

St Michaels (Ph.3 Bl.A) Manchester

Noise Insulation Scheme Report:
Planning Condition 8

Client:

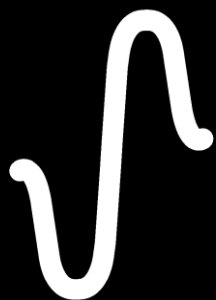
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**JAMESON
ACOUSTICS**

Consultants in acoustics,
noise and vibration

Document Control

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0	13-11-2023	AJ	-
1	18-11-2024	AJ	Update to include Albert Hall noise, MVHR penetration treatment & subsequent façade specifications & zoning

This report has been prepared with all reasonable skill, care and diligence for the sole benefit, use and information of the aforementioned Client in accordance with the purposes and terms agreed between ourselves and the Client. The liability of Jameson Acoustics Limited in respect of the information contained within this report will not extend to any third party.

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1.0 Introduction

Jameson Acoustics Limited has been commissioned to provide a noise insulation scheme for the residential elements of the St Michael's development in Manchester. This report presents the proposed noise insulation scheme to achieve the requirements of Planning Condition 8, which states:

8. No above ground construction of the tower podium (Phase 3 as defined by condition 51) shall take place unless and until a scheme for acoustically insulating the proposed residential accommodation against noise from the local area, including nearby road network, venues and other sources of noise, has been submitted to and approved in writing by the City Council as local planning authority. There may be other actual or potential sources of noise which require consideration on or near the site, including any local commercial/industrial premises. The approved noise insulation scheme shall be completed before any of the dwelling units are occupied.

Noise survey data must include measurements taken during a rush-hour period and night time to determine the appropriate sound insulation measures necessary. The internal noise criterion are as follows:

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

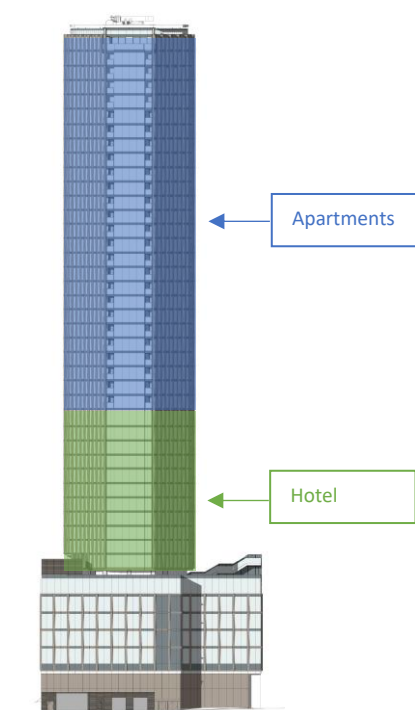
Additionally, where entertainment noise is a factor, in the noise climate, the sound insulation scheme shall be designed to achieve internal noise levels in the 63Hz and 125 Hz octave centre frequency bands so as not to exceed (in habitable rooms) 47dB and 41dB, respectively.

Reason: To secure a reduction in noise from traffic or other sources in order to protect future residents from noise disturbance, pursuant to Core Strategy policies DM1 and SP1

For a description of the acoustic terminology used herein, please see Appendix A.

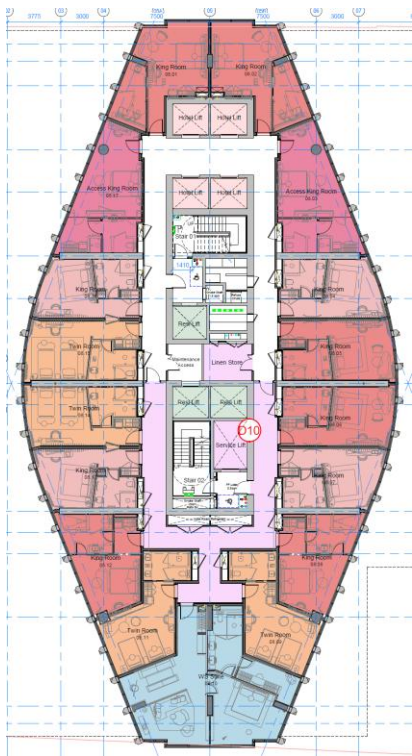
2.0 Scheme Overview

The residential accommodation is located within the Phase 3 Block A tower in the form of hotel rooms from level 7 to level 17 and apartments from level 18 to level 43(M), as illustrated below.

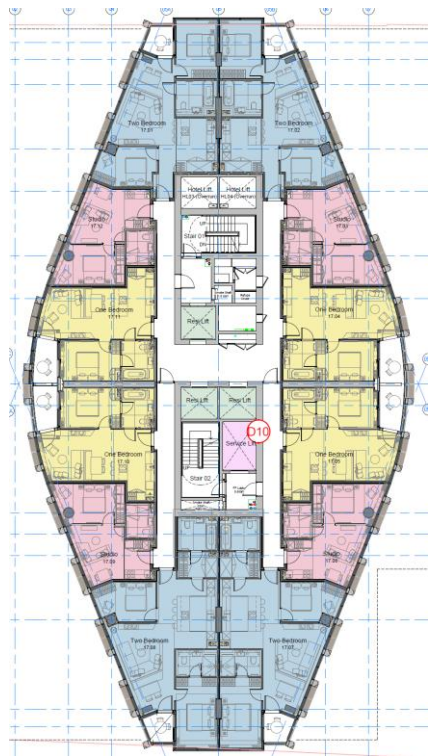


South elevation illustrating hotel/residential floors of the tower

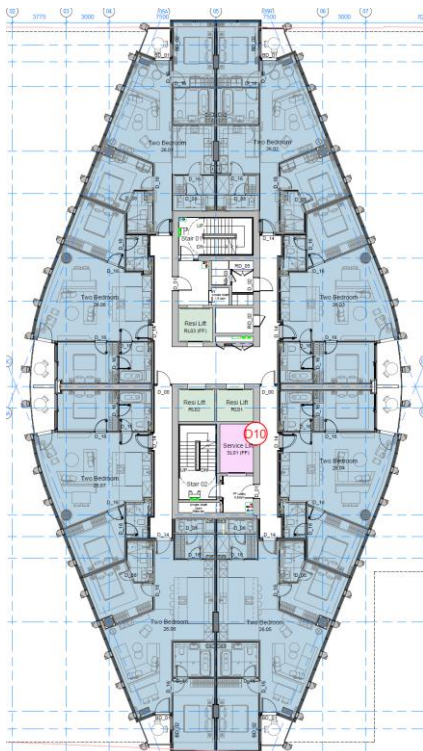
Hotel rooms will comprise a mix of twin-rooms, king rooms and suites. Apartments will comprise a mix of studios, one-beds, two-beds, three-beds and penthouses. The following Figures show a typical hotel floor layout and a typical low-level, mid-level, upper-level and penthouse level apartment floor layouts.



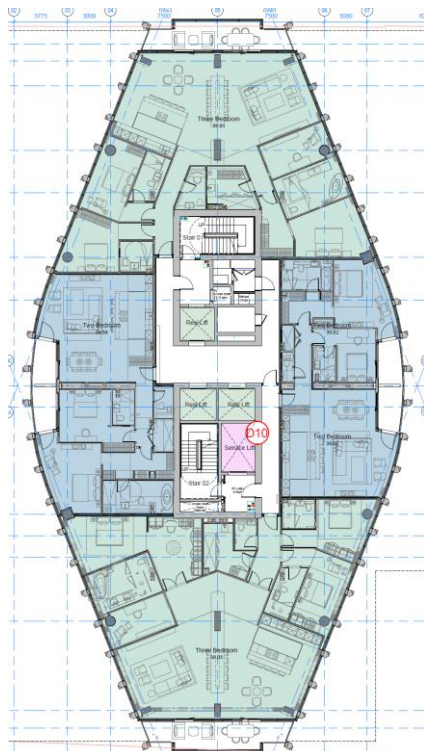
Typical hotel floor layout



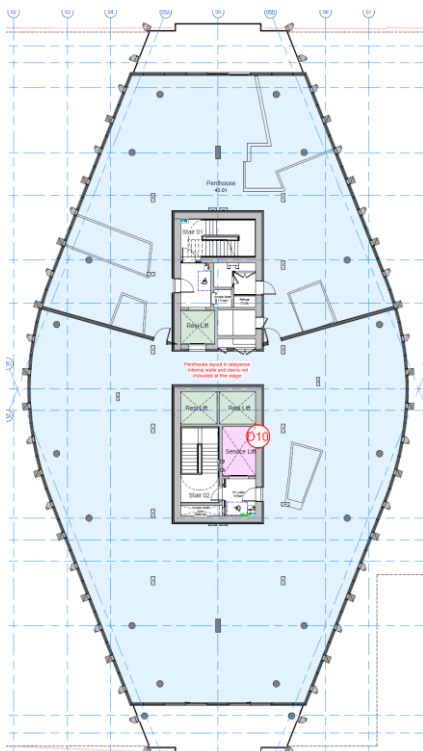
Typical low-level residences floor layout



Typical mid-level residences floor layout



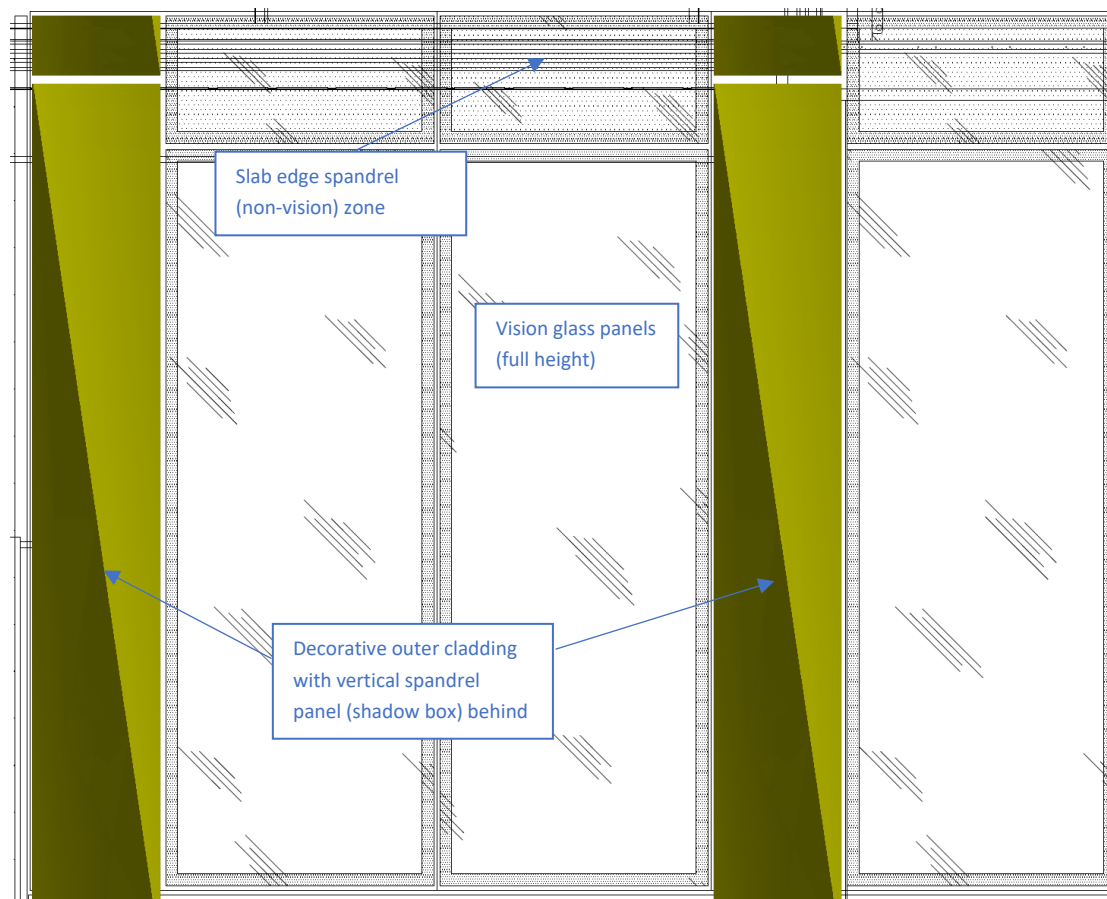
Typical upper-level residences floor layout



Penthouse residences floor layout

3.0 Façade Design

The tower facades will be formed from a unitised curtain walling system supplied by FK Group. The system will comprise aluminium frames with double glazing with spandrel (non-vision) panels to slab edges, vertical shadow boxes and vertical spandrels at party wall interfaces. The general arrangement (repeated across the tower) is shown below.



Sample elevation of unitised curtain walling

All elements of the system shall be design and specified by FK Group to achieve the sound reduction performance requirements, as specified by Jameson Acoustics, detailed below. A sample of the façade shall be taken to an accredited acoustic test laboratory to demonstrate the sound reduction performance achieves the following specification prior to installation on-site.

4.0 Façade Sound Reduction Performance Specification

The following sound reduction performance specification considers all incident environmental and entertainment noise sources. For entertainment noise sources, this specification includes event noise breakout from the nearby Albert Hall venue. In accordance with the Hoare Lea acoustic reports prepared for both the Albert Hall venue's planning application and façade mitigation report for the St

Michael’s development, compliance with their planning and licensing noise requirements (which apply at the Radisson Hotel and Great Northern Tower) would result in the following worst-case incident noise levels onto the St Michael’s tower:

- 74 dB $L_{eq,5min}$ at 63 Hz
- 69 dB $L_{eq,5min}$ at 125 Hz

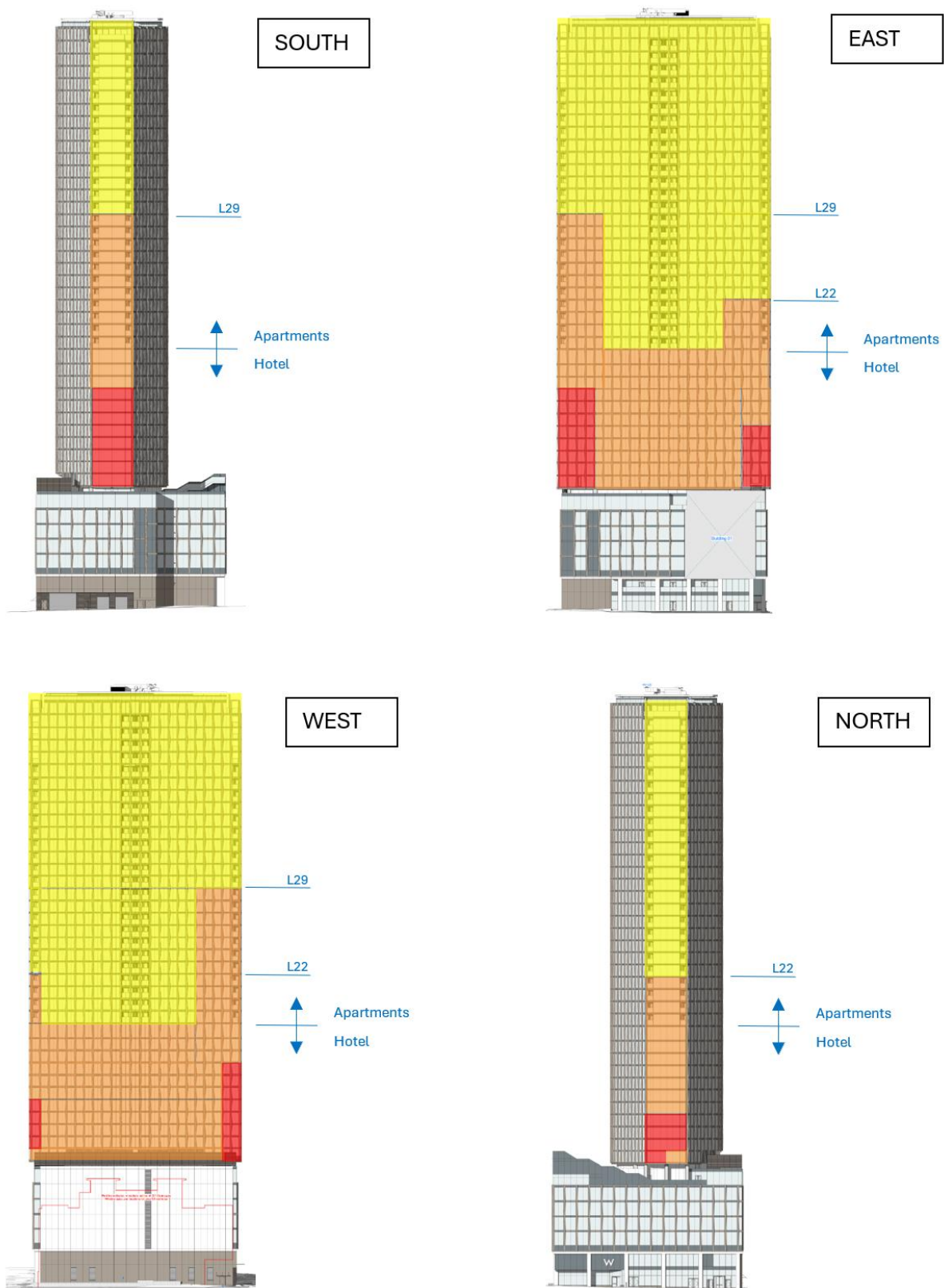
Our noise model has been calibrated based on the above levels from Albert Hall and other environmental and entertainment noise sources from various baseline noise surveys as detailed herein.

The complete curtain walling systems to hotel/residential areas shall be capable of achieving the following minimum sound reduction performance specification. This performance shall be achieved by the **complete** framed system when tested in accordance with BS EN ISO 10140-2 and rated to BS 717-1.

Zone (ref. Figures below)	Minimum Sound Reduction, R (dB) at OBCF (Hz)							Weighted $R_w + C_{tr}$ (dB)
	63	125	250	500	1k	2k	4k	
Red	31	31	34	42	44	46	46	40
Orange	28	28	34	41	44	46	46	38
Yellow	25	26	30	38	41	43	43	35

It shall be the responsibility of the cladding system supplier to ensure that the **full octave band** performance figures are achieved by complete cladding system chosen for this project, and that their associated installation methods are appropriate to achieve this. The complete framed system shall include the glass, frame, seals, spandrel panels, gaskets, opening panes/doors, etc. not just the glass.

Where structural glass or non-vision spandrel panels (including spandrel vent doors) are proposed, they should provide sound reduction performance at least equal to that required of the cladding in order to maintain the acoustic integrity of the building envelope. Internal lining systems can be factored in, subject to agreement with the Main Contractor.

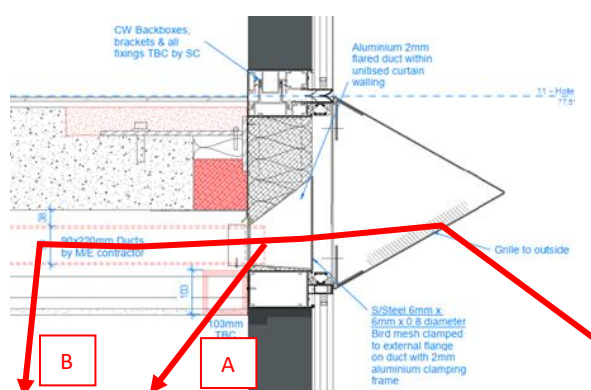


Façade Acoustic Performance Zones

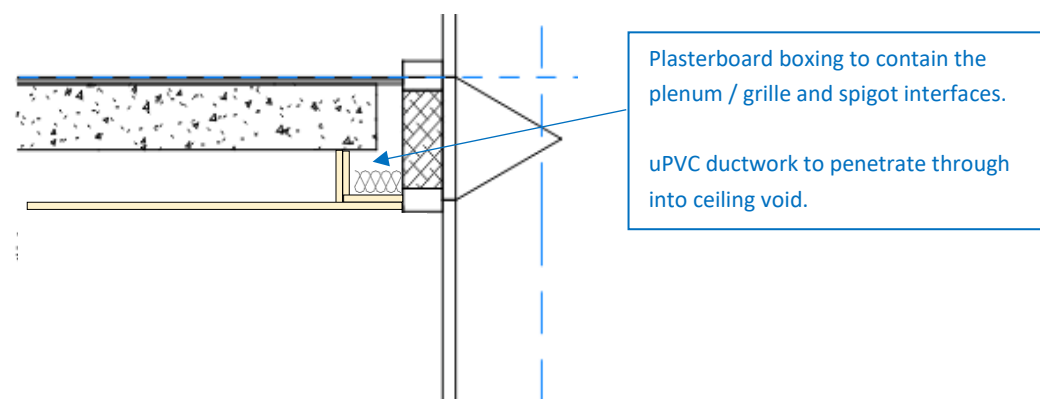
5.0 MVHR Ductwork Sound Flanking Control

MVHR Ventilation Grilles (Noise Ingress Path)

Openings in the façade will be required to provide air intake and outlet to serve each hotel guestroom and apartment MVHR unit. At the façade, a steel plenum box and grille will be inserted into the shadow box spandrel panel, with a spigot to connect ductwork that will pass directly through the ceiling void to the MVHR unit. The risk of noise intrusion through the grille and breaking out through the ceiling void ductwork and again through the plasterboard ceiling, as illustrated below, has been assessed.



For Path A, the steel plenum will be captured within the spandrel and is expected to maintain the acoustic integrity of the spandrel panel section, as the majority of acoustic protection for the spandrel will be provided by the back (roomside) panel. This will be subject to final review of FK Group's acoustic assessment evidence. If the panel cannot maintain façade integrity, provisions exist to introduce plasterboard boxing to the window head detail comprising 2 layers of 15 mm dense plasterboard and mineral wool in-fill, as illustrated below.

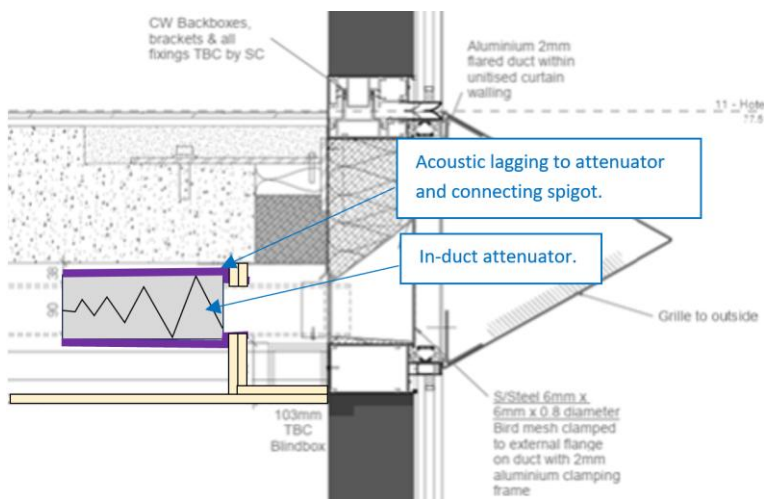


For Path B (ductwork noise breakout), the aim shall be to ensure the noise contribution to the room is non-contributory. To achieve this, external noise break-in through the ductwork shall be controlled to a level that does not degrade the sound reduction performance offered by the facade in any octave band (i.e. the flanking path would have a negligible < 0.5 dB effect, allowing it to be disregarded in the calculation process).

Calculation sheets for outside to inside sound reduction offered by an unattenuated ventilation opening indicates this criterion is likely to be exceeded in the habitable rooms in the **red** acoustic façade zones, but should be achieved within the **orange** and **yellow** zones.

Calculation sheets to demonstrate this are provided in Appendix C. Note, the “outside to inside” sound level difference achieve by the unattenuated and attenuated ventilation paths have been calculated in accordance with SRL and ASHRAE methods, as presented below.

In the **red** zone only, additional façade acoustic attenuation will be required and an acoustically lagged in-duct attenuator has been specified to each duct façade termination, as illustrated below.



Red Zone – MVHR façade interface acoustic treatment

The in-duct attenuation shall be specified to achieve the following minimum insertion loss values.

Red Zone Façade Attenuator Minimum Insertion Loss (dB) at Octave Band Centre Frequency (Hz)						
63	125	250	500	1k	2k	4k
4	5	8	10	10	10	10

It is envisaged that an attenuator of min. 500 mm length will be required to achieve the above performance.

The full length of the attenuator (including the spigot connection off the spandrel/plenum) should be acoustically lagged. The lagging should comprise 25 mm mineral wool over-wrapped with a sound matting material providing a minimum mass per unit area of 5 kg/m² (e.g. Muftilag SP 5).

5.0 Façade Performance Assessment

5.1 Baseline Noise Surveys

Incident environmental (and entertainment) noise levels have been determined through 3D acoustic noise modelling and baseline noise surveys undertaken by Jameson Acoustics and others, as summarised below.

Noise Source	Surveyed/Assessed by	Summary
Environmental	Jameson Acoustics (JA) & Hoare Lea (HL)	JA: Automated continuous noise survey taken between Fri 1 Sep – Thu 7 Sep 2023. HL: Automated continuous noise survey taken between Fri 1 Mar – Fri 8 Mar 2019.
Entertainment (excl Albert Hall)	Jameson Acoustics (JA), Hann Tucker Associates (HTA) & Hoare Lea (HL)	JA: Manned street level noise measurements taken on night of Fri 26 May 2023. HTA: Manned street level noise measurements taken on night of Thu 22 Aug 2022. HL: Assessment to set limits for amplified sound associated with Phase 1 Sky Bar at Level 10 & survey readings of The Venue nightclub between 1 Mar – 8 Mar 2019.
Entertainment (Albert Hall)	Hoare Lea	HL: Report confirming operational noise limits applicable to the venue & worst-case incident noise levels onto tower.

Full details of the above are presented in Appendix B.

5.2 Albert Hall Client Liaison & Approach to Noise Control

The façade acoustic performance specification includes event noise breakout from the nearby Albert Hall first floor venue on the basis that this venue controls their event noise egress in compliance with their planning and licensing noise requirements. In accordance with the Hoare Lea acoustic reports prepared for both the Albert Hall venue's planning application and façade mitigation report for the St Michael's development, compliance with their planning and licensing noise requirements (which apply at the Radisson Hotel and Great Northern Tower) would result in the following worst-case incident noise levels onto the St Michael's tower:

- 74 dB $L_{eq,5min}$ at 63 Hz
- 69 dB $L_{eq,5min}$ at 125 Hz

A meeting has recently been held between the Developer, Relentless, and the Albert Hall to discuss this matter. It was confirmed to Domis Construction that the Albert Hall agreed with their obligations to adhere to their planning noise limits.

Survey data by Hoare Lea in 2019, as discussed in Appendix B, indicates that with the exception of one event (which the venue does not operate any more), noise output from the north side of the venue

was found to be commensurate with the equivalent planning noise limits presented above when extrapolated to the St Michaels tower facade.

In order to further validate the use of the above Albert Hall incident noise levels onto the St Michael’s tower, the Client intends to instruct independent noise monitoring of the venue over a full calendar month. This will capture continuous noise levels at the site boundary (at high level overlooking the venue’s roof) across the full monthly schedule of events at the Albert Hall.

The results of the survey shall be inputted into the noise model to determine equivalent incident event noise levels onto the tower. Should any of the events exceed the above ‘planning agreed’ noise levels used to inform the façade specification, Albert Hall will be informed by means of follow up meetings to seek resolution and further noise monitoring may be performed until the venue is found to be consistently operating within their planning noise limits.

5.3 Assessments

5.3.1 Environmental Noise

Criteria

Noise from environmental (e.g. traffic) sources shall be controlled to achieve the following internal noise levels in combination with the noise produced by internal mechanical ventilation/cooling systems.

Sector	Room	Internal Noise Level (Upper Limit)	
		Daytime (07:00-23:00)	Night-time (23:00-07:00)
Hotel	Guestrooms	35 dB LAeq	30 dB LAeq 45 dB LAmax*
Residential	Living Rooms	35 dB LAeq	-
	Bedrooms	-	30 dB LAeq 45 dB LAmax*

* scheduled/known individual noise events (exceeded not more than 10-15 times per night)

Incident Noise Levels (Onto Worst-Case Residential Façade)

Based on the survey data, the following table summarises the daytime and night-time environmental noise levels incident on the worst-case residential facades (Level 7) on the north and south facing building elevations (worst-case elevations).

Elevation	Daytime (0700-2300), dB LAeq,16hr	Night-time (2300-0700), dB LAeq,8hr	Night-Time (2300-0700) Maximum Noise Level, dB LAFmax
North	63	60	78
South	63	60	75

The following table presents the corresponding worst-case daytime 16-hr and night-time 8-hr L_{eq} spectral data (Position A) for the assessment.

Period	L _{eq} Sound Level, dB (dB) at Octave Band Centre Frequency (Hz)							A-weighted broadband L _{Aeq} (dB)
	63	125	250	500	1k	2k	4k	
Daytime	65	63	61	58	58	55	51	63
Night-time	62	61	57	56	56	53	49	60

Demonstrating Compliance

Our calculations are based on the BS 8233 external noise intrusion assessment method, as per the following equation:

$$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{ne}}{10}} + \frac{S_w}{S} 10^{\frac{-R_w}{10}} + \frac{S_g}{S} 10^{\frac{-R_g}{10}} + \frac{S_r}{S} 10^{\frac{-R_r}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{A} \right) + 3$$

Calculation sheets to demonstrate compliance with internal noise levels are presented in Appendix D. These sheets present calculations into worst-case hotel guestrooms on the north/south gable end façades at Level 12.

The results indicate the following internal noise levels within a typical L12 hotel room (with orange façade, unattenuated MVHR duct route). This is considered a worst-case scenario relative to façade performance and distance from principal road noise sources.

Desc.	Daytime (0700-2300), dB L _{Aeq,16hr}	Night-time (2300-0700), dB L _{Aeq,8hr}	Night-Time (2300-0700) Maximum Noise Level, dB L _{AFmax}
Calculated internal noise level in worst-case hotel room	25	22	39
Design Criterion	35	30	45
Compliance?	✓	✓	✓

The resultant levels are significantly lower than the design criteria, owing to the fact that entertainment noise sources are dominate and are driving the façade performance specifications (see following Section).

Variations in room sizes and façade areas may cause minor fluctuations in calculation internal noise level (circa +/-1 dB), but any unfavourable variances would be countered by the reduction in incident traffic noise levels as you move up the building.

The above (and attached) evidence is therefore deemed sufficient to demonstrate the façade will provide sufficient protection of ‘environmental’ noise intrusion to achieve the requirements of Planning Condition 8.

Overheating Assessment

Note all residential accommodation (hotel and apartments) will be air conditioned. There will be no reliance on openable windows.

5.3.2 Entertainment Noise

Criteria

In accordance with Planning Condition 8, where existing entertainment noise is a factor, the sound insulation scheme shall be designed to achieve the following low frequency internal noise limits.

Sector	Location	Internal Noise Level from Entertainment Sources, L _{eq,5min} at Octave Band Centre Frequency	
		63 Hz	63 Hz
Hotel/Residential	Guestrooms/Habitable Rooms	47 dB	41 dB

At mid-high sound frequencies, entertainment noise intrusion shall be designed to achieve at least 25 dB L_{Aeq,5min} in rooms (spectrum based approximately on NR 20 L_{eq,5min}). This is in addition to the Manchester City Council requirements to ensure noises from pub/club patrons on the street (e.g. shouting) are controlled to a level at least 5 dB below the anticipated prevailing background noise level in hotel guestrooms and apartments. All values are expressed as a room spatial average.

Assessment Clarifications

1. The key existing (off-site) entertainment noise sources considered are:
 - Albert Hall (first floor) event space.
 - The Venue, nightclub (patrons & music breakout).
 - Sir Ralph Abercrombie public house.
 - Albert Hall rear smoking terrace (including door opening to venue circulation).
 - Albert’s Schloss rear smoking terrace (including door opening to bar).
 - Peter’s Street bar frontages (patrons & music breakout) – Albert’s Schloss, Peaky Blinders, Revolution De Cuba & Impossible.
 - Deansgate Manahatta bar frontage (patrons & music breakout).
 - Revolution De Cuba rear windows (music breakout).
 - 42s nightclub (queuing patrons & music breakout).
2. Social noise from people (talking/shouting) at street level has been considered where those people are confined to a known venue, such as a designated smoking area, bar front seating or queuing for a venue, general frontages/streets around bars entrances, but not when generally walking through the streets. Similarly, amplified music noise coming from passing cars has not been considered. This would be regarded as anti-social behaviour which should not form the basis for this technical assessment.

3. All measurements of specific entertainment noise sources listed above were taken when the source was considered ‘active’, e.g. for smoking terraces, the terraces were representative ‘full’ with people talking loudly and doors to the venue open with audible music noise breakout through the door opening. NB: for the Alberts Schloss terrace, a live band was playing inside the bar for part of the survey, with amplified (DJ) music playing for the remainder.
4. Our assessment considers all ‘active’ entertainment sources operating concurrently (cumulative assessment).
5. Our assessment includes amplified sound from the proposed Phase 1 Sky Bar (Level 10) terrace loudspeakers and internal loudspeakers (noise breakout) based on the Hoare Lea Phase 1 Planning Condition 32 and 35 Report.
6. Our calculations are based on the BS 8233 external noise intrusion assessment method, as per the following equation:

$$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_0}{S} 10^{\frac{-D_{ne}}{10}} + \frac{S_w}{S} 10^{\frac{-R_w}{10}} + \frac{S_g}{S} 10^{\frac{-R_g}{10}} + \frac{S_r}{S} 10^{\frac{-R_r}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{A} \right) + 3$$

7. To simplify the calculations, a transfer function for each ‘type’ of internal habitable room has been determined, accounting for variations in façade surface area, room dimensions, reverberation time (0.5 seconds in habitable rooms), and ventilation openings for MVHR ductwork (negligible contribution). Façade specifications have been determined for each apartment/guestroom on each façade/floor of the building by subtracting the internal noise level from the external incident noise level at any given location, and then adding on the transfer function.

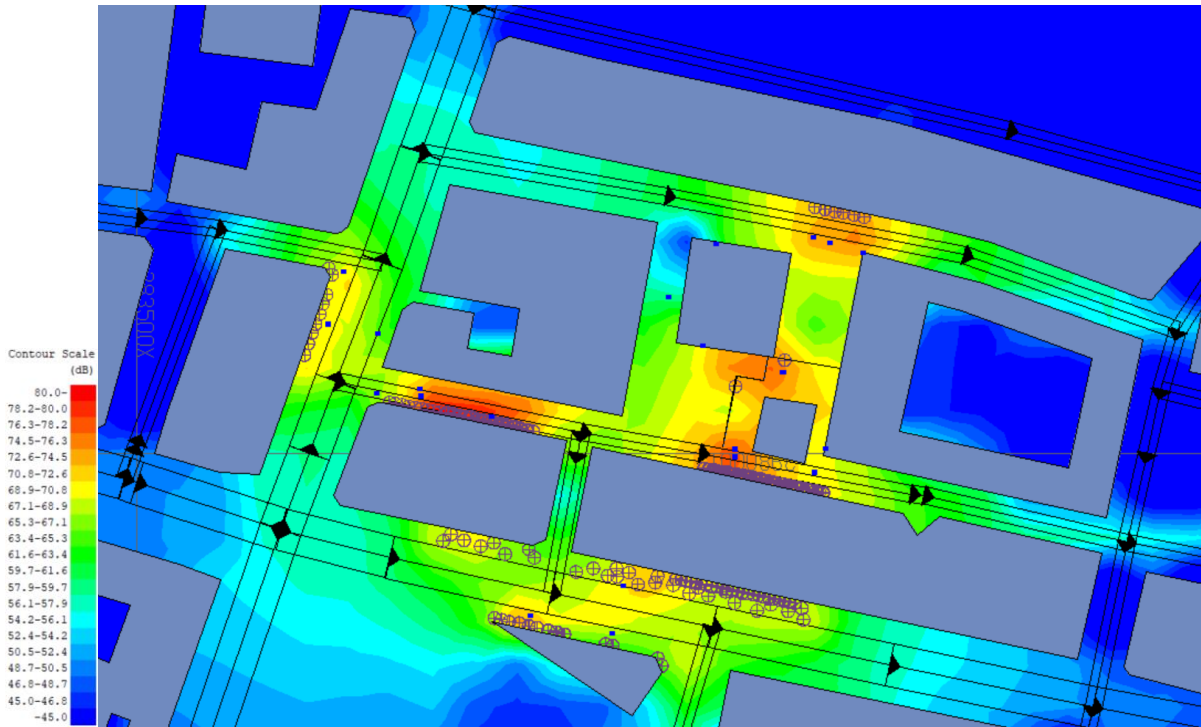
Sector	Room Type	Transfer Function, K (dB) at OBCF (Hz)						
		63	125	250	500	1k	2k	4k
Hotel	Twin	1	1	1	1	1	1	1
	King	0	0	0	0	0	0	0
	King (corner)	2	2	2	2	2	2	2
	WS Suite	2	2	2	2	2	2	2
	Accessible	2	2	2	2	2	2	2
	W Suite (bed)	1	1	1	1	1	1	1
	WOW Suite (bed)	2	2	2	2	2	2	2
	WOW Suite (liv)	2	2	2	2	2	2	2
Residential	Typical St/1B/2B Bed	2	2	2	2	2	2	2
	Studio Liv	3	3	3	3	3	3	3
	1B Liv	1	1	1	1	1	1	1
	2B Liv	3	3	3	3	3	3	3

Sector	Room Type	Transfer Function, K (dB) at OBCF (Hz)						
		63	125	250	500	1k	2k	4k
	2B Bed (gable)	3	3	3	3	3	3	3
	3B Bed (L37-40)	3	3	3	3	3	3	3
	3B Liv (L37-40)	2	2	2	2	2	2	2
	Penthouse Liv	1	1	1	1	1	1	1

Incident Noise Levels

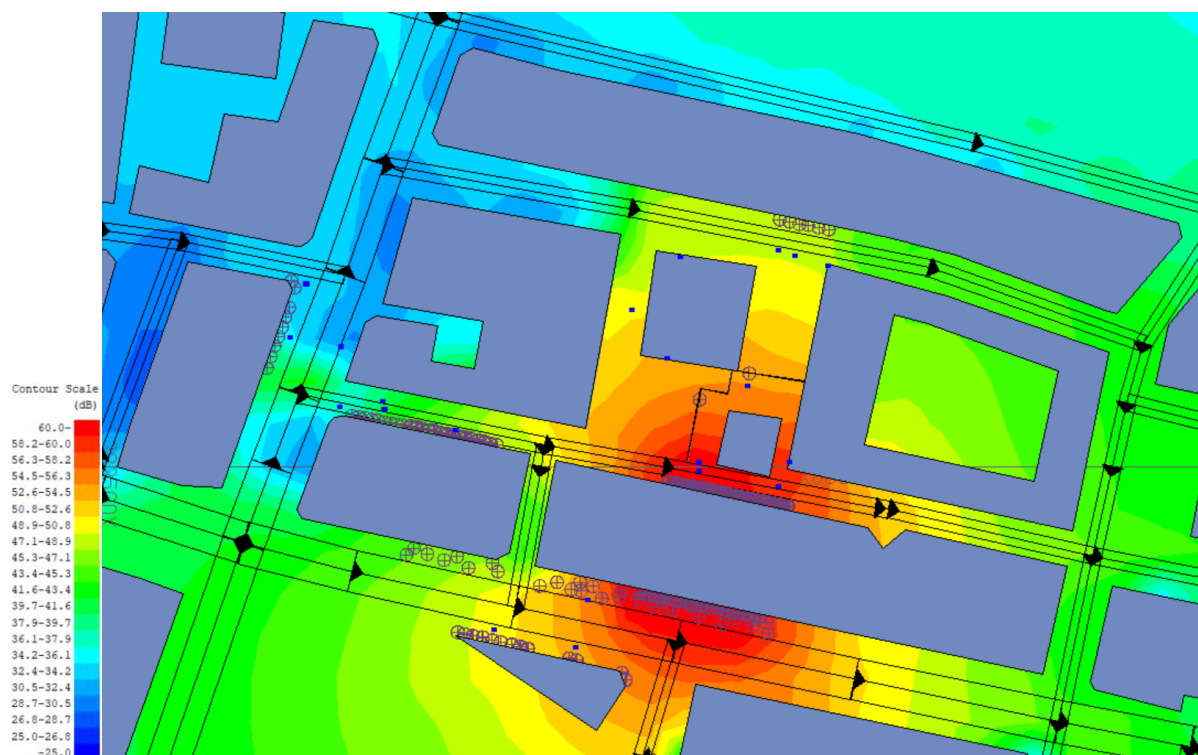
To evaluate entertainment noise impacts, the dominant factor for this scheme, a 3D noise model of the site has been developed. The model has been calibrated using survey data summarise above and in Appendix B.

The following Figure presents the *existing* site in plan and shows the street-level spread of noise from all off-site entertainment noise sources excluding the Albert Hall event space.



Existing Site Plan showing spread of 'off-site' entertainment noise excl Albert Hall (at street level), dB LAeq,5min

The following Figure presents the *existing* site in plan and shows the spread of noise from the Albert Hall event space only at a grid height of 15 metres.



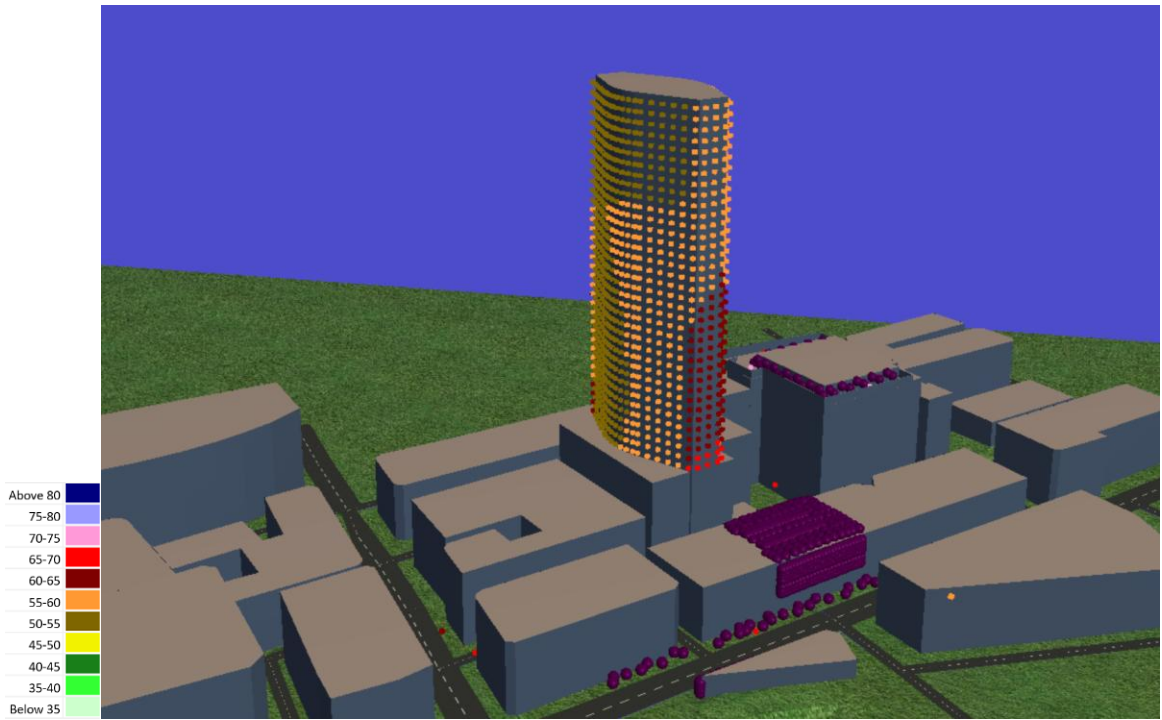
Existing Site Plan showing spread of Albert Hall entertainment noise (at 15 m height), dB $L_{Aeq,5min}$

The following Figures illustrate incident off-site and on-site (Sky Bar) entertainment noise levels on the facades of the *proposed* St Michael's tower. Noise levels from the Phase 1 Sky Bar have been calibrated based on the Hoare Lea Phase 1 Planning Condition 32 and 35 Report (see Appendix B for full details). NB: These figures present the broadband (dBA) incident noise levels and not the specific low frequency (63/125 Hz) incident noise levels.

For the full octave band incident noise level spectra, see Appendix B (B3).



Proposed Site (looking northwest) showing incident entertainment noise levels, dB LAeq,5min



Proposed Site (looking northeast) showing incident entertainment noise levels, dB LAeq,5min



Proposed Site (looking southeast) showing incident entertainment noise levels, dB $L_{Aeq,5min}$



Proposed Site (looking southwest) showing incident entertainment noise levels, dB $L_{Aeq,5min}$

Demonstrating Compliance

Calculation sheets to demonstrate compliance with internal noise levels are presented in Appendix E.

The evidence demonstrates that façade performance specifications presented in Section 4.0 will provide sufficient protection of existing (off-site) and proposed (on-site, Phase 1) entertainment noise sources to achieve the requirements of Planning Condition 8.

6.0 Conclusions

Jameson Acoustics Limited has been commissioned to provide a noise insulation scheme for the residential elements of the St Michael's development in Manchester. This report presents the proposed noise insulation scheme to assist in the discharge of Planning Condition 8.

The evidence presented herein confirms the façade sound reduction performance specifications and demonstrates the façade will provide sufficient protection against all environmental and entertainment noise sources, including the Albert Hall music venue (operating as per their planning agreement).

Appendix A – Acoustic Terminology

dB	Decibel - Used as a measurement of sound level. Decibels are not an absolute unit of measurement but an expression of ratio between two quantities expressed in logarithmic form.
dB(A)	The human ear is more susceptible to mid-frequency noise than the high and low frequencies. The 'A'-weighting scale approximates this response and allows sound levels to be expressed as an overall single figure value in dBA. The _A subscript is applied to an acoustical parameter to indicate the stated noise level is A-weighted (e.g. $L_{Aeq,T}$ in dB). Noise levels in dBA do not have a linear relationship to each other; for similar noises, a change in noise level of 10dBA represents a doubling or halving of subjective loudness. A change of 3dBA is only just perceptible.
$L_{Aeq,T}$	$L_{Aeq,T}$ is the equivalent continuous sound pressure level. It is an average of the total sound energy measured over a specified time measurement period, T .
$L_{10,T}$	L_{10} is the noise level exceeded for 10% of the measurement period T (i.e. the quietest 10% of the measurement) and has, for many years, been used in the assessment of road traffic noise.
$L_{90,T}$	L_{90} is the noise level exceeded for 90% of the measurement period T (i.e. the quietest 10% of the measurement) and is often used to describe the 'background' noise level.
L_{max}	L_{max} is the maximum sound pressure level recorded over the measurement period, T . L_{max} is often used in assessing scheduled environmental noise 'events' (such as train passbys), particularly at night where such events may cause sleep disturbance.
R_w	The weighted sound reduction index, R_w , is a single figure description of sound reduction as defined in BS EN ISO 717-1. It is single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies. The R_w is calculated from sound insulation measurements taken in an acoustic laboratory. Sound insulation ratings derived from site measurements are invariably lower than the laboratory figures and are referred to as the apparent weighted sound reduction index, R'_w .
$D_{n,e,w}$	The weighted element-normalised level difference, $D_{n,e,w}$, is a single figure description of the sound insulation performance of small building elements, such as a trickle ventilator.
C_{tr}	C_{tr} is correction term applied against the sound insulation single-number values (e.g. R_w) to provide a weighting against low frequency performance. The reference values used within the C_{tr} calculation are based on urban traffic noise.

Appendix B – Noise Surveys/Studies

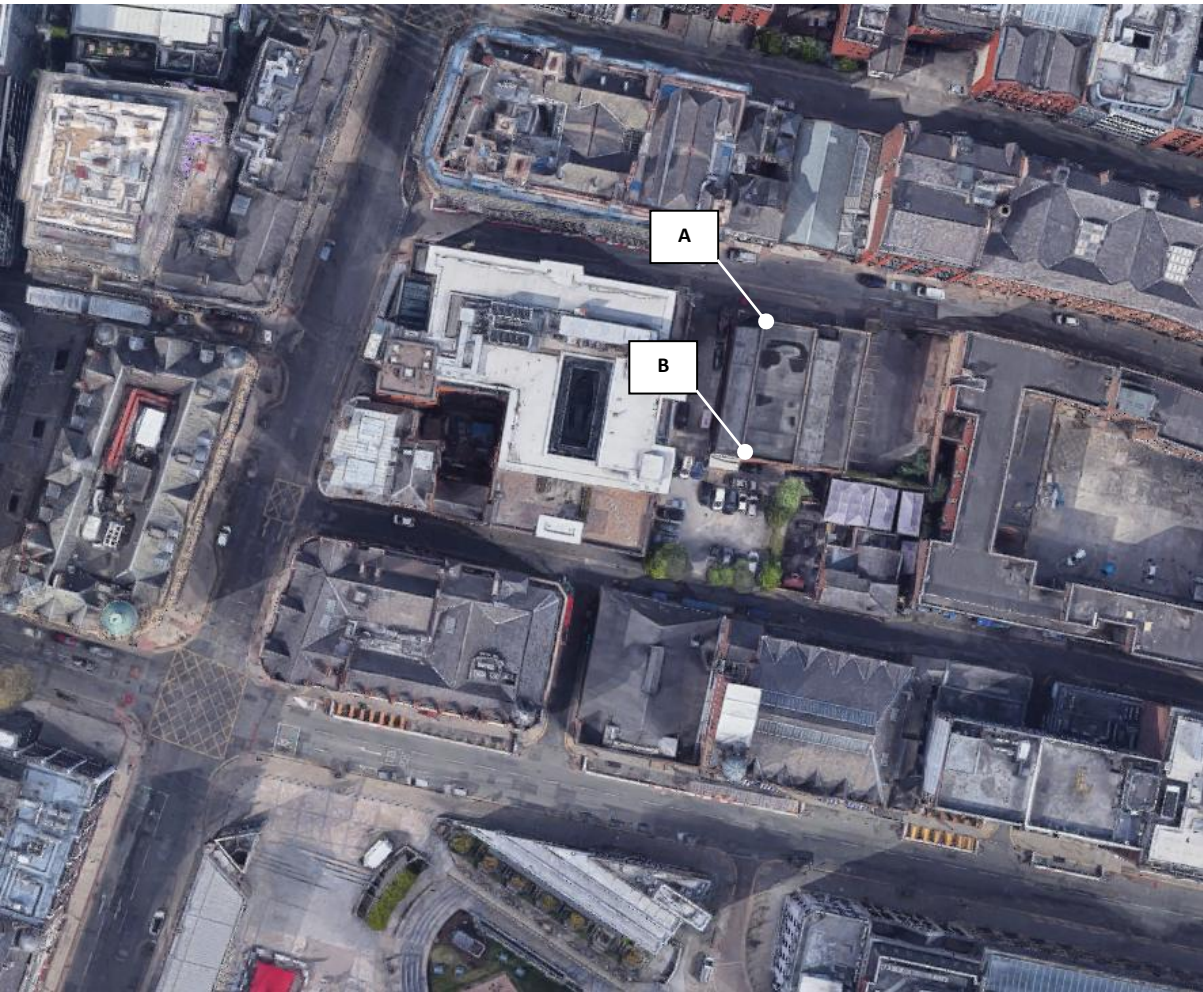
B1 – Environmental Noise Surveys/Studies

Survey by Jameson Acoustics

Automated continuous noise level measurements were taken from 12:00 hr on Friday 1 September 2023 to 12:00 hr on Thursday 7 September 2023 to establish incident environmental noise levels onto the development site.

The survey was conducted at 2nr measurement positions as described and illustrated below. At both positions the microphone was mounted in “free-field” conditions approximately 1.5 metres above roof level.

Position	Description
A	On the roof of the Synagogue on the north edge on Jacksons Row.
B	On the roof of the Synagogue on the north edge on Bootle Street.



The equipment was set to record all relevant A-weighted broadband (dBA) and linear spectral noise level indices, including L_{eq} , L_{90} , L_{10} and L_{max} , over continuous intervals of 5-min and 15-min. The survey was conducted in general accordance with BS 7445-1:2003 ‘Description and Measurement of Environmental Noise’.

The following instrumentation was used for the survey.

Description	Equipment	Serial Nr	Lab Calibration Expiry	Lab Calibration Certificate Nr
Class 1 sound level meter	Svantek 971A (with Type 7152 microphone)	124663 (82835)	12 August 2024	2292773
Class 1 sound level meter	Cirrus CR:171B (with MK:224 microphone)	G056718 (204055A)	8 Nov 2024	182767 (182766)
Class 1 sound calibrator	Cirrus CR:515	57570	8 Nov 2023	182770

The equipment was hand-calibrated at the beginning and end of the survey periods. No significant deviations were noted (not greater than 0.1 dB). The microphones were fitted with a windshield.

During the survey, internal weather reports indicate suitable conditions for obtaining representative measurement results, with no prolonged periods of heavy rainfall, sufficiently low wind speed and predominantly dry road surfaces for the majority of the survey.

On install and collection, the noise climate was noted to comprise:

- Position A :

Distant road traffic from Deansgate and vehicle passbys on Jacksons Row. Some rooftop building services plant on neighbouring buildings noted to be faintly audible.
- Position B :

Distant road traffic from Deansgate and Peter Street. Vehicle passbys on Bootle Street were sparse and at low speed. Building services plant serving neighbouring buildings (notably bars/restaurants on Peter Street) was audible but not necessarily dominant.

The results of the survey are summarised in the following tables, presenting the daytime $L_{Aeq,16hr}$ and night-time $L_{Aeq,8hr}$ and L_{AFmax} (10-15th highest over shorten 5-min periods). Note, daytime readings on Mon-Wed of Position 1 were unduly influenced by internal strip out works within the Synagogue at the time of the survey (entrance door to the Synagogue for waste removal was on this north elevation).

Position A

Period (Day / Night of...) 2023	Daytime (0700-2300), dB L_{Aeq}	Night-time (2300-0700), dB L_{Aeq}	Night-time (2300-0700), dB L_{Amax}
Friday 1 September	64	60	78
Saturday 2 September	64	61	79
Sunday 3 September	63	58	78
Monday 4 September	65*	56	74
Tuesday 5 September	66*	58	76

Period (Day / Night of...) 2023	Daytime (0700-2300), dB L _{Aeq}	Night-time (2300-0700), dB L _{Aeq}	Night-time (2300-0700), dB L _{Amax}
Wednesday 6 September	65*	58	77
Taken for Assessment	63	60	78

Position B

Period (Day / Night of...) 2023	Daytime (0700-2300), dB L _{Aeq}	Night-time (2300-0700), dB L _{Aeq}	Night-time (2300-0700), dB L _{Amax}
Friday 1 September	62	60	75
Saturday 2 September	63	62	76
Sunday 3 September	62	58	73
Monday 4 September	62	57	72
Tuesday 5 September	63	58	73
Wednesday 6 September	62	57	72
Typical Highest taken for Assessment	63	60	75

Comparative Review Against Survey Data by Hoare Lea

The methodology and results of the Hoare Lea environmental noise survey are presented in their Planning Condition 23 and 35 Assessment Report Rev 01 (Appendix A).

The survey results of their surveyed incident L_{Aeq} noise levels onto the south and north façades show a reasonable correlation with the Jameson Acoustics noise levels. The following table presents a comparison of the two weekly averages. The night-time L_{Aeq} readings show good correlation. For the daytime readings, the Jameson Acoustics levels are higher and shall be used to inform a worst-case assessment.

Façade	Desc.	Jameson Acoustics	Hoare Lea	JA-HL Difference
Level 7 (North)	Incident Daytime L _{Aeq,16hr}	63	60	+3
	Incident Night-time L _{Aeq,16hr}	60	60	0
	Incident Night-time L _{Amax}	78	Not given	-
Level 7 (South)	Incident Daytime L _{Aeq,16hr}	63	61	+2
	Incident Night-time L _{Aeq,16hr}	60	60	0
	Incident Night-time L _{Amax}	75	Not given	-

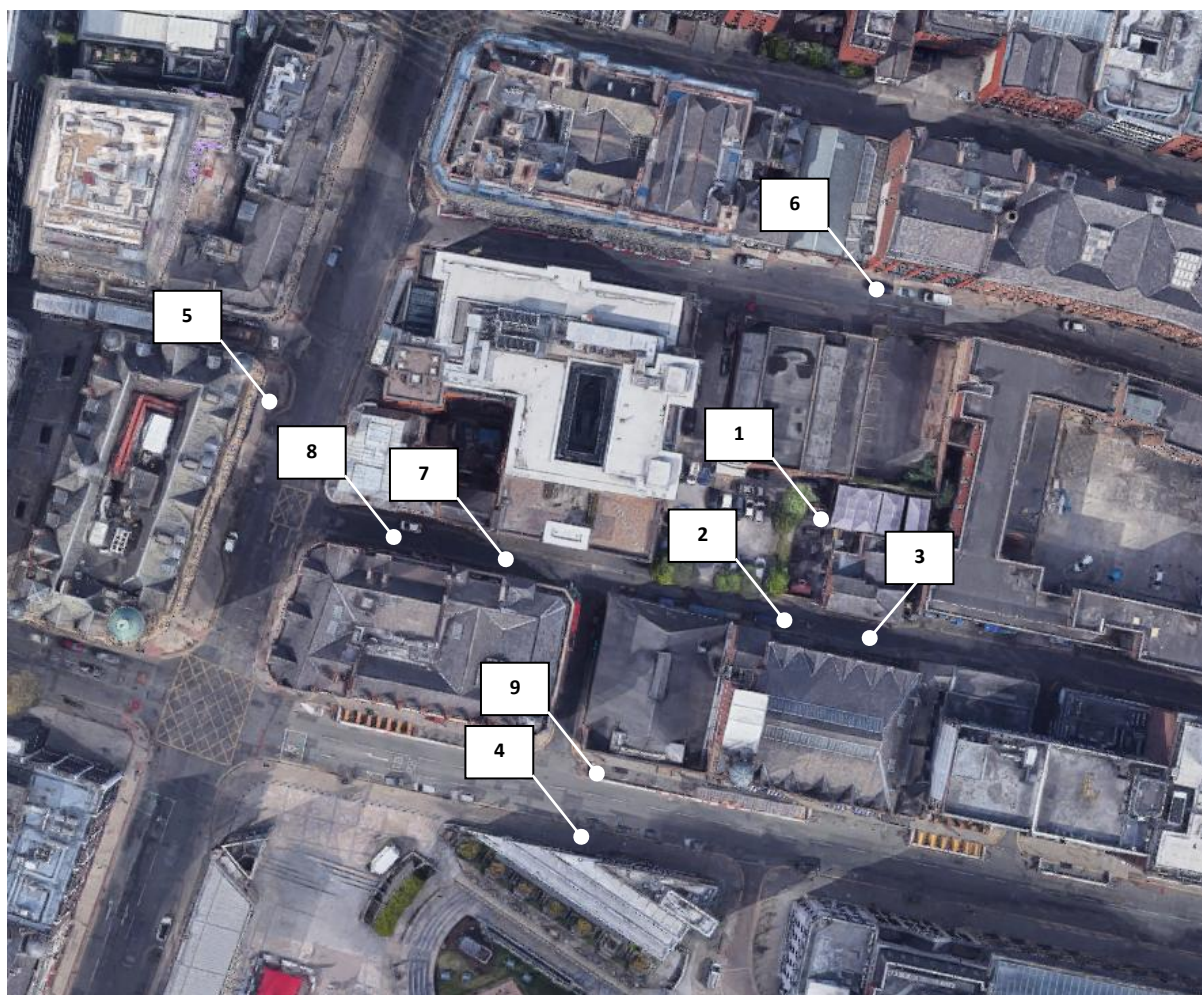
B2 – Entertainment Noise Surveys/Studies

Survey by Jameson Acoustics

Manned noise level measurements were taken during between 22:00 hr and 01:00 hr on the night of Friday 26 May 2023 to establish entertainment noise levels on the streets surrounding the development site (excluding Albert Hall music venue).

The measurement positions are described and illustrated below. In all positions the microphone was mounted in “free-field” conditions approximately 1.5 metres above local ground level.

In each position, the measurement was considered to obtain representative noise level readings for the source in question. Extraneous noise (e.g. from traffic) was minimised as far as practically possible.



Site plan showing Jameson Acoustics survey measurement positions (© maps.google.co.uk)

Position	Description
1	Within the outdoor terrace of Sir Ralph Abercrombie (amplified music and patrons). NB this terrace will not exist once the development is built.
2	3 metres from the Albert's Schloss smoking terrace (bustling) and door (open, live music breakout).
3	3 metres from the Albert Hall smoking terrace (bustling).
4	3 metres from the doors to Impossible (amplified music breakout, patrons entering/exiting).
5	2 metres from the front doors/windows to Manahatta bar (amplified music breakout, patrons entering/exiting and smoking along bar frontage).
6	3 metres from the front door to the Venue nightclub (minor music noise breakout, patrons queuing).
7	1 metre from Revolution De Cuba rear windows (amplified music breakout).
8	3 metres from queue to 42s nightclub (including some music breakout from RDC windows).
9	Peter's Street ambient nightlife noise from bar frontages.

The sound level meter was set to record all relevant A-weighted broadband (dBA) and linear spectral noise level indices, including L_{eq} , L_{90} , L_{10} and L_{max} , over periods of 5-minutes.

The instrumentation used for the survey is summarised below.

Description	Equipment	Serial Nr	Lab Calibration Expiry	Lab Calibration Certificate Nr
Class 1 sound level meter	Cirrus CR:171B (with MK:224 microphone)	G056718 (204055A)	8 Nov 2024	182767 (182766)
Class 1 sound calibrator	Cirrus CR:515	57570	8 Nov 2023	182770

The equipment was hand-calibrated at the beginning and end of the survey period. No significant deviations were noted (not greater than 0.05 dB). The microphone was fitted with a windshield.

Weather conditions were considered to be suitable for obtaining representative measurement results. Skies were generally clear with patchy cloud cover, road surfaces were dry, there were no periods of rainfall and wind speeds were suitable low.

Several measurements were taken at each position throughout the survey period. However, for brevity, the following table summarises the typical highest octave band and overall A-weighted L_{eq} noise levels recorded.

Position	Sound Level, $L_{eq,5min}$ (dB) at OBCF (Hz)							A-Weighted, $L_{Aeq,5min}$ (dB)
	63	125	250	500	1k	2k	4k	
1	72	76	68	74	73	72	70	78
2	82	79	71	77	74	70	62	79
3	82	76	69	73	72	68	59	76

Position	Sound Level, $L_{eq,5min}$ (dB) at OBCF (Hz)							A-Weighted, $L_{Aeq,5min}$ (dB)
	63	125	250	500	1k	2k	4k	
4	87	78	71	71	69	65	60	73
5	83	77	75	69	68	65	61	73
6	70	66	64	66	63	57	53	67
7	92	83	75	79	76	70	64	80
8	86	79	74	73	70	65	58	75
9	82	74	67	70	68	64	58	73

Surveys by Others

Noise survey/assessment data by others presented in the following documents have been considered in our assessment.

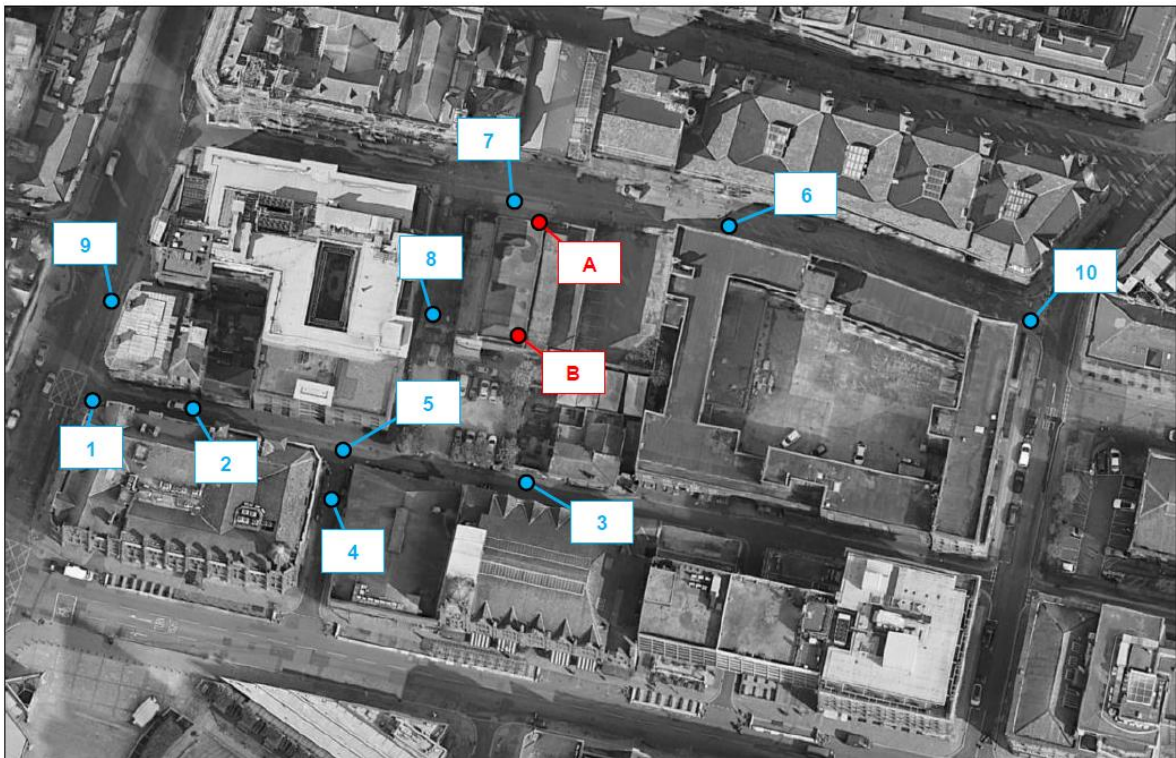
- Hann Tucker Stage 3 Residential Acoustic Design Report, Appendix D.
- Hoare Lea Planning Condition 32 & 35 Assessment Report Rev 01 (Phase 1 Sky Bar).

A comparative review of the Jameson Acoustics street level nightlife noise survey data and that of Hann Tucker shows good correlation. However, many of the Hann Tucker survey readings include extraneous noise sources, such as plant and vehicle passbys, which do not constitute ‘entertainment’ noise. Where ‘valid’ data from the Hann Tucker shows a disparity, the higher noise level of the two has been used in our assessment.

The Hann Tucker survey positions (1-10) and results are presented below.

Position	Hann Tucker Measurement Description
1	Measurement located on Deansgate at a height of 1.5m above ground level and approximately 6m from the queue for 42’s Nightclub. Noise level was dictated by traffic on Deansgate and patrons in the queue for 42’s Nightclub. Noise Levels measured are considered to be free field noise levels.
2	Measurement located on Bootle Street at a height of 1.5m above ground level and approximately 4m from the entrance door to 42’s Nightclub. Noise level was dictated by patrons in the queue for 42’s Nightclub. Noise Levels measured are considered to be free field noise levels.
3	Measurement located on Bootle Street kerbside at a height of 1.5m above ground level approximately 7m from the Albert Schloss smoking area and directly adjacent to the Abercrombie terrace. The main source of noise in this location was music and chatter from Albert Schloss and general patron noise on Bootle Street. Noise Levels measured are considered to be free field noise levels.
4	Measurement located on Jerusalem Place at a height of 1.5m above ground directly across from an extract fan grille. The main source of noise was mainly plant. However, a working from the Peaky Blinders bar emptied bottles into a large bin next to the measurement location. Noise Levels measured are considered to be free field noise levels.
5	Measurement located on the corner of Jerusalem Place and Bootle Street at a height of 1.5m above ground. The main source of noise was mainly plant and patron noise from Bootle Street. Noise Levels measured are considered to be free field noise levels.

Position	Hann Tucker Measurement Description
6	Measurement located on Jacksons Row at a height of 1.5m above ground, directly opposite Venue nightclub. Main source of noise was patron noise with low levels of music noise breakout. Noise Levels measured are considered to be free field noise levels.
7	Measurement location on the entrance steps of the existing synagogue at a height of 1.5m above ground. Main source of noise was patron noise with low levels of music noise breakout. Cars located on Jacksons Row were also playing music with windows open. Noise Levels measured are considered to be free field noise levels.
8	Measurement location in the alley at the side of the existing synagogue at a height of 1.5m above ground. Noise climate dictated by music noise from car on Jacksons Row and people audible outside Venue. Plant noise is also audible. Noise Levels measured are considered to be free field noise levels
9	Measurement located on Deansgate at a height of 1.5m above ground level. Music from Manhatta is dominant noise source as doors are kept open and maximum noise events are caused by cars and patron noise. Noise Levels measured are considered to be free field noise levels.
10	Measurement located on the corner of Jacksons Row at a height of 1.5m above ground level. Noise climate consisted of road, patron noise and low levels of music noise breakout from nearby venues. Noise Levels measured are considered to be free field noise levels.



Positon	Measured Sound Pressure Level, L_{eq} , at each Octave Band Central Frequency (Hz)							
	Time	63	125	250	500	1000	2000	4000
1	23:32:38	81	76	73	72	70	64	59
	00:59:19	78	72	70	74	75	65	61
2	23:38:50	80	73	73	74	73	63	57
	01:04:59	81	75	74	79	78	68	63
3	23:45:34	82	73	71	76	74	65	60
	01:11:43	79	73	70	73	68	59	54
4	23:53:09	81	83	79	76	74	71	69
	01:17:52	81	82	78	74	73	66	62
5	23:59:08	79	78	73	74	72	61	57
	01:23:22	80	78	73	72	71	61	57
6	00:06:06	72	70	67	70	67	57	54
	01:30:40	73	67	66	68	66	54	51
7	00:12:08	66	64	61	62	62	51	45
	01:36:55	66	63	59	59	57	48	43
8	00:19:14	67	63	58	60	59	49	46
	01:43:47	70	64	58	56	57	47	44
9	00:26:31	74	68	66	67	66	58	53
	01:51:53	78	71	65	67	66	57	50
10	00:36:37	67	60	57	54	54	46	44
	02:00:54	64	58	57	54	52	43	39

Hann Tucker entertainment noise survey readings

For proposed 'entertainment' sources associated with the Phase 1 Level 10 Sky Bar, maximum entertainment noise levels have been assigned based on the Hoare Lea Planning Condition 32 and 35 Assessment Report Rev 01. This report advising the following noise limits for amplified sound levels in terrace areas.

Time period	Proposed amplified sound limit	Comments on subjective impression
Daytime typical (07:00 - 23:00)	$L_{Aeq,15min}$ 65-70 dB; L_{eq} 70-73 dB in the 63 Hz and 125 Hz octave bands respectively	This would allow for music levels that are typical of those found in bars where the music is intended to be background – i.e. clearly audible but does not require occupants to raise their voices to hold a conversation. Limited bass frequencies would be expected to be required to ensure compliance during more bass heavy music.
Saturday afternoon (12:00 - 17:00)	$L_{Aeq,15min}$ 70-75 dB; L_{eq} 73-76 dB in the 63 Hz and 125 Hz octave bands respectively	This would allow for noticeably increased noise levels when compared to the description above. The noise levels are likely to be considered as 'background' but would be more prominent. Again, limited bass is likely to be required.
Night (23:00 - 07:00)	N/A - Loudspeakers understood to be switched off from 23:00.	

For noise breakout from internal amplified sound, the Hoare Lea report advises the following maximum internal noise limits.

Frequency	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	L _{Aeq}
Internal noise limit, Leq,1min (dB)	94	96	89	88	83	81	81	79	90

The report advises the façade glazing will achieve 35 dB R_w+C_{tr} with suitable low frequency performance. The roof will be ≥ 200 mm concrete. Based on a typical double glazed window achieving this rating, we have calculated the resultant noise breakout at 2 metres from the façade (i.e. on the terrace) to be 73 dB at 63 Hz and 125 Hz, with a overall A-weighted noise level of 63 dB L_{Aeq} .

The combined terrace + breakout noise levels from the sky bar combined are calculated to be, at its highest, around 77 dB L_{eq} at 63 Hz and 125 Hz and 75 dB L_{Aeq} on the terrace. The two sources (terrace loudspeakers and façade noise breakout) have been added to our noise model and calibrated to these levels at receivers on the terrace.

Albert Hall First Floor Venue Space Noise Study (Hoare Lea)

The acoustic information used to inform our analysis of Albert Hall event noise impacts onto the St Michael’s tower are set out in two documents:

- Hoare Lea Acoustic Report in Support of Planning Application (for Albert Hall) Ref. REP-1-10-04499-MM-280812-F Rev 1 dated 1 October 2012.
- Hoare Lea Building Envelope Mitigation Report (for St Michaels) Ref. STM-HLE-ZZ-ZZ-RP-Y-0002 dated 15 March 2019.

The first report outlines acoustic attenuation measures for the venue space to reduce music noise egress and allow the venue to generate high levels of amplified sound during events. These measures were to be adopted for the complete venue, both north and south facing facades and the roof. It then provides overriding noise output limits for the venue, which apply at the nearest noise sensitive receptors at the time of the study; the Radisson Hotel and Great Northern Tower (residential apartments). These limits apply irrespective of whatever acoustic attenuation measures have been applied. Attenuation measures would simply allow the venue to generate higher levels of internal noise and still adhere to the external noise limits.

The following exert is taken from the Hoare Lea report, setting out the significance criteria (noise limits) agreed with Manchester City Council for the Albert Hall.

Significance Criteria

In the absence of any strict guidance and target values for the scheme, a set of significance criteria for the scheme has been developed for noise emissions associated with the proposed operation.

Significance criteria are applicable in cases where a non-standard assessment methodology is required and present what are considered to be reasonable noise limits based on a combination of factors such as observable effect levels (as per DEFRA NPSE), structural limitations effecting the commercial viability of the scheme and suitable upper limits for noise internally. The limits were discussed and agreed with Mr. Richard Knightley of Manchester City Council Environmental Health in a presentation session held on 20th June 2012. The criteria are presented in Table 2 and an explanation of the derivation is presented in Appendix A.

The significance criteria is applicable to live music only as it is understood that noise limiters can be used for amplified music, such as DJs. The aim for the scheme is to achieve a negligible to minor impact. Noise from conference events is assumed to be automatically controlled by conforming to the standards presented below.

Table 2: Propose significance criteria – Live Music

Significance	Condition
Major	C weighted noise level in the presence of entertainment noise is generally greater than 6dB above C-weighted background ambient L_{eq} noise levels. (Implies noise source is dominant over background.)
Moderate	C weighted noise level in the presence of entertainment noise is generally between 4 and 6dB above C-weighted background ambient L_{eq} noise levels. (Implies noise source is greater than background.) Additionally, Music noise level of the 63Hz octave band ≤ 70 dB Music noise level of the 125Hz octave band ≤ 65 dB
Minor	C weighted noise level in the presence of entertainment noise is generally between 1 and 3dB above C-weighted background ambient L_{eq} noise levels. (Implies noise source is less than or equal to background.) Additionally, Music noise level of the 63Hz octave band ≤ 70 dB Music noise level of the 125Hz octave band ≤ 65 dB
Negligible	C weighted noise level in the presence of entertainment noise is generally less than or equal 1dB above C-weighted background ambient L_{eq} noise levels. (Implies noise source is lower than background.) Additionally, Music noise level of the 63Hz octave band ≤ 70 dB Music noise level of the 125Hz octave band ≤ 65 dB

The key descriptor here, relevant to the music noise criteria applicable to the St Michael's development, is the low frequency noise limits of 70 dB L_{eq} at 63 Hz and 65 dB L_{eq} at 125 Hz. These limits apply at the Radisson Hotel and Great Northern Tower receptors.

The second Hoare Lea report confirms that planning permission for the Albert Hall (Application number 100865/LO/2012/C1) was granted in which the acoustic enhancements and noise limits advised above were conditioned.

The need for Albert Hall to comply with Environmental Health noise limits are also confirmed in their licensing agreement which states:

9. All amplified music to be routed through a tamperproof sound limiter.
10. Noise levels to be fixed in consultation with Environmental Health.

11. Noise generated by music shall be controlled and shall be at such levels that no noise nuisance is caused at the nearest noise sensitive locations.

The report then considers these noise limits and determines the equivalent worst-case incident noise levels onto the St Michael's tower façade. The report confirms worst-case incident noise levels on the tower as follows:

For assessment purposes, a revised façade sound insulation assessment has been undertaken to determine the implications of the façade design on the basis that the Albert Hall are operating within the noise limits presented in their planning application. For the purposes of this assessment the focus is on the low frequency noise limits which stipulates the following:

- Music noise levels at 1 m from the nearest façade of the Radisson Edwardian Hotel should not exceed:
 - 70 dB at 63Hz octave band
 - 65 dB at 125 Hz octave band

The closest façade of the Radisson Edwardian Hotel is approximately 30 m from the Albert Hall. The closest façade from the Albert Hall to the nearest affected St Michaels façade is approximately 10 m from the development. The noise from the Albert Hall has been recalibrated in the 3D noise model to comply with the limits above, which results in the following noise levels at the worst case hotel guestroom façade:

- 74 dB at 63Hz octave band at 1 m
- 69 dB at 125 Hz octave band at 1 m.

Note, this is formed on the basis that acoustic enhancements, if any, of the venue have been applied to venue as a whole and not just the façade facing the Radisson/Great Northern Tower.

Note, this report also presents survey readings from the Albert Hall venue covering the following events.

2.1.1 Events.

The following events are understood to have occurred at the Albert Hall during the noise monitoring period.

Table 2 Events at the Albert Hall during the noise survey

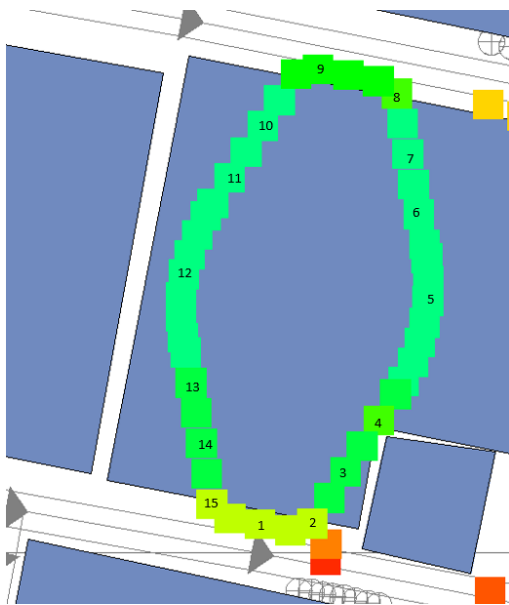
Date	Event listing	Duration	Notes
2 March 2019	Larkins	19:00 to 22:00	Rock band
2 March 2019	RETRO	23:00 to 05:00	Club night - house music
6 March 2019	Ward Thomas	19:00 to 23:00	Country music
7 March 2019	Freya Ridings	19:00 to 23:00	Piano and singing

The report confirms that, for the RETRO night, low frequency (63 Hz) noise egress was found to be in excess of the planning noise limits. However, for all other events noise egress was found to generally be in compliance. Note, the venue no longer hosts RETRO club nights.

B3 – Noise Modelling & Façade Performance Calculations

Incident ‘Entertainment’ Noise Levels

Based on the 3D noise model (presented in the main body Report), the full incident octave band $L_{eq,5min}$ ‘entertainment’ noise levels have been determined at each floor level at various positions around the building. These positions can be referenced against the following Figure. NB: These levels include contributions from Albert Hall, based on the Hoare Lea worst-case incident noise levels of 74 dB $L_{eq,5min}$ at 63 Hz and 69 dB $L_{eq,5min}$ at 125 Hz.



The following tables present the incident ‘entertainment’ noise levels extracted from the 3D model for various façade location (1-15) at each floor level. These levels are from all off-site sources (incl Albert Hall operating at their planning noise limits) and the on-site proposed Sky Bar in Phase 1. For brevity, only the values for a selection of façade locations have been presented (locations 1, 3, 7, 8, 10 and 14).

Façade Location 1 (dB $L_{eq,5min}$)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	75.6	70.1	61.5	63.3	61.3	56.3	48.8
8	75.1	69.5	60.9	62.8	60.7	55.8	48.3
9	74.6	68.9	60.3	62.3	60.2	55.2	47.9
10	74.2	68.3	59.8	61.9	59.7	54.8	47.6
11	73.7	67.8	59.4	61.5	59.4	54.5	47.5
12	73.3	67.4	59.0	61.2	59.0	54.1	47.3
13	73.0	67.0	58.5	60.9	58.7	53.9	47.2
14	72.7	66.5	58.1	60.6	58.4	53.5	47.0
15	72.4	66.1	57.7	60.3	58.0	53.2	46.8
16	72.0	65.7	57.4	59.9	57.7	52.9	46.5
17	71.7	65.3	57.2	59.6	57.4	52.6	46.2
18	71.3	64.9	57.0	59.3	57.0	52.2	45.9
19	71.0	64.5	56.7	59.0	56.8	51.9	45.7
20	70.7	64.2	56.5	58.7	56.4	51.6	45.4
21	70.4	63.9	56.3	58.5	56.2	51.4	45.2
22	70.1	63.5	56.1	58.2	55.9	51.1	44.9
23	69.8	63.2	55.8	57.9	55.6	50.8	44.7

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
24	69.6	62.9	55.6	57.6	55.3	50.5	44.4
25	69.3	62.6	55.3	57.4	55.1	50.3	44.2
26	69.0	62.4	55.1	57.1	54.8	50.0	44.0
27	68.8	62.1	54.9	56.9	54.6	49.8	43.7
28	68.5	61.8	54.7	56.6	54.3	49.5	43.5
29	68.3	61.6	54.6	56.4	54.1	49.3	43.3
30	68.1	61.3	54.3	56.2	53.9	49.1	43.1
31	67.8	61.1	54.2	56.0	53.6	48.9	42.9
32	67.6	60.9	54.1	55.8	53.5	48.7	42.7
33	67.4	60.6	54.0	55.6	53.2	48.5	42.5
34	67.2	60.4	53.9	55.4	53.1	48.3	42.4
35	67.0	60.2	53.7	55.2	52.9	48.1	42.2
36	66.8	60.0	53.5	55.0	52.6	47.9	42.0
37	66.6	59.8	53.3	54.8	52.4	47.7	41.8
38	66.4	59.6	53.1	54.6	52.3	47.5	41.6
39	66.2	59.4	52.9	54.4	52.1	47.3	41.4
40	66.0	59.2	52.7	54.2	51.9	47.1	41.2
41	65.9	59.0	52.6	54.0	51.7	47.0	41.0
42	65.7	58.9	52.4	53.8	51.5	46.8	40.9

Façade Location 3 (dB L_{eq,5min})

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	67.6	61.5	53.6	54.9	52.6	48	42.4
8	68.4	63.4	55.4	56.3	54.2	49.8	44.1
9	70.6	65.8	56.8	57.4	55.6	51.4	45
10	71.2	65.8	56.9	57.6	55.6	51.4	45.5
11	70.9	65.5	57.1	57.5	55.4	51.2	45.6
12	70.5	65.1	57.9	58.4	56.2	51.9	46.5
13	70.1	64.8	58.1	58.4	56.2	51.9	46.6
14	69.8	64.5	58.9	58.9	56.6	52.3	47.3
15	69.5	64.9	59.1	60	57.8	53.3	47.8
16	69.3	64.7	59	59.7	57.5	53	47.6
17	69	64.5	58.7	59.4	57.2	52.7	47.4
18	68.7	64.2	58.5	59.1	56.9	52.4	47.1
19	68.4	63.9	58.2	58.8	56.5	52.1	46.9
20	68	63.7	58	58.5	56.3	51.8	46.6
21	67.7	63.4	57.7	58.2	55.9	51.5	46.3
22	67.4	63.1	57.5	58	55.7	51.2	46.1
23	67.2	62.9	57.2	57.7	55.3	50.9	45.8
24	66.9	62.6	57	57.4	55.1	50.7	45.5
25	66.6	62.3	56.7	57.1	54.8	50.4	45.3
26	66.4	62.1	56.5	56.9	54.6	50.2	45.1
27	66.1	61.9	56.2	56.6	54.3	49.9	44.8
28	65.9	61.6	56	56.3	54	49.6	44.5
29	65.7	61.4	55.7	56.1	53.8	49.4	44.3
30	65.4	61.1	55.5	55.8	53.5	49.1	44
31	65.2	60.9	55.2	55.6	53.3	48.9	43.8
32	65	60.6	55	55.3	53	48.6	43.5
33	64.8	60.4	54.7	55.1	52.8	48.4	43.3
34	64.6	60.1	54.5	54.9	52.5	48.1	43.1
35	64.4	59.9	54.3	54.6	52.3	47.9	42.8
36	64.2	59.7	54	54.4	52.1	47.7	42.6
37	64	59.5	53.8	54.2	51.9	47.5	42.4
38	63.8	59.3	53.7	54	51.7	47.3	42.2
39	63.7	59.1	53.4	53.8	51.5	47.1	42
40	63.5	58.9	53.2	53.6	51.3	46.9	41.8
41	63.3	58.7	53	53.4	51.1	46.7	41.6
42	63.2	58.5	52.8	53.2	50.9	46.5	41.4

Façade Location 7 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	63.5	56.9	51.8	52.6	50	45.2	40.3
8	65	58.5	53.4	53.4	50.7	46.1	41.7
9	66.2	58.7	53.6	53.4	50.7	46.2	41.9
10	67	60.7	55.6	54.8	52	47.6	43.8
11	67.3	61.8	56.8	55.6	52.8	48.5	44.9
12	67.3	62.5	57.4	56.1	53.3	49	45.5
13	67	62.5	57.6	56.5	53.7	49.3	45.7
14	66.7	63.1	58.1	57	54.1	49.7	46.3
15	66.5	63.1	58.4	57.6	54.7	50.1	46.6
16	66.3	63	58.3	57.5	54.6	50	46.5
17	66.3	62.9	58.1	57.3	54.4	49.8	46.3
18	66.3	62.6	57.9	57	54.1	49.6	46.1
19	66.3	62.4	57.7	56.8	53.9	49.3	45.8
20	66.4	62.3	57.5	56.6	53.8	49.3	45.7
21	66.6	62	57.2	56.4	53.6	49.1	45.4
22	66.8	62	57.1	56.5	53.8	49.4	45.4
23	66.9	61.8	56.9	56.3	53.6	49.2	45.2
24	66.8	61.6	56.7	56	53.4	48.9	44.9
25	66.8	61.3	56.4	55.8	53.1	48.7	44.7
26	66.7	61.1	56.2	55.5	52.9	48.4	44.4
27	66.6	60.9	56	55.3	52.6	48.2	44.2
28	66.4	60.7	55.7	55.1	52.4	48	44
29	66.2	60.4	55.5	54.8	52.2	47.8	43.7
30	66	60.2	55.2	54.6	51.9	47.5	43.5
31	65.8	59.9	55	54.3	51.7	47.3	43.2
32	65.6	59.7	54.8	54.1	51.5	47.1	43
33	65.3	59.5	54.5	53.9	51.3	46.9	42.8
34	65.1	59.2	54.3	53.7	51	46.6	42.5
35	64.9	59	54.1	53.5	50.8	46.4	42.3
36	64.7	58.8	53.8	53.2	50.6	46.2	42.1
37	64.5	58.6	53.6	53	50.4	46	41.9
38	64.3	58.4	53.4	52.8	50.2	45.8	41.7
39	64.1	58.1	53.2	52.6	50	45.6	41.4
40	63.9	57.9	53	52.4	49.8	45.4	41.2
41	63.7	57.7	52.8	52.2	49.6	45.2	41
42	63.5	57.5	52.6	52	49.4	45	40.8

Façade Location 8 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	75.1	66.2	58.2	60.1	58.1	54.1	45.2
8	74.5	65.5	57.5	59.5	57.5	53.5	45.2
9	73.9	64.9	56.9	58.9	56.9	52.9	45.2
10	73.3	64.3	57.3	58.3	56.3	52.3	45.8
11	72.8	63.8	57.6	57.8	55.8	51.7	46
12	72.2	63.3	57.9	57.7	55.2	51.2	46.3
13	71.7	62.8	57.7	57.4	54.7	50.7	46.1
14	71.3	62.6	57.9	57.5	54.5	50.3	46.2
15	70.8	62.6	57.9	57.3	54.4	49.8	46.2
16	70.4	62.4	57.7	57.1	54.2	49.5	46
17	70	62.3	57.6	56.9	54	49.3	45.8
18	69.6	62.1	57.4	56.6	53.7	49.1	45.6
19	69.3	61.9	57.1	56.4	53.5	48.9	45.4
20	68.9	61.7	56.9	56.1	53.2	48.7	45.1
21	68.6	61.5	56.7	55.9	53	48.4	44.9
22	68.2	61.3	56.5	55.8	52.9	48.4	44.7
23	67.9	61.1	56.3	55.5	52.7	48.2	44.5
24	67.6	60.9	56.1	55.3	52.5	48	44.3
25	67.3	60.9	56	55.5	52.8	48.3	44.3
26	67	60.7	55.8	55.2	52.5	48.1	44.1
27	66.7	60.5	55.6	55	52.3	47.9	43.8

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
28	66.5	60.2	55.3	54.8	52.1	47.7	43.6
29	66.3	60	55.1	54.5	51.9	47.4	43.4
30	66	59.9	54.9	54.3	51.7	47.3	43.2
31	65.7	59.6	54.7	54.1	51.5	47	43
32	65.5	59.4	54.5	53.9	51.2	46.8	42.8
33	65.3	59.2	54.3	53.7	51	46.6	42.5
34	65	59	54.1	53.5	50.8	46.4	42.3
35	64.8	58.8	53.8	53.3	50.6	46.2	42.1
36	64.6	58.6	53.6	53	50.4	46	41.9
37	64.4	58.4	53.4	52.8	50.2	45.8	41.7
38	64.2	58.2	53.2	52.6	50	45.6	41.5
39	64	58	53	52.5	49.8	45.4	41.3
40	63.8	57.7	52.8	52.2	49.6	45.2	41.1
41	63.6	57.5	52.6	52.1	49.4	45	40.9
42	63.4	57.4	52.4	51.9	49.2	44.8	40.7

Façade Location 10 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	61.0	55.4	50.0	51.4	48.9	44.0	38.6
8	60.8	55.3	49.9	51.2	48.8	43.9	38.5
9	60.7	55.2	49.8	51.1	48.6	43.7	38.4
10	60.5	55.1	49.7	50.9	48.4	43.6	38.2
11	60.5	55.1	49.6	50.7	48.3	43.4	38.1
12	60.6	55.0	49.5	50.6	48.1	43.3	38.0
13	60.4	54.9	49.4	50.4	47.9	43.2	37.9
14	60.3	54.8	49.3	50.2	47.8	43.0	37.8
15	60.1	54.6	49.1	50.1	47.6	42.8	37.6
16	60.0	54.5	49.0	49.9	47.5	42.7	37.5
17	59.9	54.4	49.0	49.7	47.3	42.6	37.4
18	59.8	54.3	48.8	49.5	47.1	42.4	37.2
19	59.7	54.2	48.8	49.4	46.9	42.3	37.1
20	59.8	54.1	48.9	49.3	46.8	42.2	37.1
21	59.9	54.1	49.0	49.1	46.7	42.1	37.0
22	60.0	54.1	49.1	49.0	46.6	42.1	37.0
23	60.1	54.1	49.3	48.9	46.6	42.1	37.0
24	60.2	54.2	49.7	48.9	46.6	42.3	37.2
25	60.2	54.4	50.2	48.9	46.7	42.5	37.4
26	60.2	54.5	50.4	48.8	46.7	42.5	37.4
27	60.2	54.4	50.3	48.7	46.5	42.4	37.3
28	60.3	54.2	50.2	48.5	46.4	42.2	37.1
29	60.3	54.0	50.0	48.3	46.2	42.0	37.0
30	60.5	53.9	49.8	48.2	46.0	41.9	36.8
31	60.6	53.7	49.7	48.0	45.9	41.7	36.6
32	60.5	53.6	49.6	47.9	45.8	41.6	36.5
33	60.4	53.7	49.5	48.1	45.9	41.6	36.5
34	60.3	53.9	49.5	48.4	46.2	41.7	36.6
35	60.5	53.9	49.4	48.6	46.2	41.8	36.6
36	60.4	53.9	49.4	48.5	46.2	41.7	36.4
37	60.3	53.7	49.2	48.3	46.0	41.5	36.3
38	60.1	53.6	49.1	48.2	45.8	41.4	36.1
39	60.2	53.5	49.0	48.2	45.8	41.3	36.0
40	60.9	53.9	49.1	48.7	46.3	41.6	36.3
41	61.3	54.1	49.1	49.0	46.5	41.7	36.4
42	62.0	54.5	49.3	49.6	47.0	42.1	36.7

Façade Location 14 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	65.1	57.5	51.2	53.6	51.4	46.5	40.2
8	66.4	58.2	51.0	53.3	51.0	46.2	40.0
9	67.7	60.3	52.1	54.1	51.6	46.7	40.5
10	68.3	61.2	53.7	56.3	53.6	48.3	42.2

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
11	69.4	61.8	54.3	57.1	54.4	48.9	42.9
12	69.7	62.0	54.4	57.2	54.4	48.9	43.0
13	69.9	62.1	54.3	56.9	54.2	48.8	42.8
14	69.9	62.0	54.2	56.7	54.0	48.6	42.8
15	69.8	61.8	54.2	56.6	53.9	48.6	42.8
16	69.7	61.6	54.1	56.4	53.7	48.5	42.7
17	69.5	61.3	53.9	56.2	53.5	48.2	42.5
18	69.3	61.0	53.7	55.9	53.2	47.9	42.2
19	69.0	60.8	53.5	55.6	52.9	47.7	42.0
20	68.8	60.5	53.3	55.4	52.7	47.5	41.8
21	68.5	60.3	53.0	55.1	52.4	47.2	41.6
22	68.3	60.1	52.9	54.9	52.2	47.0	41.4
23	68.0	59.8	52.8	54.7	52.0	46.8	41.2
24	67.8	59.6	52.7	54.5	51.8	46.6	41.0
25	67.6	59.4	52.6	54.3	51.6	46.5	40.9
26	67.4	59.1	52.5	54.0	51.4	46.3	40.7
27	67.1	58.9	52.3	53.8	51.2	46.1	40.5
28	66.9	58.7	52.5	53.7	51.0	46.0	40.4
29	66.7	58.5	52.6	53.5	50.9	45.9	40.4
30	66.5	58.4	52.5	53.3	50.7	45.8	40.3
31	66.3	58.2	52.4	53.1	50.6	45.6	40.1
32	66.1	58.0	52.2	52.9	50.4	45.4	39.9
33	65.9	57.8	52.0	52.7	50.2	45.2	39.7
34	65.8	57.7	51.8	52.5	50.0	45.0	39.5
35	65.6	57.6	51.7	52.3	49.8	44.8	39.4
36	65.5	57.4	51.5	52.2	49.6	44.7	39.2
37	65.3	57.3	51.3	52.0	49.4	44.5	39.0
38	65.2	57.1	51.2	51.8	49.2	44.3	38.8
39	65.0	56.9	51.0	51.6	49.0	44.1	38.6
40	64.8	56.7	50.8	51.4	48.9	44.0	38.5
41	64.7	56.6	50.7	51.3	48.7	43.8	38.3
42	64.5	56.4	50.5	51.1	48.5	43.6	38.1

Appendix C – MVHR Duct Penetrations (Sound Flanking)

Red Zone (Attenuated)

Sound Flanking via MVHR Façade Openings									
Sound Flanking Path:	EXTERNAL noise into grille > acoustically lagged metal plenum+silencer > PVCu rectangular duct length in ceiling void > transmission through duct wall > through ceiling > ROOM								
Calculation Method:	SRL								
Room:	Bedroom (Red Zone - Attenuated)								
	Value	63	125	250	500	1k	2k	4k	dBA Notes
Normalised spec shape		0	0	0	0	0	0	0	arbitrary
Incident external Lp	100	100	100	100	100	100	100	100	
duct opening width (m)	0.22								
duct opening height (m)	0.06								
Lw into duct (+10*log10A)		81	81	81	81	81	81	81	< same as plenum to plenum
Silencer loss		-4	-5	-8	-10	-10	-10	-10	*500mm attenuator (35% EFA)
ceiling void duct width (m)	0.22								
ceiling void duct height (m)	0.06								
length of duct in room, L (m)	5								
number of duct runs	1								Always one duct per room
Transmission coefficient duct -10lg(1/T)		-20.0	-23.0	-25.0	-25.0	-27.0	-30.0	-34.0	See below from ASHRAE
SRL calculation corrections:									
Length effect		0.0	0.0	0.0	0.0	0.0	0.0	0.0	SRL book page 282, relatively short run & high transmission coefficient correction = 0
+10lgW correction		7.0	7.0	7.0	7.0	7.0	7.0	7.0	
Lw breakout of duct, LwB:		64	60	55	53	51	48	44	
Room width (m)	5								
Room length (m)	4								
Room height (m)	2.5								
Receiver distance (m)	1								
Reverberation time (s)	0.5								
Ceiling loss:		-8	-10	-12	-17	-20	-20	-20	plasterboard ceiling
Room Corrections:									
Directionality (Q=2, right up to soffit, 3dB):		3.0	3.0	3.0	3.0	3.0	3.0	3.0	
+10lg[2π/(1+cos(1/L/2π))]		-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	
+10lgW		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Direct Lp:		56.0	50.0	43.0	36.0	31.0	28.0	24.0	
+10*log(T/V)*14		-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	
+10lgW		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Reverb Lp:		50.2	44.2	37.2	30.2	25.2	22.2	18.2	
Total Lp In Room:		57.0	51.0	44.0	37.0	32.0	29.0	25.0	
Outside to Inside		43	49	56	63	68	71	75	

ASHRAE rectangular duct transmission loss calculation									
Lp	23 dB								
duct L =	220 duct length (mm)								
duct W =	60 duct width (mm)								
a =	8.661422 duct length (inches)								
b =	2.362206 duct width (inches)								
l =	5 length of duct in room (m)								
l (in feet) =	16.5 length of duct in room (feet)								
mass of duct wall	2.9216 kg/m2 (3.2mm of 913 kg/m3 PVC)								
conversion	0.598443261 lb/sqft								
Cross Over	1179 cross over freq from stiffness to mass								
fl =									
	63	125	250	500	1000	2000	4000		
delta LTLio (< fl)	20	23	26	29	32	35	38		
delta LTLio (> fl)					22	28	34		
Taken	20	23	25	25	27	30	34		

External Building Fabric Calculation									
$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_s}{S} 10^{-\frac{D_{nL}}{10}} + \frac{S_{gl}}{S} 10^{-\frac{R_{gl}}{10}} + \frac{S_r}{S} 10^{-\frac{R_r}{10}} + \frac{S_v}{S} 10^{-\frac{R_v}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{A} \right) + 3$									
external noise level (free-field)	100	dB							
size/no.									
wall	0.00	m2	0	%					
glazing	13.75	m2	1	%					
roof	0.00	m2							
vent	2.00	No.							
room	w (façade)/	4	l/	5	h/	2.5			
reverberation	T (s)	0.5							
normalised spectrum	arbitrary	63	125	250	500	1k	2k	4k	
shifted spectrum		100	100	100	100	100	100	100	
Wall:	none	0	0	0	0	0	0	0	
Glazing:	A	31	31	34	42	44	46	46	
Roof:	none	0	0	0	0	0	0	0	
Vent (Out-to-In loss):	D	43	49	56	63	68	71	75	
Internal Noise Level (without Vent)		71.3	71.3	68.3	60.3	58.3	56.3	56.3	66 [63-4kHz]
Internal Noise Level (with 2 x Vents)		71.6	71.4	68.3	60.4	58.3	56.3	56.3	66 [63-4kHz]
Level Difference (dB)		0.3	0.1	0.0	0.0	0.0	0.0	0.0	

Rw+Ctr	Glazing Config:
40	Red Spec
	Vent config:
-	MVHR (attenuated)

Orange & Yellow Zones

NB Calculation sheets only presented for the higher performance **orange** zone (the lesser performing **yellow** zone therefore compliant by default).

Sound Flanking via MVHR Façade Openings

Sound Flanking Path:	EXTERNAL noise into grille > acoustically lagged metal plenum+silencer > PVCu rectangular duct length in ceiling void > transmission through duct wall > through ceiling > ROOM									
Calculation Method:	SRL									
Room:	Bedroom (Orange & Yellow Zone - Unattenuated)									
	Value	63	125	250	500	1k	2k	4k	dBA	Notes
Normalised spec shape		0	0	0	0	0	0	0		arbitrary
Incident external Lp	100	100	100	100	100	100	100	100		
duct opening width (m)	0.22									
duct opening height (m)	0.06									
Lw into duct (+10*log10A)		81	81	81	81	81	81	81		< same as plenum to plenum
Silencer loss										
ceiling void duct width (m)	0.22									
ceiling void duct width (m)	0.06									
length of duct in room, L (m)	5									
number of duct runs	1									Always one duct per room
Transmission coefficient duct -10lg(1/T)		-20.0	-23.0	-25.0	-25.0	-27.0	-30.0	-34.0		See below from ASHRAE
SRL calculation corrections:										
Length effect		0.0	0.0	0.0	0.0	0.0	0.0	0.0		SRL book page 282, relatively short run & high transmission coefficient correction = 0
+10logL correction		7.0	7.0	7.0	7.0	7.0	7.0	7.0		
Lw breakout of duct, LwB:		68	65	63	63	61	58	54		
Room width (m)	5									
Room length (m)	4									
Room height (m)	2.5									
Receiver distance (m)	1									
Reverberation time (s)	0.5									
Ceiling loss:		-8	-10	-12	-17	-20	-20	-20		plasterboard ceiling
Room Corrections:										
Directionality (Q=2, tight up to soffit, 3dB):		3.0	3.0	3.0	3.0	3.0	3.0	3.0		
+10lg((2π/L)/tan-1(L/2π))		-3.2	-3.2	-3.2	-3.2	-3.2	-3.2	-3.2		
+10lgN		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Direct Lp:		60.0	55.0	51.0	46.0	41.0	38.0	34.0		
+10*log(T/V)+14		-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0		
+10lgN		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Reverb Lp:		54.2	49.2	45.2	40.2	35.2	32.2	28.2		
Total Lp in Room:		61.0	56.0	52.0	47.0	42.0	39.0	35.0		
Outside to Inside		39	44	48	53	58	61	65		

ASHRAE rectangular duct transmission loss calculation

Lp	23	dB																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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External Building Fabric Calculation

$$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_s}{S} 10^{-\frac{D_{N,e}}{10}} + \frac{S_w}{S} 10^{-\frac{R_w}{10}} + \frac{S_g}{S} 10^{-\frac{R_g}{10}} + \frac{S_r}{S} 10^{-\frac{R_r}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{S_A} \right) + 3$$

external noise level (free-field)		100	dB					
	size/no.							
wall		0.00	m2	0	%			
glazing		13.75	m2	1	%			
roof		0.00	m2					
vent		2.00	No.					
room	w (façade)/	4	l/	5	h/	2.5		
reverberation	T (s)	0.5						
		63	125	250	500	1k	2k	4k
normalised spectrum	arbitrary	0	0	0	0	0	0	0
shifted spectrum		100	100	100	100	100	100	100
Wall:	none	0	0	0	0	0	0	0
Glazing:	B	28	28	34	41	44	46	46
Roof:	none	0	0	0	0	0	0	0
Vent (Out-to-In loss):	C	39	44	48	53	58	61	65
Internal Noise Level (without Vent)		74.3	74.3	68.3	61.3	58.3	56.3	56.3
Internal Noise Level (with 2 x Vents)		74.7	74.4	68.5	61.6	58.5	56.5	56.4
Level Difference (dB)		0.4	0.1	0.2	0.3	0.2	0.2	0.1

Rw+Ctr	Glazing Config:
38	Orange Spec
	Vent config:
-	MVHR (unattenuated)

66	(63-4kHz)
66	(63-4kHz)

Rw+Ctr	38
Glazing Config:	Orange Spec
Vent config:	MVHR (unattenuated)
-	

Appendix D – Environmental Noise Calculation Sheets

Example Calculation Sheets – Noise Intrusion into Worst-Case L12 Hotel Room (Orange Zone)

Level 12 Worst-Case Hotel Room – Daytime Leq,16hr

External Building Fabric Calculation									
$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_g}{S} 10^{\frac{-D_{n,g}}{10}} + \frac{S_w}{S} 10^{\frac{-R_w}{10}} + \frac{S_g}{S} 10^{\frac{-R_g}{10}} + \frac{S_r}{S} 10^{\frac{-R_r}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{A} \right) + 3$									
external noise level (free-field)	62	dB							
size/no.									
wall	0.00	m2	0	%					
glazing	14.85	m2	1	%					
roof	0.00	m2							
vent	1.00	No.							
room reverberation	w (façade)/ T (s)	4 0.5	l/ 5	h/ 2.7					
		63	125	250	500	1k	2k	4k	
normalised spectrum	day	2	0	-2	-5	-5	-8	-12	
shifted spectrum		64	62	60	57	57	54	50	
Wall:	none	0	0	0	0	0	0	0	Rw+Ctr 38
Glazing:	A	28	28	34	41	44	46	46	Glazing Config: Orange Spec
Roof:	none	0	0	0	0	0	0	0	Dn,e,w+Ctr 51
Vent:	D	37	42	46	51	56	59	63	Vent config: MVHR (unatten)
Internal Noise Levels		39	36	28	19	15	10	6	25 (63-4kHz)

Level 12 Worst-Case Hotel Room – Night-time Leq,16hr

External Building Fabric Calculation									
$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_g}{S} 10^{\frac{-D_{n,g}}{10}} + \frac{S_w}{S} 10^{\frac{-R_w}{10}} + \frac{S_g}{S} 10^{\frac{-R_g}{10}} + \frac{S_r}{S} 10^{\frac{-R_r}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{A} \right) + 3$									
external noise level (free-field)	59	dB							
size/no.									
wall	0.00	m2	0	%					
glazing	14.85	m2	1	%					
roof	0.00	m2							
vent	1.00	No.							
room reverberation	w (façade)/ T (s)	4 0.5	l/ 5	h/ 2.7					
		63	125	250	500	1k	2k	4k	
normalised spectrum	night	1	1	-3	-4	-4	-7	-11	
shifted spectrum		60	60	56	55	55	52	48	
Wall:	none	0	0	0	0	0	0	0	Rw+Ctr 38
Glazing:	A	28	28	34	41	44	46	46	Glazing Config: Orange Spec
Roof:	none	0	0	0	0	0	0	0	Dn,e,w+Ctr 51
Vent:	D	37	42	46	51	56	59	63	Vent config: MVHR (unatten)
Internal Noise Levels		35	34	24	17	13	8	4	22 (63-4kHz)

Level 12 Worst-Case Hotel Room – Night-time L_{max}

External Building Fabric Calculation									
$Lp(int) = Lp(ext) + 10 \times \log_{10} \left(\frac{A_n}{S} 10^{\frac{-D_{n,e}}{10}} + \frac{S_w}{S} 10^{\frac{-R_w}{10}} + \frac{S_g}{S} 10^{\frac{-R_g}{10}} + \frac{S_r}{S} 10^{\frac{-R_r}{10}} \right) + 10 \times \log_{10} \left(\frac{S}{A} \right) + 3$									
external noise level (free-field)		76	dB						
	size/no.								
wall		0.00	m2	0	%				
glazing		14.85	m2	1	%				
roof		0.00	m2						
vent		2.00	No.						
room	w (façade)/	4	l/	5	h/	2.7			
reverberation	T (s)	0.5							
		63	125	250	500	1k	2k	4k	
normalised spectrum	night	1	1	-3	-4	-4	-7	-11	
shifted spectrum		77	77	73	72	72	69	65	
Wall:	none	0	0	0	0	0	0	0	Rw+Ctr
Glazing:	A	28	28	34	41	44	46	46	38
Roof:	none	0	0	0	0	0	0	0	Dn,e,w+Ctr
Vent:	D	37	42	46	51	56	59	63	51
Internal Noise Levels		52	52	42	34	31	26	21	39
									(63-4kHz)

Appendix E – Entertainment Noise Calculation Sheets

Calculations of internal noise levels are based on the incident noise levels presented in Appendix B, minus the façade sound reduction performance specification in Section 4.0, plus the highest hotel/apartment transfer function (i.e. the façade/room correction for the worst-case hotel/apartment habitable rooms). The worst-case transfer functions are +2 dB (in each octave band) for hotel guestrooms, and +3 dB (in each octave band) for apartments.

The target ‘entertainment’ internal noise levels are summarised below.

‘Entertainment’ Internal Noise Limit, dB Leq,5min

Room	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Hotel/Apt	47	41	32	24	20	17	14

The following tables present the predicted internal noise levels for the façade locations presented in Appendix B at each floor level.

Façade Location 1 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	47	41	30	23	19	12	5
8	46	41	29	23	19	12	4
9	46	40	28	22	18	11	4
10	46	39	28	22	18	11	4
11	45	39	27	22	17	11	4
12	45	39	27	21	17	10	3
13	44	38	27	21	17	10	3
14	44	38	26	21	16	10	3
15	47	40	26	22	16	9	3
16	46	40	26	21	16	9	3
17	46	39	25	21	16	9	2
18	47	40	26	22	16	9	3
19	46	40	26	21	16	9	3
20	46	39	26	21	16	9	3
21	46	39	26	21	15	9	2
22	46	39	25	21	15	8	2
23	45	38	25	20	15	8	2
24	45	38	25	20	15	8	2
25	45	38	25	20	14	8	1
26	44	38	24	19	14	7	1
27	44	37	24	19	14	7	1
28	44	37	24	19	14	7	1
29	47	39	28	22	16	9	3
30	46	38	27	21	16	9	3
31	46	38	27	21	16	9	3
32	46	38	27	21	16	9	3
33	46	38	27	21	15	9	3
34	45	38	27	21	15	8	2
35	45	37	27	20	15	8	2
36	45	37	27	20	15	8	2
37	45	37	26	20	15	8	2
38	45	37	26	20	14	8	2
39	44	37	26	20	14	7	1

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
40	44	36	26	19	14	7	1
41	44	36	26	19	14	7	1
42	44	36	26	19	14	7	1

Façade Location 3 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	42	36	22	16	11	4	-2
8	42	37	23	17	12	6	0
9	45	40	25	18	14	7	1
10	45	40	25	19	14	7	2
11	45	40	25	19	13	7	2
12	45	39	26	19	14	8	3
13	44	39	26	19	14	8	3
14	44	39	27	20	15	8	3
15	44	39	27	21	16	9	4
16	43	39	27	21	16	9	4
17	43	39	27	20	15	9	3
18	44	39	28	21	16	9	4
19	43	39	27	21	16	9	4
20	43	39	27	21	15	9	4
21	46	40	31	23	18	12	6
22	45	40	31	23	18	11	6
23	45	40	30	23	17	11	6
24	45	40	30	22	17	11	6
25	45	39	30	22	17	10	5
26	44	39	30	22	17	10	5
27	44	39	29	22	16	10	5
28	44	39	29	21	16	10	5
29	44	38	29	21	16	9	4
30	43	38	29	21	16	9	4
31	43	38	28	21	15	9	4
32	43	38	28	20	15	9	4
33	43	37	28	20	15	8	3
34	43	37	28	20	15	8	3
35	42	37	27	20	14	8	3
36	42	37	27	19	14	8	3
37	42	37	27	19	14	8	2
38	42	36	27	19	14	7	2
39	42	36	26	19	14	7	2
40	42	36	26	19	13	7	2
41	41	36	26	18	13	7	2
42	41	36	26	18	13	7	1

Façade Location 7 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	38	31	20	14	8	1	-4
8	39	33	21	14	9	2	-2
9	40	33	22	14	9	2	-2
10	41	35	24	16	10	4	0
11	41	36	25	17	11	5	1
12	41	37	25	17	11	5	2
13	41	37	26	18	12	5	2
14	41	37	26	18	12	6	2
15	41	37	26	19	13	6	3
16	40	37	26	19	13	6	3
17	40	37	26	18	12	6	2
18	44	40	31	22	16	10	6
19	44	39	31	22	16	9	6
20	44	39	31	22	16	9	6
21	45	39	30	21	16	9	5

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
22	45	39	30	22	16	9	5
23	45	39	30	21	16	9	5
24	45	39	30	21	15	9	5
25	45	38	29	21	15	9	5
26	45	38	29	21	15	8	4
27	45	38	29	20	15	8	4
28	44	38	29	20	14	8	4
29	44	37	29	20	14	8	4
30	44	37	28	20	14	8	4
31	44	37	28	19	14	7	3
32	44	37	28	19	14	7	3
33	43	37	28	19	13	7	3
34	43	36	27	19	13	7	3
35	43	36	27	19	13	6	2
36	43	36	27	18	13	6	2
37	43	36	27	18	12	6	2
38	42	35	26	18	12	6	2
39	42	35	26	18	12	6	1
40	42	35	26	17	12	5	1
41	42	35	26	17	12	5	1
42	42	35	26	17	11	5	1

Façade Location 8 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	46	37	26	20	16	10	1
8	46	37	26	20	16	10	1
9	45	36	25	19	15	9	1
10	44	35	25	18	14	8	2
11	44	35	26	18	14	8	2
12	46	37	26	19	13	7	2
13	46	37	26	18	13	7	2
14	45	37	26	19	13	6	2
15	45	37	26	18	12	6	2
16	44	36	26	18	12	6	2
17	44	36	26	18	12	5	2
18	45	37	26	19	13	6	3
19	44	37	26	18	13	6	2
20	44	37	26	18	12	6	2
21	44	37	26	18	12	5	2
22	46	38	30	21	15	8	5
23	46	38	29	21	15	8	5
24	46	38	29	20	15	8	4
25	45	38	29	21	15	8	4
26	45	38	29	20	15	8	4
27	45	38	29	20	14	8	4
28	45	37	28	20	14	8	4
29	44	37	28	20	14	7	3
30	44	37	28	19	14	7	3
31	44	37	28	19	14	7	3
32	44	36	28	19	13	7	3
33	43	36	27	19	13	7	3
34	43	36	27	19	13	6	2
35	43	36	27	18	13	6	2
36	43	36	27	18	12	6	2
37	42	35	26	18	12	6	2
38	42	35	26	18	12	6	2
39	42	35	26	18	12	5	1
40	42	35	26	17	12	5	1
41	42	35	26	17	11	5	1
42	41	34	25	17	11	5	1

Façade Location 10 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	35	29	18	12	7	0	-5
8	35	29	18	12	7	0	-6
9	35	29	18	12	7	0	-6
10	35	29	18	12	6	0	-6
11	35	29	18	12	6	-1	-6
12	35	29	18	12	6	-1	-6
13	34	29	17	11	6	-1	-6
14	34	29	17	11	6	-1	-6
15	34	29	17	11	6	-1	-6
16	34	29	17	11	6	-1	-7
17	34	28	17	11	5	-1	-7
18	38	31	22	15	9	2	-3
19	38	31	22	14	9	2	-3
20	38	31	22	14	9	2	-3
21	38	31	22	14	9	2	-3
22	38	31	22	14	9	2	-3
23	38	31	22	14	9	2	-3
24	38	31	23	14	9	2	-3
25	38	31	23	14	9	3	-3
26	38	32	23	14	9	3	-3
27	38	31	23	14	9	2	-3
28	38	31	23	14	8	2	-3
29	38	31	23	13	8	2	-3
30	39	31	23	13	8	2	-3
31	39	31	23	13	8	2	-3
32	39	31	23	13	8	2	-4
33	38	31	23	13	8	2	-4
34	38	31	23	13	8	2	-3
35	39	31	22	14	8	2	-3
36	38	31	22	14	8	2	-4
37	38	31	22	13	8	2	-4
38	38	31	22	13	8	1	-4
39	38	31	22	13	8	1	-4
40	39	31	22	14	8	2	-4
41	39	31	22	14	9	2	-4
42	40	32	22	15	9	2	-3

Façade Location 14 (dB Leq,5min)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	39	32	19	15	9	3	-4
8	40	32	19	14	9	2	-4
9	42	34	20	15	10	3	-4
10	42	35	22	17	12	4	-2
11	43	36	22	18	12	5	-1
12	44	36	22	18	12	5	-1
13	44	36	22	18	12	5	-1
14	44	36	22	18	12	5	-1
15	44	36	22	18	12	5	-1
16	44	36	22	17	12	5	-1
17	44	35	22	17	12	4	-2
18	44	36	23	18	12	5	-1
19	44	36	23	18	12	5	-1
20	44	36	22	17	12	5	-1
21	44	35	22	17	11	4	-1
22	43	35	22	17	11	4	-2
23	43	35	22	17	11	4	-2
24	43	35	22	17	11	4	-2
25	43	34	22	16	11	4	-2
26	42	34	22	16	10	3	-2

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
27	42	34	21	16	10	3	-3
28	42	34	22	16	10	3	-3
29	45	36	26	19	13	6	0
30	45	35	26	18	13	6	0
31	44	35	25	18	13	6	0
32	44	35	25	18	12	5	0
33	44	35	25	18	12	5	0
34	44	35	25	18	12	5	-1
35	44	35	25	17	12	5	-1
36	44	34	25	17	12	5	-1
37	43	34	24	17	11	5	-1
38	43	34	24	17	11	4	-1
39	43	34	24	17	11	4	-1
40	43	34	24	16	11	4	-2
41	43	34	24	16	11	4	-2
42	43	33	24	16	11	4	-2