

7 Rainforth Street Manchester

Acoustic Planning Report
0586/APR1
Revision 1

8 January 2020

For:

Shoaib Muhammad



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Contents	Page
1.0 Introduction	1
2.0 Objectives	1
3.0 Site Description	1
4.0 Local Authority Requirements	2
5.0 Environmental Sound Survey	3
6.0 Detailed Sound Assessment	8
7.0 Building Services Sound Limits	12
8.0 Conclusions	12

Appendices

Time History Graphs 0586/THG1 & 0586/THG2

Detailed Calculations BS 8233:2014

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1.0 Introduction

Lighthouse Acoustics has been appointed by Shoaib Muhammad to undertake an environmental sound survey at 7 Rainforth Street, Manchester and to undertake a detailed sound assessment for the proposed development.

The proposed development comprises the change of use of the existing 5 storey building (including basement) from commercial to form 8 residential flats at 1st, 2nd, 3rd and 4th floors with a retail unit at basement and ground floor.

The survey methodology, results and assessment for the proposed development are presented in this report.

2.0 Objectives

To establish the Local Authority's acoustic requirements for the proposed development.

To visit site to undertake a detailed environmental sound survey in order to establish existing environmental sound levels at the proposed development.

To undertake a detailed environmental sound assessment of the proposed residential development to establish the acoustic specification for glazing/ventilation elements in order to achieve the acoustic requirements of the Local Authority.

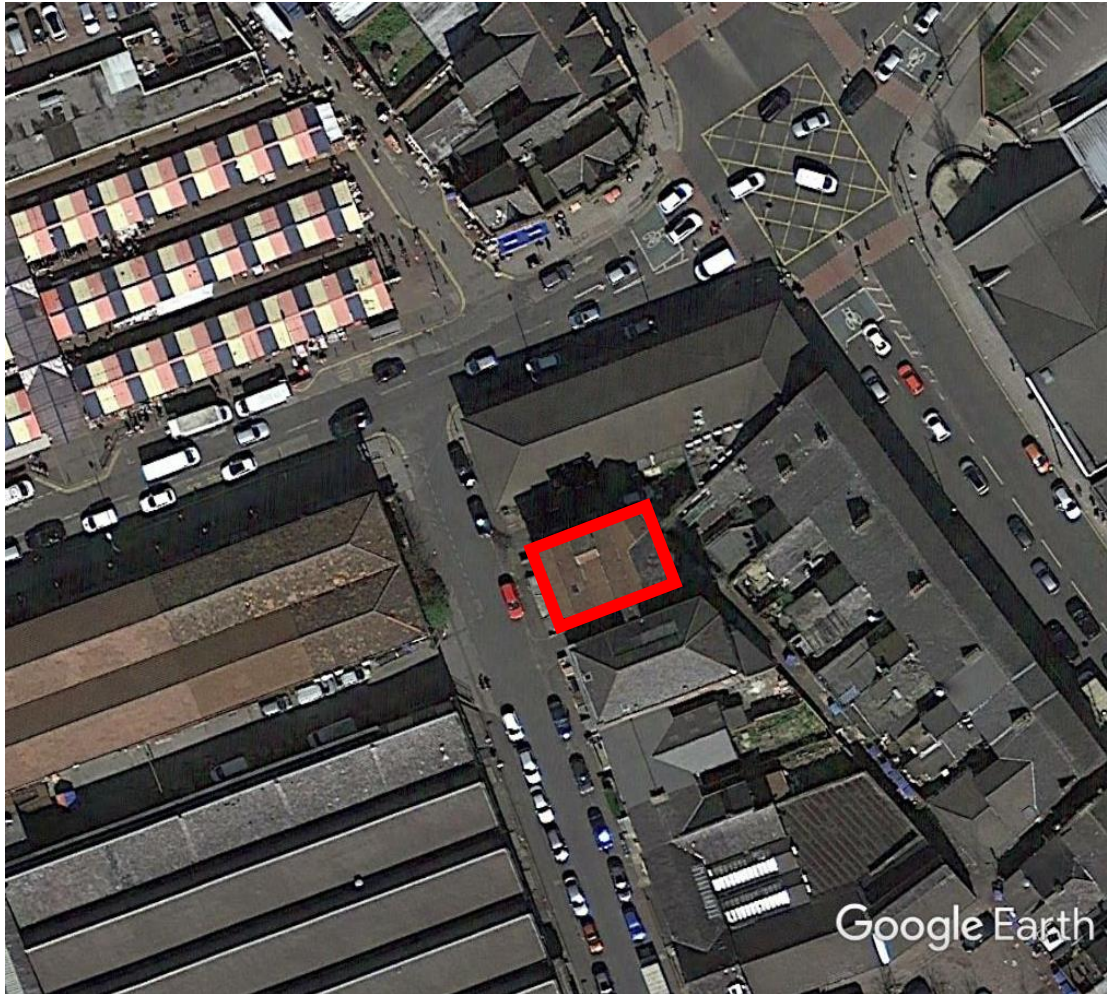
To propose atmospheric plant sound emission limits at the nearest noise sensitive receptors for subsequent use in designing building services proposals in order to comply with the requirements of the Local Authority.

3.0 Site Description

The proposed residential development is at 7 Rainforth Street, Manchester. The site comprises an existing 4 storey building.

The site is bound by an access road to the north, commercial premises to the east, an access road to the south and Rainforth Street to the west.

The site plan below indicates the extent of the site and the surrounding environment.



Site plan indicating the extent of the site and the surrounding environment

4.0 Local Authority Requirements

4.1 Residential Developments

With regard to residential developments, Section 3.6.1.1 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

"Manchester City Council has adopted the following internal noise limits for residential properties:

- **Bedrooms (night time - 23.00 - 07.00) 30dB L_{Aeq} (individual noise events should not normally exceed 45dB $L_{Amax,F}$ by more than 15 times)**
- **Living Rooms (daytime - 07.00 - 23.00) 35dB L_{Aeq}**
- **Gardens and terraces (daytime) 55dB L_{Aeq} "**

4.2 Building Services

With regard to noise and vibration from fixed plant/equipment, Section 3.6.1.5.1 of the Planning & Noise Technical Guidance document (dated December 2015) produced by Manchester City Council states the following:

“The noise assessment should be based on BS 4142: 2014 and any application for fixed plant, equipment or machinery must demonstrate that:

‘Externally mounted ancillary plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.’

5.0 Environmental Sound Survey

5.1 Measurements

Automated environmental sound measurements were undertaken from 14:00 hours on Friday 2 August 2019 to 07:00 hours on Tuesday 6 August 2019. During this period the L_{Amax} , L_{Aeq} and L_{A90} sound pressure levels were measured continuously over 15 minute periods along with the corresponding octave band sound pressure levels.

5.2 Weather Conditions

At the start of the survey period there was a light northerly breeze (<3m/s) and the sky was scattered cloud. There was no rainfall and road surfaces were dry. The temperature was approximately 21°C.

At the end of the survey period there was a light southerly breeze (<3m/s) and the sky was overcast. There was no rainfall and road surfaces were dry. The temperature was approximately 12°C.

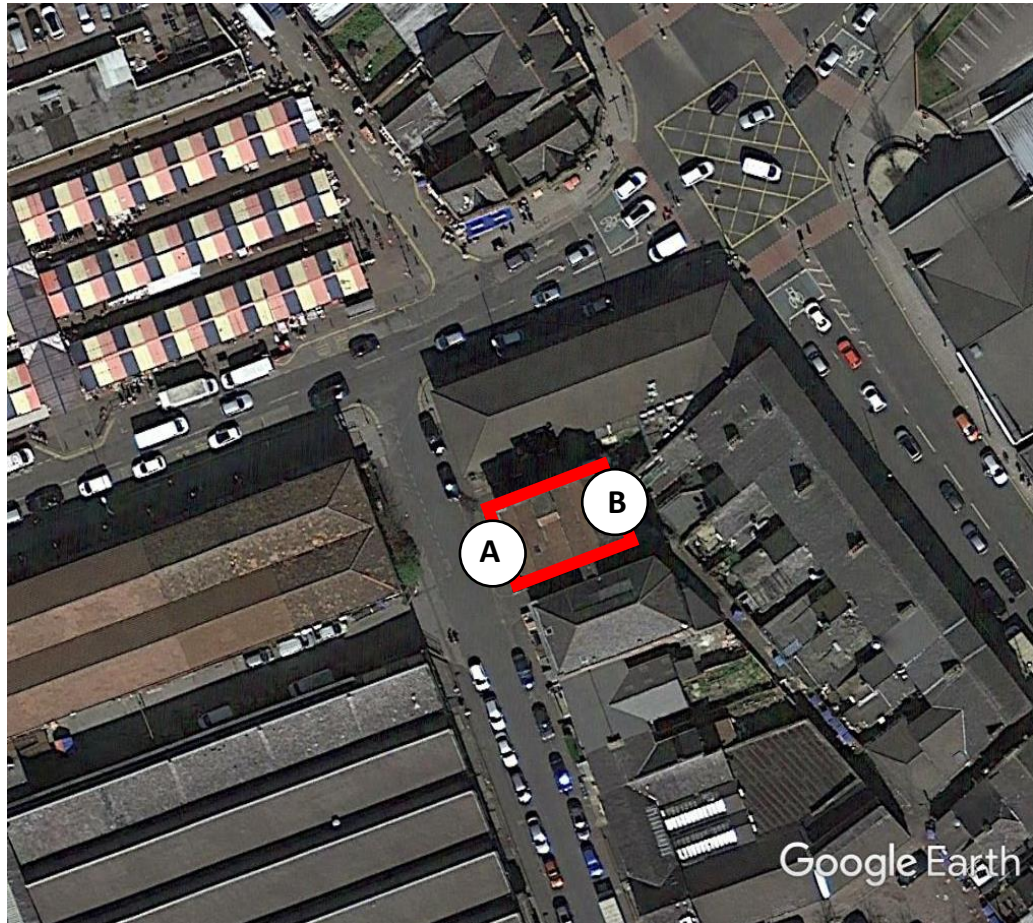
Based on publicly available weather data for the survey period we understand that weather conditions remained similar for the duration of the survey with no significant periods of rainfall or strong breezes. The weather conditions during the survey period are therefore considered to be suitable for undertaking measurements of sound levels.

5.3 Measurement Positions

Environmental sound levels were measured at 2No. positions on-site as described in the table below.

Position	Description
A	Microphone at 1 st floor level at 1m from the west façade of the existing building overlooking Rainforth Street.
B	Microphone at 1 st floor level at 1m from the east façade of the existing building overlooking the rear of the building.

The measurement positions are shown on the site plan below.



Site plan showing measurement positions

The measurement positions were selected in order to assess typical environmental sound levels incident upon the front and rear facades of the proposed residential development.

5.4 Equipment

The following equipment was used to undertake the environmental sound survey.

Equipment	Manufacturer	Model	Serial No.	Calibration Date
Class 1 Sound Level Meter	Casella	633C	0721320	11/09/2017
Preamplifier	Casella	495	001414	11/09/2017
Microphone	Casella	251	1025	11/09/2017
Class 1 Sound Level Meter	Casella	633C	0721319	08/09/2017
Preamplifier	Casella	495	001446	08/09/2017
Microphone	Casella	251	1996	08/09/2017
Class 1 Sound Calibrator	Casella	120/1	3864878	13/11/2018
Environmental Noise Kit	Casella	6847	-	-
Microphone Extension Cable	Casella	C6717/5	-	-
Weather Protection System	Casella	6737	-	-

Field calibration checks were performed on the sound level meters prior to and on completion of the survey and were found to be within acceptable tolerance limits.

5.5 Results

5.5.1 Time History Graphs

The results of the environmental sound survey are presented on Time History Graphs 0586/THG1 and 0576/THG2 enclosed at the rear of the report. The presented results for Positions A and B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.5.2 $L_{Aeq,T}$ Ambient Sound Levels

In order to compare the results of the environmental sound survey with the internal BS 8233: 2014 levels it is necessary to convert the $L_{Aeq,15min}$ sound levels into single figure daytime $L_{Aeq,16hour}$ and night-time $L_{Aeq,8hour}$ sound levels. This has been calculated using the following formula:

$$L_{Aeq,T} = 10 \log_{10} \left(\frac{1}{N} \sum_i^N 10^{L_{Aeq,15min i}/10} \right)$$

The calculated daytime $L_{Aeq,16hour}$ and night-time $L_{Aeq,8hour}$ sound levels at each measurement position are presented in the table below.

Day	Position A		Position B	
	Daytime $L_{Aeq,16hour}$ (dB)	Night-time $L_{Aeq,8hour}$ (dB)	Daytime $L_{Aeq,16hour}$ (dB)	Night-time $L_{Aeq,8hour}$ (dB)
Friday	-	55	-	51
Saturday	60	57	54	51
Sunday	59	55	54	51
Monday	60	55	54	49

The presented results for Positions A and B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

The highest daytime $L_{Aeq,16\text{hour}}$ and night-time $L_{Aeq,8\text{hour}}$ sound levels at each measurement position are presented in the table below along with the corresponding octave band sound pressure levels.

Position	Period	L_{eq} Sound Pressure Level (dB) at Octave Band Centre Frequency (Hz)								dBA
		63	125	250	500	1k	2k	4k	8k	
A	Daytime (16 hour)	66	63	60	56	55	51	49	42	60
	Night-time (8 hour)	59	59	57	52	53	50	42	35	57
B	Daytime (16 hour)	61	62	57	51	49	44	38	31	54
	Night-time (8 hour)	57	57	54	46	46	42	35	29	51

The presented results for Positions A and B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.5.3 $L_{Amax,F}$ Sound Level Events

The highest 15No. individual $L_{Amax,F}$ sound level events measured during the night-time period (23:00 to 07:00 hours) over the survey period at each measurement position are detailed in the table below along with the corresponding octave band sound pressure levels.

Position	$L_{max,F}$ Sound Pressure Level (dB) at Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
A	81	74	64	64	96	96	81	69	99
	81	79	75	69	81	86	82	72	89
	79	71	68	71	80	82	80	73	87
	80	76	67	70	79	82	79	74	86
	76	76	70	68	84	74	72	68	85
	85	96	88	81	73	74	70	64	85
	71	70	64	70	83	75	74	66	84
	78	74	79	76	78	79	75	67	83
	75	70	65	57	81	73	58	48	81
	80	84	73	71	81	69	66	57	81
	77	69	75	74	77	75	65	58	80
	69	68	64	61	79	63	55	53	79
	86	83	83	79	79	73	68	63	79
	83	78	81	81	72	69	68	65	79
	72	65	62	60	77	72	56	45	79

The presented results for Position A have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

Position	L _{max,F} Sound Pressure Level (dB) at Octave Band Centre Frequency (Hz)								dBA
	63	125	250	500	1k	2k	4k	8k	
B	73	69	63	58	72	79	62	54	81
	81	75	75	75	77	73	64	56	80
	67	69	62	57	74	78	55	42	80
	72	71	64	66	74	76	62	47	79
	69	72	69	73	74	75	65	63	79
	66	66	57	53	71	77	51	35	79
	70	63	59	53	71	74	48	36	76
	75	70	71	69	71	69	65	63	76
	73	67	68	75	69	68	59	51	75
	74	71	76	73	67	64	59	55	73
	71	72	67	70	72	63	57	48	73
	71	71	72	74	66	64	59	50	73
	71	69	68	66	69	66	63	59	73
	70	67	73	73	70	66	59	53	73
	73	73	72	70	67	65	57	49	72

The presented results for Position B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.5.4 LA_{90,T} Background Sound Levels

The lowest representative daytime and night-time LA_{90,15min} background sound levels measured at each position during the survey period are detailed in the table below.

Position	Lowest Representative LA _{90,15min} Background Sound Levels (dB)	
	Daytime	Night-time
A	58	44
B	55	43

The presented results for Positions A and B have been corrected for reflections from the façade by subtracting 3dB from the measured sound levels in order to obtain free field sound levels.

5.6 Discussion of Sound Climate

At the start and end of the survey period the dominant sound sources at Position A were noted to be frequent road traffic along Rainforth Street and the surrounding road network and low level building services noise from the surrounding commercial premises.

At the start and end of the survey period the dominant sound sources at Position B were noted to be road traffic from the surrounding road network and low level building services noise from the surrounding commercial premises.

Whilst we are unable to comment on dominant sound sources or individual sound events during the survey period, based on the surrounding environment it is likely that road traffic and low level building services remained the dominant sound sources.

6.0 Detailed Sound Assessment

6.1 Assessment Method

In order to establish the acoustic specification for glazing/ventilation elements required to achieve the internal daytime $L_{Aeq,16hour}$, night-time $L_{Aeq,8hour}$ and night-time $L_{Amax,F}$ requirements an assessment has been undertaken in accordance with the more rigorous calculation method detailed in BS 8233:2014, "Guidance on sound insulation and noise reduction for buildings".

This calculation method takes into account the external sound pressure level, the sound reduction indices of the façade elements, the area of the facade and the absorption within the room at octave band centre frequencies.

Detailed calculation sheets for living rooms, dining rooms and bedrooms are enclosed at the rear of the report.

6.2 Proposed Development

The assessment has been based on the following drawings.

Author	Drawing No.	Revision	Date
PHA Architects	F11/EA/01	H	03/19
	F11/EA/11	-	08/19
	F11/EA/12	-	08/19
	F11/EA/13	C	08/19

The proposals include the change of use of the existing 5 storey building (including basement) from commercial to form 8 residential flats at 1st, 2nd, 3rd and 4th floors with a retail unit at basement and ground floor.

6.3 Acoustic Requirements

The proposed residential apartments comprise living room/kitchen and bedroom spaces. Based on the requirements of the Local Authority detailed in Section 4.0, the following internal sound limits have been assessed to.

Room Type	07:00 to 23:00	23:00 to 07:00
Living Room/Kitchen	35dB $L_{Aeq,16hour}$	-
Bedroom	35dB $L_{Aeq,16hour}$	30dB $L_{Aeq,8hour}$ 45dB L_{Amax}^*

* should not be exceeded more than 15 times per night.

6.4 Room Assumptions

The following typical dimensions and finishes/furnishings have been assumed for the purpose of the assessment.

Room Type	Typical Room Dimensions	Typical Window Dimensions	Typical Room Finishes / Furnishings
Living Room/ Kitchen	5m x 3m x 2.4m	1.5m x 2m	Wood/vinyl floor, curtains, sofa, table, chairs
Bedroom	3m x 2.5m x 2.4m	1.5m x 1m	Carpet & underlay, curtains, bed

Should the proposed dimensions/finishes/furnishings differ from those detailed above a re-assessment may be required.

6.5 Construction Proposals

It is understood that the external walls and roof of the dwellings will comprise the following typical constructions.

Element	Typical Construction
External Walls	Brickwork with cavity, insulation and internal plasterboard lining
Roof	Tiles with insulation in void and plasterboard ceiling

The following typical Sound Reduction Indices have been assumed for the various elements.

Element	Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
External Walls	32	40	44	45	51	56	56	56
Roof	20	28	34	40	45	49	49	49

6.6 Glazing Specifications

In order to achieve the internal daytime and night-time requirements the glazing system as a whole including glass, frame, seals and openings shall provide the following minimum sound insulation performance when tested in accordance with BS EN ISO 10140-2: 2010.

Facade	Room Type	Sound Reduction Index (dB) at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Front & Sides to Front (Rainforth Street)	Living Room/ Kitchen	21	25	22	33	40	43	44	48
	Bedroom	23	27	29	36	41	42	52	56
Rear & Sides to Rear	Living Room/ Kitchen	20	24	20	25	34	37	35	39
	Bedroom	21	25	22	33	40	43	44	48

The table below presents typical configurations and R_w sound insulation values which may be expected to achieve the sound insulation performance specified above.

Facade	Room Type	Typical R_w Sound Insulation Value (dB)	Typical Configuration
Front & Sides to Front (Rainforth Street)	Living Room/ Kitchen	35	10mm/16mm/4mm
	Bedroom	40	10mm/16mm/6.4mm
Rear & Sides to Rear	Living Room/ Kitchen	30	6mm/16mm/4mm
	Bedroom	35	10mm/16mm/4mm

Acoustic test data for the proposed glazing systems should be forwarded for review.

6.7 Ventilation Provision

6.7.1 Background Ventilation

In order to achieve the internal daytime and night-time requirements openable windows must remain closed. Background ventilation shall therefore be provided by ventilators in the building façade and shall provide the following minimum element normalised level differences in the open position when tested in accordance with BS EN ISO 10140-2: 2010.

Facade	Room Type	Element Normalised Level Difference, $D_{n,e}$ (dB) in Open Position at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Front & Sides to Front (Rainforth Street)	Living Room/ Kitchen	27	33	39	39	43	50	50	50
	Bedroom	42	48	46	49	54	65	65	65
Rear & Sides to Rear	Living Room/ Kitchen	31	34	39	34	41	31	33	35
	Bedroom	27	33	39	39	43	50	50	50

Should more than one ventilator be required per room the above element normalised level differences shall be increased by the following values:

Number of Ventilators Required Per Room	Additional Performance Required Per Ventilator (dB)
1	0
2	+3
3	+5
4	+6

The table below presents typical configurations and $D_{n,e,w}$ sound insulation values which may be expected to achieve the sound insulation performance specified above.

Facade	Room Type	Typical Open $D_{n,e,w}$ Sound Insulation Value (dB)	Typical Configuration
Front & Sides to Front (Rainforth Street)	Living Room/ Kitchen	40	Acoustic Window Ventilators (e.g. Greenwood EAR42W)
	Bedroom	50	Acoustic Wall Ventilator (e.g. Greenwood MA3051) Or Acoustically Treated Forced Mechanical Ventilation
Rear & Sides to Rear	Living Room/ Kitchen	35	Standard Window Ventilators
	Bedroom	40	Acoustic Window Ventilators (e.g. Greenwood EAR42W)

Acoustic test data for the proposed ventilators should be forwarded for review.

Should acoustically treated forced mechanical ventilation be considered to provide continuous background ventilation, this may be in the form of separate fans serving individual rooms or a larger system which provides whole house ventilation.

The system should achieve noise levels of L_{Aeq} 30dB in living rooms and bedrooms and L_{Aeq} 35dB in kitchens and bathrooms where providing continuous background ventilation.

A mechanical services engineer should be consulted to ensure that a suitable system is proposed. Detailed proposals should be forwarded for review acoustically.

6.7.2 Rapid/Summer Cooling Ventilation

In addition to background ventilation Manchester City Council require rapid/summer cooling ventilation in order to minimize the need for occupants to open windows during hot summer days.

In order to provide this, the acoustically treated forced mechanical ventilation should feature a user controllable 'boost' function which delivers increased air flow at the occupants discretion.

A mechanical services engineer should be consulted to ensure that a suitable system is proposed. Detailed proposals should be forwarded for review acoustically.

6.7.3 Purge Ventilation

Purge ventilation will be provided via openable windows at the occupants discretion. As such, the internal daytime and night-time requirements may potentially be exceeded during purge ventilation conditions. It is understood that this method of providing purge ventilation is deemed acceptable by Manchester City Council.

7.0 Building Services Sound Limits

Plant selections for the proposed residential flats have not been made at this stage of the development. As such, it is not possible to assess atmospheric building services sound to the nearest noise sensitive receptors.

Based on the requirements of Manchester City Council detailed in Section 4.3 and the lowest representative L_{A90} sound levels measured during the environmental sound survey detailed in Section 5.5.4, it is proposed that cumulative atmospheric plant sound emissions should be designed to achieve the following limits at the nearest noise sensitive receptors.

Nearest Noise Sensitive Receptor	L_{Aeq} Cumulative Atmospheric Plant Sound Emission Limits at Nearest Noise Sensitive Receptor (dB)	
	Daytime (07:00–23:00)	Night-time (23:00–07:00)
To the south of the site along Hyde Road	53	39
To the north of the site	50	38

Plant sound emissions should be assessed in accordance with BS 4142:2014.

Plant sound limits for individual plant items will be dependent on the total number of plant items, the location of plant items in relation to nearest noise sensitive receptors and the proposed operational hours.

Once detailed design proposals are developed an assessment of atmospheric plant sound emissions from the proposed plant items to the nearest noise sensitive receptors should be undertaken. This will determine whether any attenuation measures are required in order to achieve the proposed limits.

8.0 Conclusions

The Local Authority's acoustic requirements for the proposed development have been established.

A detailed environmental sound survey has been undertaken in order to establish existing environmental sound levels at the proposed development.

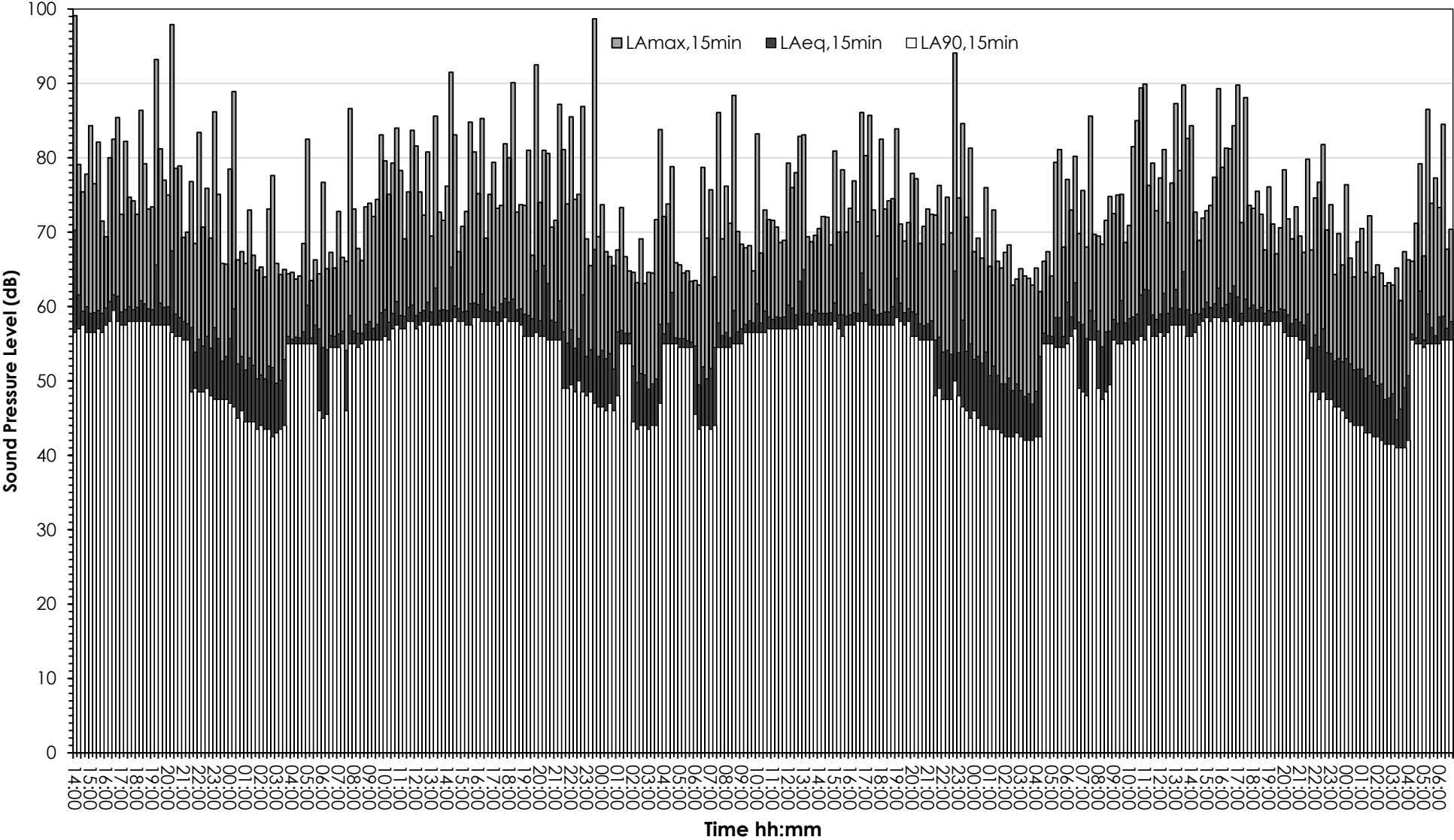
A detailed environmental sound assessment of the proposed residential development has been undertaken and acoustic specifications for glazing/ventilation elements have been provided in order to achieve the requirements of the Local Authority.

Atmospheric plant sound emission limits have been proposed at the nearest noise sensitive receptors for subsequent use in designing building services proposals in order to comply with the requirements of the Local Authority.

A handwritten signature in black ink, appearing to read 'Robin Wood', with a stylized flourish underneath.

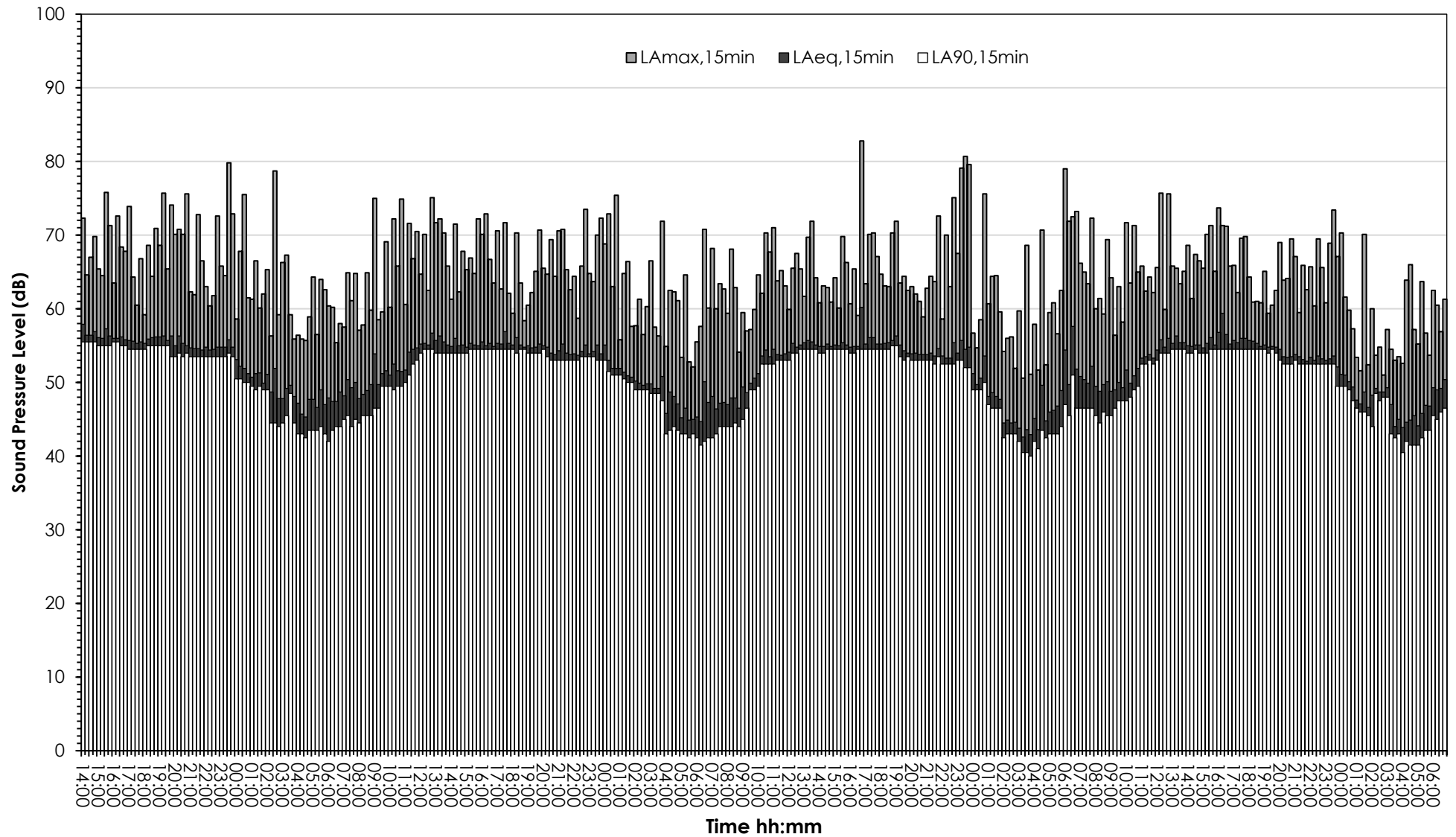
Robin Wood
LIGHTHOUSE ACOUSTICS

7 Rainforth Street, Manchester
Time History Graph - Friday 2 August 2019 to Tuesday 6 August 2019
L_{Amax,15min}, L_{Aeq,15min} & L_{A90,15min} Noise Levels at Position A



0586THG2

7 Rainforth Street, Manchester
Time History Graph - Friday 2 August 2019 to Tuesday 6 August 2019
 $L_{Amax,15min}$, $L_{Aeq,15min}$ & $L_{A90,15min}$ Noise Levels at Position B



Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	3
S _{ew}	Wall Area S _r - S _{wi}	4.2
S _{tr}	Ceiling Area	2
S	Total Area S _f + S _{tr}	9.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	7 Rainforth Street, Manchester
Façade:	Front & Sides to Front (Rainforth Street)
Room:	Livingroom/Kitchen
Zone:	-

$$L_{p,in} = L_{p,out(ff)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	Free Field External Daytime L _{eq,16hour}	66	63	60	56	55	51	49	42	60
D _{n,e}	Greenwood EAR 42W	27	33	39	39	43	50	50	50	
R _{wi}	10/12/4	21	25	22	33	40	43	44	48	
R _{ew}	Brick, cavity, insulation & plasteboard	32	40	44	45	51	56	56	56	
R _{tr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	7	7	6	3	3	2	3	3	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	From Table Above	From Table Above								
D _{n,e}		27	33	39	39	43	50	50	50	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00217	0.00054	0.00014	0.00014	0.00005	0.00001	0.00001	0.00001	
R _{wi}		21	25	22	33	40	43	44	48	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00259	0.00103	0.00206	0.00016	0.00003	0.00002	0.00001	0.00001	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00029	0.00005	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	
R _{tr}		20	28	34	40	45	49	49	49	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00217	0.00034	0.00009	0.00002	0.00001	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-21	-27	-26	-35	-40	-45	-46	-47	
A (furnished)		7	7	6	3	3	2	3	3	
10 log S / A	G	1	1	2	4	5	6	5	5	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	49	40	39	28	23	15	11	3	33

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	1.5
S _{ew}	Wall Area S _f - S _{wi}	5.7
S _{rr}	Ceiling Area	2
S	Total Area S _f + S _{rr}	9.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	7 Rainforth Street, Manchester
Façade:	Front & Sides to Front (Rainforth Street)
Room:	Bedroom
Zone:	-

$$L_{p,in} = L_{p,out(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	Free Field External Daytime L _{eq,16hour}	66	63	60	56	55	51	49	42	60
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	59	59	57	52	53	50	42	35	57
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	81	74	64	64	96	96	81	69	99
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	81	79	75	69	81	86	82	72	89
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	79	71	68	71	80	82	80	73	87
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	80	76	67	70	79	82	79	74	86
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	76	76	70	68	84	74	72	68	85
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	85	96	88	81	73	74	70	64	85
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	71	70	64	70	83	75	74	66	84
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	78	74	79	76	78	79	75	67	83
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	75	70	65	57	81	73	58	48	81
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	80	84	73	71	81	69	66	57	81
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	77	69	75	74	77	75	65	58	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	69	68	64	61	79	63	55	53	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	86	83	83	79	79	73	68	63	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	83	78	81	81	72	69	68	65	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	72	65	62	60	77	72	56	45	79
D _{n,e}	Greenwood MA3051	42	48	46	49	54	65	65	65	
R _{wi}	10/12/6.4	23	27	29	36	41	42	52	56	
R _{ew}	Brick, cavity, insulation & plasteboard	32	40	44	45	51	56	56	56	
R _{rr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	5	5	4	4	4	4	5	5	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	From Table Above	From Table Above								
D _{n,e}		42	48	46	49	54	65	65	65	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00007	0.00002	0.00003	0.00001	0.00000	0.00000	0.00000	0.00000	
R _{wi}		23	27	29	36	41	42	52	56	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00082	0.00033	0.00021	0.00004	0.00001	0.00001	0.00000	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00039	0.00006	0.00002	0.00002	0.00000	0.00000	0.00000	0.00000	
R _{rr}		20	28	34	40	45	49	49	49	
$\frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}}$	E	0.00217	0.00034	0.00009	0.00002	0.00001	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-25	-31	-35	-40	-45	-48	-52	-53	
A (furnished)		5	5	4	4	4	4	5	5	
10 log S / A	G	3	3	4	4	4	4	3	3	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	47	38	32	23	17	10	2	-5	28
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	40	34	29	19	15	9	-5	-12	24
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	62	49	36	31	58	55	34	22	60
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	62	54	47	36	43	45	35	25	49
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	60	46	40	38	42	41	33	26	46
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	61	51	39	37	41	41	32	27	46
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	57	51	42	35	46	33	25	21	47
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	66	71	60	48	35	33	23	17	57
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	52	45	36	37	45	34	27	19	46
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	59	49	51	43	40	38	28	20	47
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	56	45	37	24	43	32	11	1	44
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	61	59	45	38	43	28	19	10	47
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	58	44	47	41	39	34	18	11	44
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	50	43	36	28	41	22	8	6	41
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	67	58	55	46	41	32	21	16	50
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	64	53	53	48	34	28	21	18	48
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	53	40	34	27	39	31	9	-2	40

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	3
S _{ew}	Wall Area S _r - S _{wi}	4.2
S _{tr}	Ceiling Area	2
S	Total Area S _f + S _{tr}	9.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	7 Rainforth Street, Manchester
Faade:	Rear & Sides to Rear
Room:	Livingroom/Kitchen
Zone:	-

$$L_{p,in} = L_{p,out(ff)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	Free Field External Daytime L _{eq,16hour}	61	62	57	51	49	44	38	31	54
D _{n,e}	Standard Trickle Ventilator	31	34	39	34	41	31	33	35	
R _{wi}	6/16/4	20	24	20	25	34	37	35	39	
R _{ew}	Brick, cavity, insulation & plasterboard	32	40	44	45	51	56	56	56	
R _{tr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	7	7	6	3	3	2	3	3	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(ff)}	From Table Above	From Table Above								
D _{n,e}		31	34	39	34	41	31	33	35	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00086	0.00043	0.00014	0.00043	0.00009	0.00086	0.00054	0.00034	
R _{wi}		20	24	20	25	34	37	35	39	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00326	0.00130	0.00326	0.00103	0.00013	0.00007	0.00010	0.00004	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00029	0.00005	0.00002	0.00001	0.00000	0.00000	0.00000	0.00000	
R _{tr}		20	28	34	40	45	49	49	49	
$\frac{S_{tr}}{S} 10^{-\frac{R_{tr}}{10}}$	E	0.00217	0.00034	0.00009	0.00002	0.00001	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-22	-27	-25	-28	-36	-30	-32	-34	
A (furnished)		7	7	6	3	3	2	3	3	
10 log S / A	G	1	1	2	4	5	6	5	5	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	43	39	38	30	21	22	14	5	33

Term	Derivation	Value (m ²)
S _f	Facde Area (including window) S _{wi} + S _{ew}	7.2
S _r	Roof Area (exposed side)	2
S _{wi}	Window Area	1.5
S _{ew}	Wall Area S _f - S _{wi}	5.7
S _{rr}	Ceiling Area	2
S	Total Area S _f + S _{rr}	9.2
A ₀	Ref. Absorption Area Given in BS EN ISO 10140-2	10
K	Correction Factor	3

BS 8233:2014 More Rigorous Calculation Method

Project:	7 Rainforth Street, Manchester
Façade:	Rear & Sides to Rear
Room:	Bedroom
Zone:	-

$$L_{p,in} = L_{p,out(f)} + 10 \log_{10} \left(\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}} + \frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}} + \frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}} + \frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}} \right) + 10 \log_{10} \left(\frac{S}{A} \right) + 3$$

Term	Description	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	Free Field External Daytime L _{eq,16hour}	61	62	57	51	49	44	38	31	54
L _{p,out(f)}	Free Field External Night-time L _{eq,8hour}	57	57	54	46	46	42	35	29	51
L _{p,out(f)}	Free Field External Night-time L _{max} No.1	73	69	63	58	72	79	62	54	81
L _{p,out(f)}	Free Field External Night-time L _{max} No.2	81	75	75	75	77	73	64	56	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.3	67	69	62	57	74	78	55	42	80
L _{p,out(f)}	Free Field External Night-time L _{max} No.4	72	71	64	66	74	76	62	47	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.5	69	72	69	73	74	75	65	63	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.6	66	66	57	53	71	77	51	35	79
L _{p,out(f)}	Free Field External Night-time L _{max} No.7	70	63	59	53	71	74	48	36	76
L _{p,out(f)}	Free Field External Night-time L _{max} No.8	75	70	71	69	71	69	65	63	76
L _{p,out(f)}	Free Field External Night-time L _{max} No.9	73	67	68	75	69	68	59	51	75
L _{p,out(f)}	Free Field External Night-time L _{max} No.10	74	71	76	73	67	64	59	55	73
L _{p,out(f)}	Free Field External Night-time L _{max} No.11	71	72	67	70	72	63	57	48	73
L _{p,out(f)}	Free Field External Night-time L _{max} No.12	71	71	72	74	66	64	59	50	73
L _{p,out(f)}	Free Field External Night-time L _{max} No.13	71	69	68	66	69	66	63	59	73
L _{p,out(f)}	Free Field External Night-time L _{max} No.14	70	67	73	73	70	66	59	53	73
L _{p,out(f)}	Free Field External Night-time L _{max} No.15	73	73	72	70	67	65	57	49	72
D _{n,e}	Greenwood EAR 42W	27	33	39	39	43	50	50	50	
R _{wi}	10/12/4	21	25	22	33	40	43	44	48	
R _{ew}	Brick, cavity, insulation & plasterboard	32	40	44	45	51	56	56	56	
R _{rr}	Tiled with insulation in loft and plasterboard ceiling	20	28	34	40	45	49	49	49	
A	Equivalent Absorption Area of Room (Calculated)	5	5	4	4	4	4	5	5	

Term From Equation	Reference Letter of Result	Octave Band Centre Frequency (Hz)								A-weighted Level
		63	125	250	500	1k	2k	4k	8k	
L _{p,out(f)}	From Table Above	From Table Above								
D _{n,e}		27	33	39	39	43	50	50	50	
$\frac{A_0}{S} 10^{-\frac{D_{n,e}}{10}}$	B	0.00217	0.00054	0.00014	0.00014	0.00005	0.00001	0.00001	0.00001	
R _{wi}		21	25	22	33	40	43	44	48	
$\frac{S_{wi}}{S} 10^{-\frac{R_{wi}}{10}}$	C	0.00130	0.00052	0.00103	0.00008	0.00002	0.00001	0.00001	0.00000	
R _{ew}		32	40	44	45	51	56	56	56	
$\frac{S_{ew}}{S} 10^{-\frac{R_{ew}}{10}}$	D	0.00039	0.00006	0.00002	0.00002	0.00000	0.00000	0.00000	0.00000	
R _{rr}		20	28	34	40	45	49	49	49	
$\frac{S_{rr}}{S} 10^{-\frac{R_{rr}}{10}}$	E	0.00217	0.00034	0.00009	0.00002	0.00001	0.00000	0.00000	0.00000	
10log(B + C + D + E)	F	-22	-28	-29	-36	-41	-46	-47	-48	
A (furnished)		5	5	4	4	4	4	5	5	
10 log S / A	G	3	3	4	4	4	4	3	3	
L _{p,in}	Free Field External Daytime L _{eq,16hour} + F + G + 3	45	40	35	22	15	5	-3	-11	29
L _{p,in}	Free Field External Night-time L _{eq,8hour} + F + G + 3	41	35	32	17	12	3	-6	-13	25
L _{p,in}	Free Field External Night-time L _{max} No.1 + F + G + 3	57	47	41	29	38	40	21	12	43
L _{p,in}	Free Field External Night-time L _{max} No.2 + F + G + 3	65	53	53	46	43	34	23	14	49
L _{p,in}	Free Field External Night-time L _{max} No.3 + F + G + 3	51	47	40	28	40	39	14	0	43
L _{p,in}	Free Field External Night-time L _{max} No.4 + F + G + 3	56	49	42	37	40	37	21	5	44
L _{p,in}	Free Field External Night-time L _{max} No.5 + F + G + 3	53	50	47	44	40	36	24	21	46
L _{p,in}	Free Field External Night-time L _{max} No.6 + F + G + 3	50	44	35	24	37	38	10	-7	41
L _{p,in}	Free Field External Night-time L _{max} No.7 + F + G + 3	54	41	37	24	37	35	7	-6	40
L _{p,in}	Free Field External Night-time L _{max} No.8 + F + G + 3	59	48	49	40	37	30	24	21	44
L _{p,in}	Free Field External Night-time L _{max} No.9 + F + G + 3	57	45	46	46	35	29	18	9	45
L _{p,in}	Free Field External Night-time L _{max} No.10 + F + G + 3	58	49	54	44	33	25	18	13	47
L _{p,in}	Free Field External Night-time L _{max} No.11 + F + G + 3	55	50	45	41	38	24	16	6	43
L _{p,in}	Free Field External Night-time L _{max} No.12 + F + G + 3	55	49	50	45	32	25	18	8	45
L _{p,in}	Free Field External Night-time L _{max} No.13 + F + G + 3	55	47	46	37	35	27	22	17	41
L _{p,in}	Free Field External Night-time L _{max} No.14 + F + G + 3	54	45	51	44	36	27	18	11	45
L _{p,in}	Free Field External Night-time L _{max} No.15 + F + G + 3	57	51	50	41	33	26	16	7	44