3] [A:11m2]

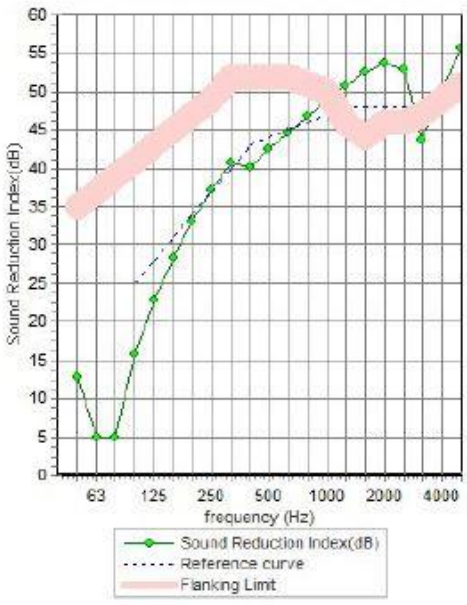
System description

- 1 x 4.0 mm Glass (ρ:2430 kg/m3,E:52GPa,η:0.02)
- 1 x 4.0 mm Glass (ρ:2430 kg/m3,E:52GPa,η:0.02)

Mass-air-mass resonant frequency =68 Hz

frequency (Hz)	R(dB)	R(dB)
50	13	
63	5	6
80	5	
100	16	
125	23	20
160	28	
200	33	
250	37	36
315	41	
400	40	
500	42	42
630	45	
800	47	
1000	49	49
1250	51	
1600	53	
2000	54	53
2500	53	
3150	44	
4000	50	47
5000	56	

Panel Size 2.7x4 m; Mass 19.7 kg/m2



Existing 4mm Glazing, 150mm Air Gap + Secondary 6mm Panel

Sound Insulation Prediction (v8.0.4)

Program copyright Marshall Day Acoustics 2014

- Key No. 2539

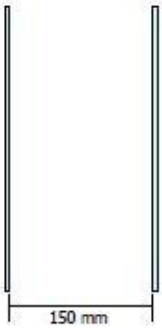
Margin of error is generally within Rw +/- 3 dB

Job Name:

Job No.: Page No.: Notes:

Date: 15 May 17 Initials:tim

File Name: Insul 4 150 6.0.ixl



Rw	47 dB
C	-3 dB
C_{tr}	-9 dB
D_{nTw}	49 dB [V:50m3] [A:11m2]

System description

+ 1 x 4.0 mm Glass (ρ:2430 kg/m3,E:52GPa,η:0.02)

+ 1 x 6.0 mm Glass (ρ:2430 kg/m3,E:52GPa,η:0.02)

Mass-air-mass resonant frequency =62 Hz

frequency (Hz)	R(dB)	R(dB)
50	13	
63	5	8
80	11	
100	20	
125	26	24
160	32	
200	36	
250	40	39
315	43	
400	43	
500	45	45
630	47	
800	49	
1000	51	50
1250	52	
1600	53	
2000	51	51
2500	50	
3150	51	
4000	55	54
5000	60	

Panel Size 2.7x4 m; Mass 24.6 kg/m2

