St Michaels (Ph.3 Bl.A) Manchester

Noise Insulation Scheme Report:
Planning Condition 8

Client:
St Michaels UK Propco 2 Limited
Unit 3, Birchwood One Business Park
Dewhurst Road, Birchwood
Warrington, WA3 7GB

Date:
13 November 2023

Our Ref:
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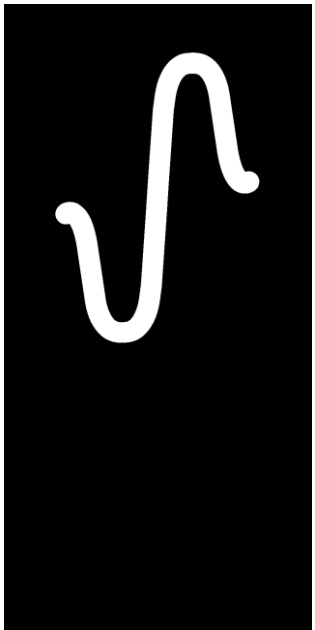

JAMESON ACOUSTICS

Consultants in acoustics,
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Document Control

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1.0 Introduction

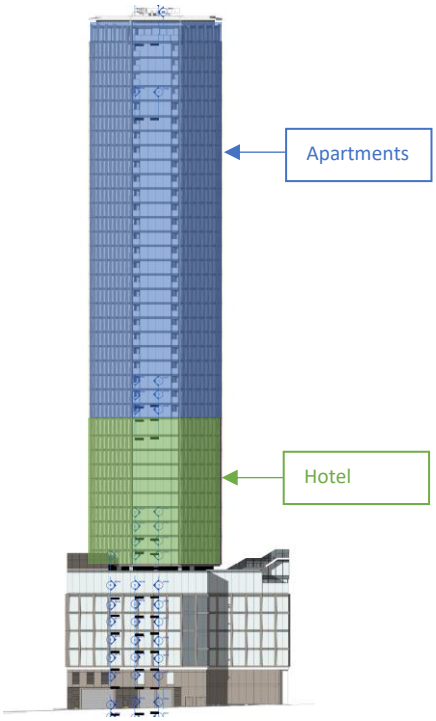
Jameson Acoustics Limited has been commissioned to provide a noise insulation scheme for the residential elements of the St Michael's development in Manchester. This report presents the proposed noise insulation scheme to achieve the requirements of Planning Condition 8, which states:

> ***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.

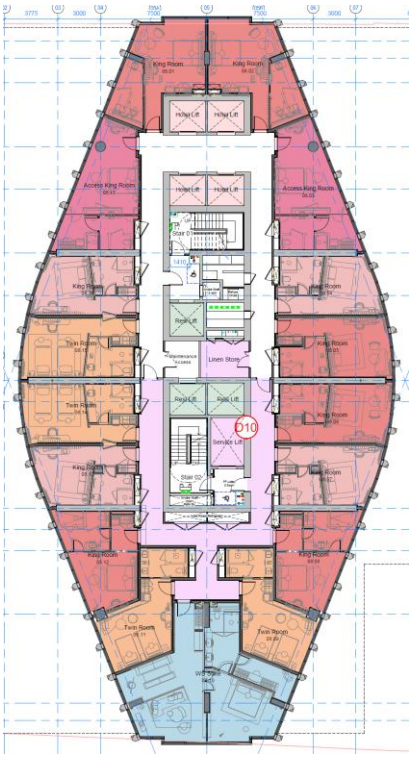
2.0 Scheme Overview

The residential accommodation is located within the Phase 3 Block A tower in the form of hotel rooms from level 7 to level 16 and apartments from level 17 to level 43, as illustrated below.

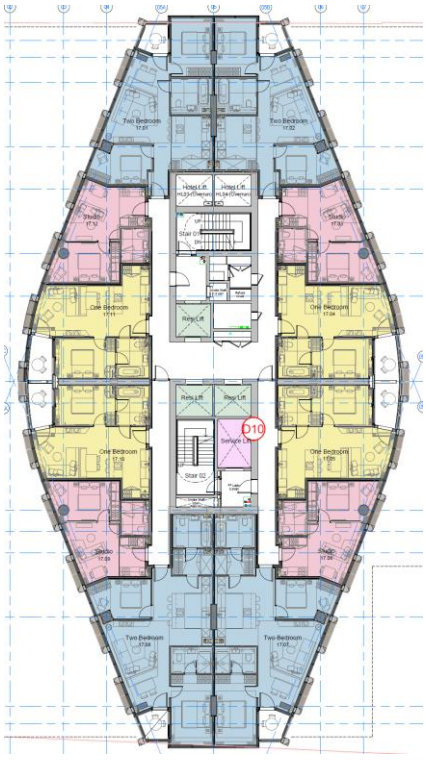


South elevation illustrating hotel/residential floors of the tower

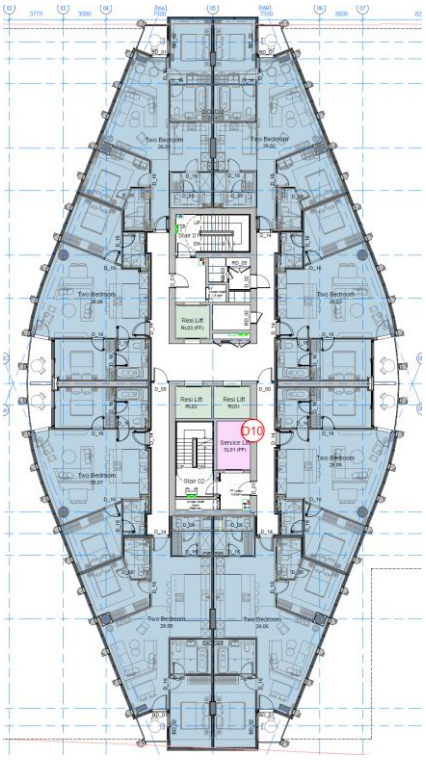
Hotel rooms will comprise a mix of twin-rooms, king rooms and suites. Apartments will comprise a mix of studios, one-beds, two-beds, three-beds and penthouses. The following Figures show a typical hotel floor layout and a typical low-level, mid-level, upper-level and penthouse level apartment floor layouts.



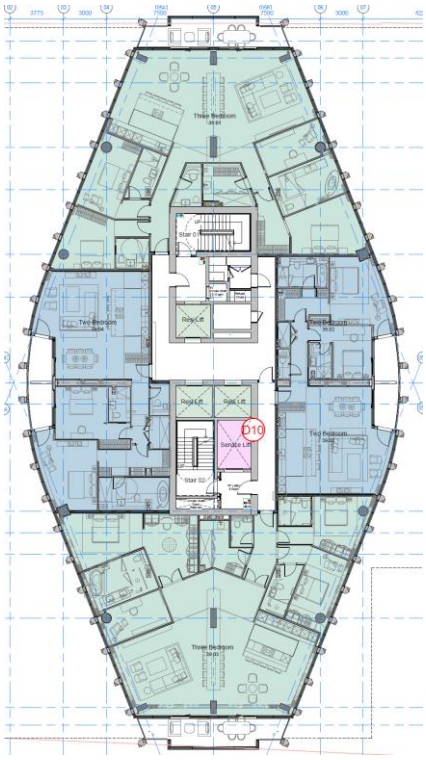
Typical hotel floor layout



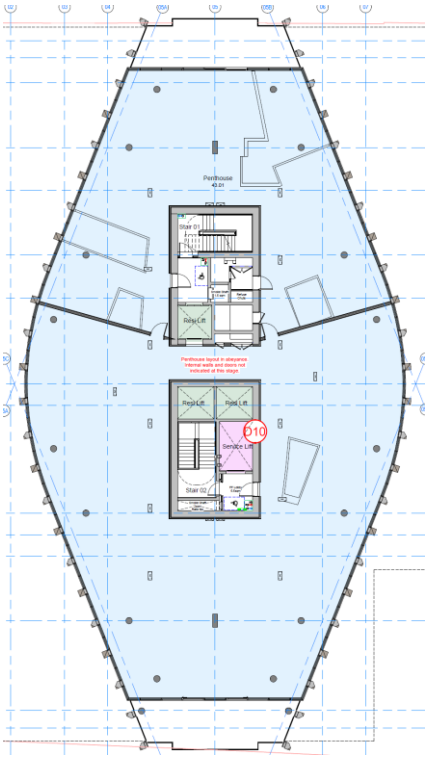
Typical low-level residences floor layout



Typical mid-level residences floor layout



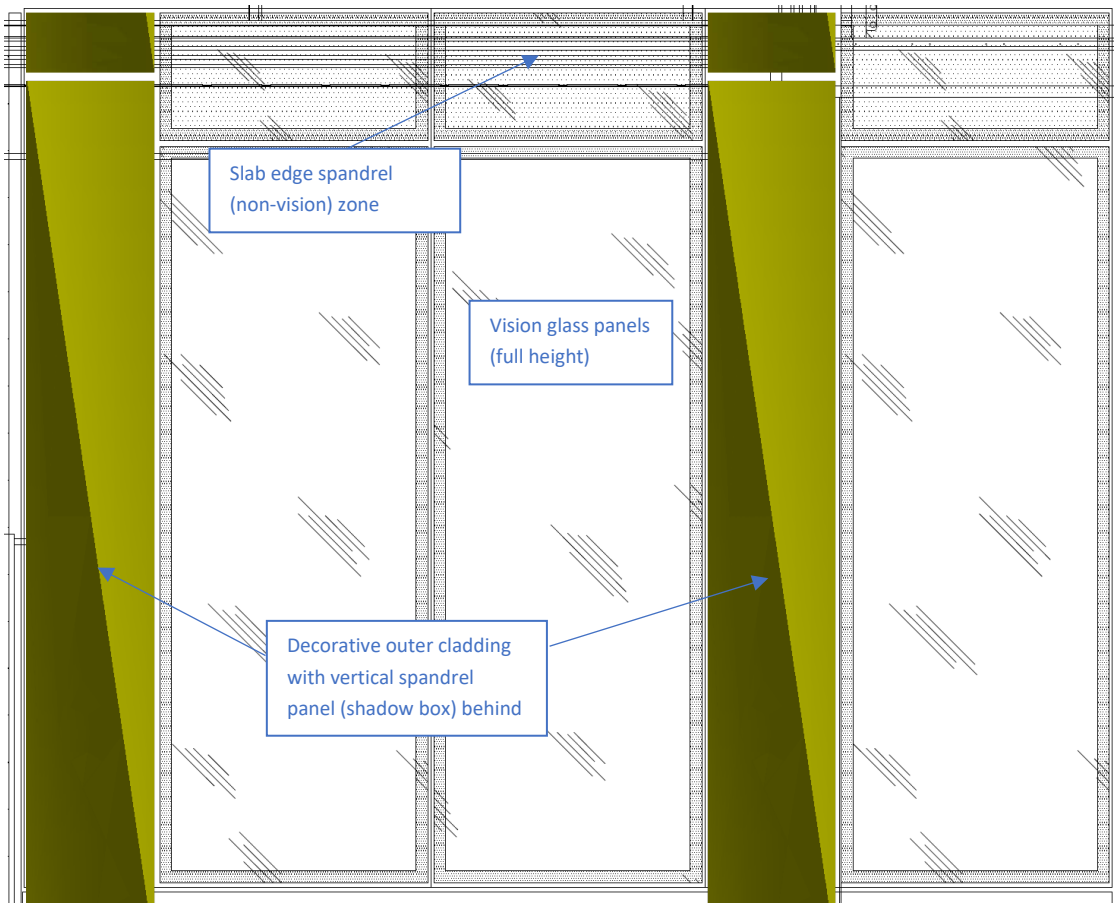
Typical upper-level residences floor layout



Penthouse residences floor layout

3.0 Façade Design

The tower facades will be formed from a unitised curtain walling system supplied by Yuanda Europe Limited. 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 Yuanda 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.

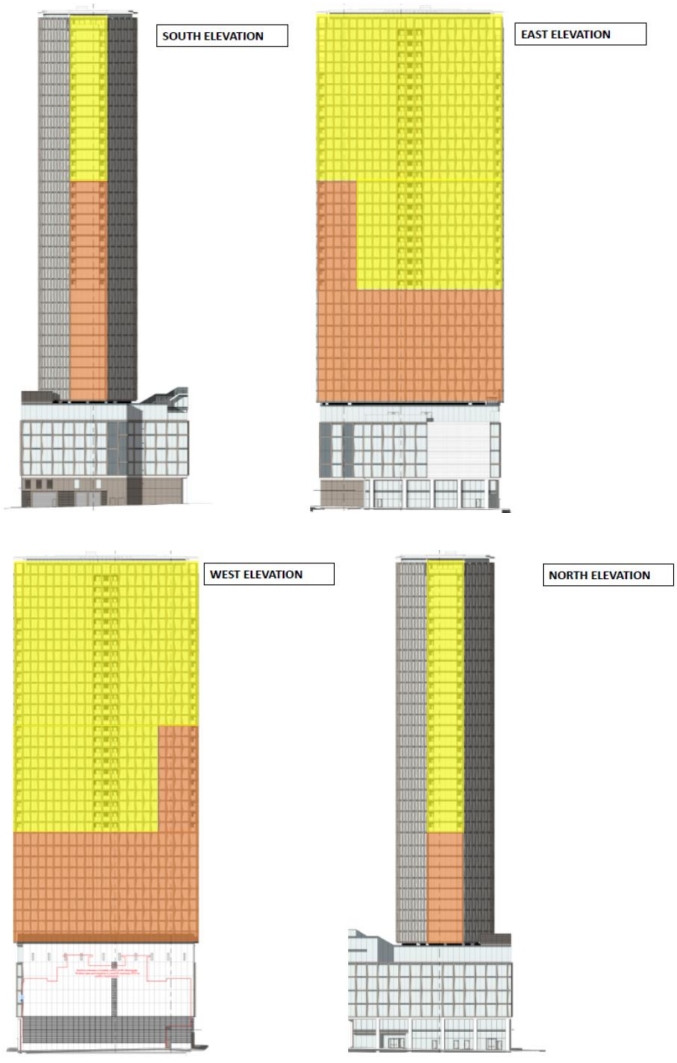
4.0 Façade Sound Reduction Performance Specification

The 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	
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.



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	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.

Full survey details are presented in Appendix B.

5.2 Assessments

5.2.1 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 L_{Aeq}	30 dB L_{Aeq} 45 dB L_{Amax}*
Residential	Living Rooms	35 dB L_{Aeq}	-
	Bedrooms	-	30 dB L_{Aeq} 45 dB L_{Amax}*

* 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 $L_{Aeq,16hr}$	Night-time (2300-0700), dB $L_{Aeq,8hr}$	Night-Time (2300-0700) Maximum Noise Level, dB L_{AFmax}
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:

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

Calculation sheets to demonstrate compliance with internal noise levels are presented in Appendix C. These sheets present calculations into worst-case hotel guestrooms on the north/south façade at Level 7.

The façade construction comprises unitised curtain walling (achieving the specification presented in Section 4.0). Noise intrusion via façade mounted MVHR ventilation grilles has been considered, with no façade attenuators. These losses are based on a calculation (also included in Appendix C) in accordance with SRL and ASHRAE methods.

The results indicate the following internal noise levels within a typical L7 hotel room. 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).

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	**26**	**23**	**41**
Design Criterion	*35*	*30*	*45*
Compliance?	✓	✓	✓

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.

5.2.2 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.

Assessment Clarifications

1. Music noise breakout from the Albert Hall venue has been excluded. Jameson Acoustics has been instructed to design the façade excluding this contribution on the basis that the Developer will explore solutions to combat this noise 'at source'.

2. The key existing (off-site) entertainment noise sources considered are:

   - 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).

3. 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.

4. 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.

5. Our assessment considers all 'active' entertainment sources operating concurrently (cumulative assessment).

6. 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.

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

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

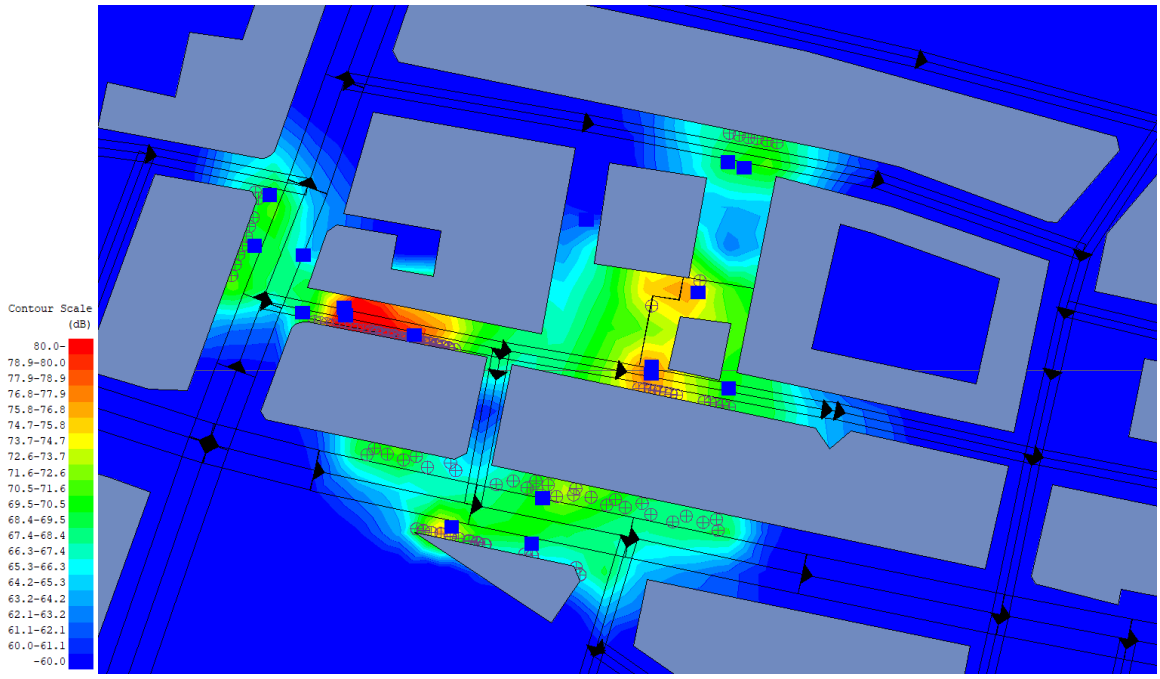
8. To simplify the calculations, a transfer function for each 'type' of internal habitable room has been determined, accounting for variations in façade surface area, room dimensions, reverberation time (0.5 seconds in habitable rooms), and ventilation openings for MVHR ductwork. Façade specifications 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
	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 by Jameson Acoustics and Hann Tucker (excluding Albert Hall music noise breakout).

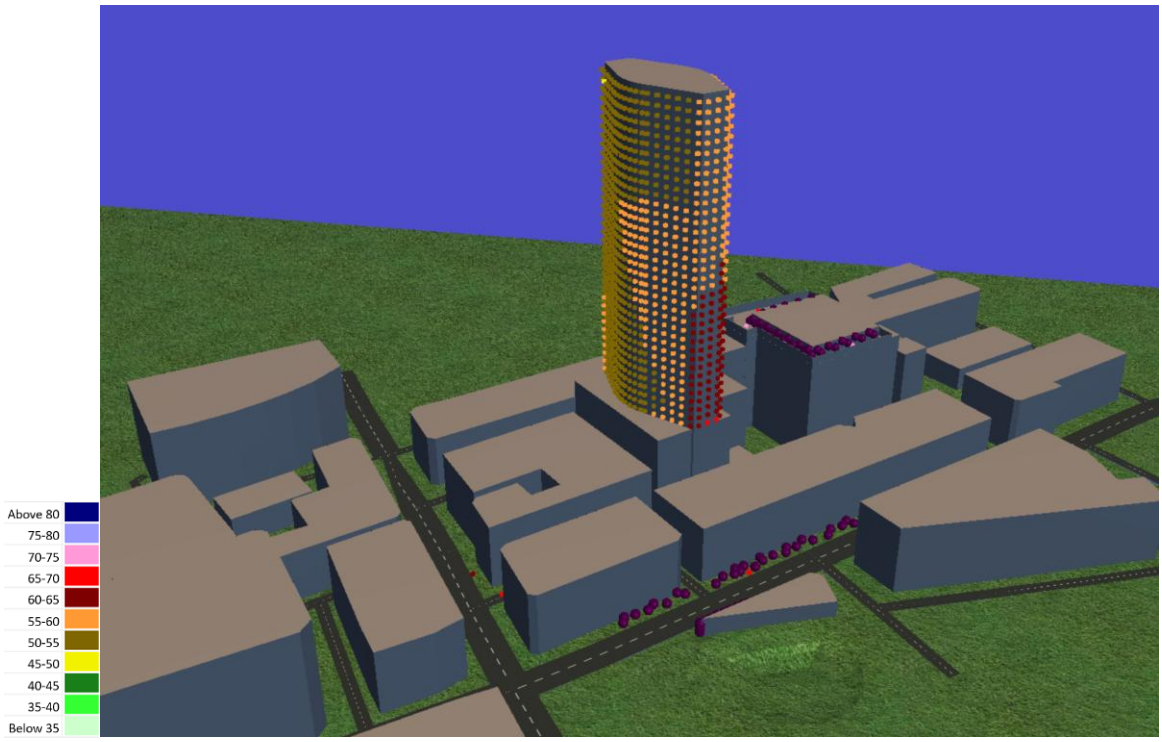
The following Figure presents the existing site in plan and shows the street-level spread of noise from the all off-site entertainment noise sources.



Existing Site Plan showing spread of 'off-site' entertainment noise (at street level), dB $L_{Aeq,5min}$

The following Figures illustrate incident off-site and on-site (Sky Bar) entertainment noise levels (dBA) 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).

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



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

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

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

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

Demonstrating Compliance

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

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, with the exception of music noise breakout from the Albert Hall venue.

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, excluding music noise breakout from the Albert Hall venue.

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

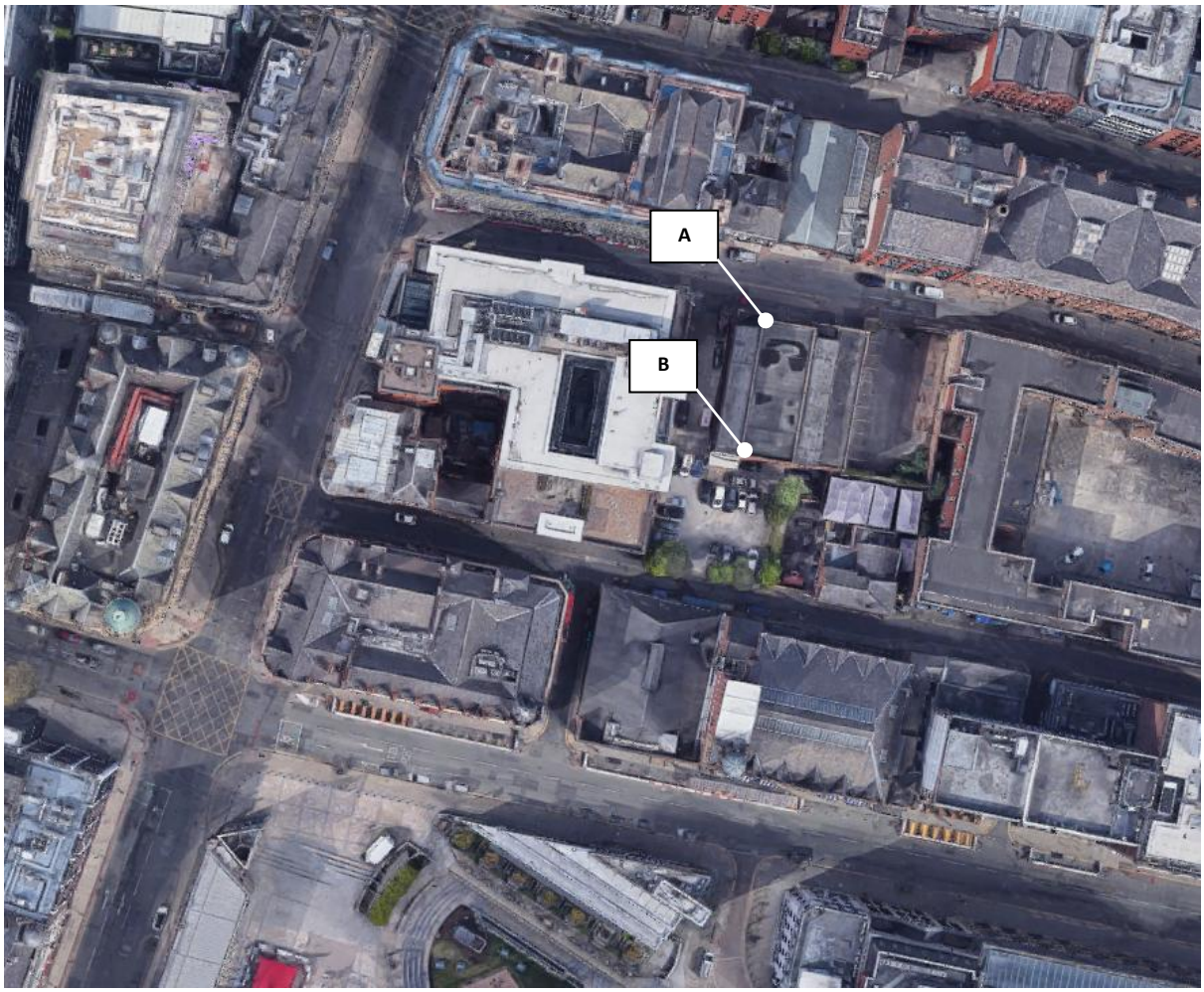
B1 – Environmental Noise Surveys/Studies

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 LAeq 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	-

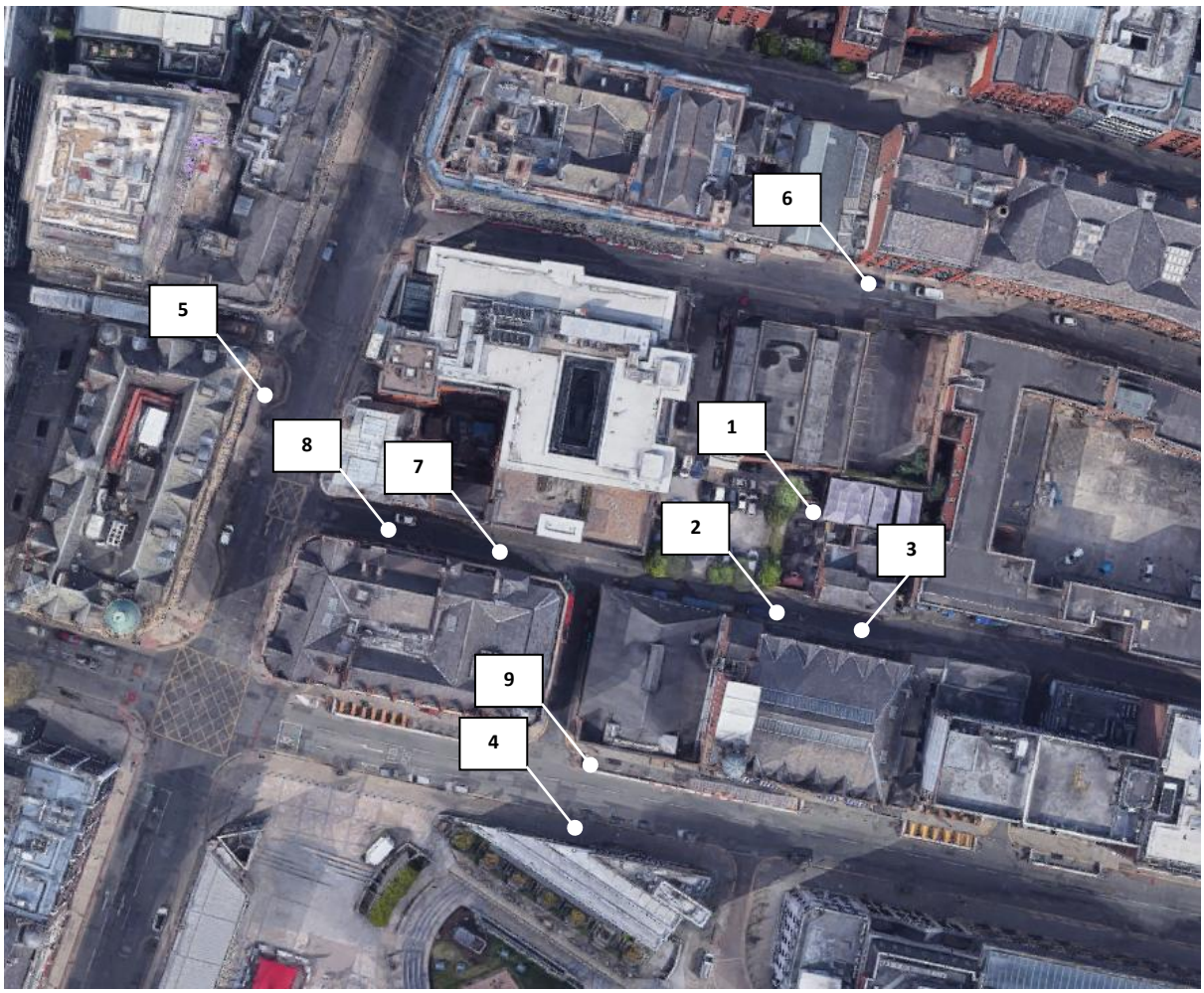
B2 – Entertainment Noise Surveys/Studies

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.

Position	Description
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**
4	87	78	71	71	69	65	60	**73**
5	83	77	75	69	68	65	61	**73**

Position	Sound Level, $L_{eq,5min}$ (dB) at OBCF (Hz)							A-Weighted, $L_{Aeq,5min}$ (dB)
	63	125	250	500	1k	2k	4k	
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.

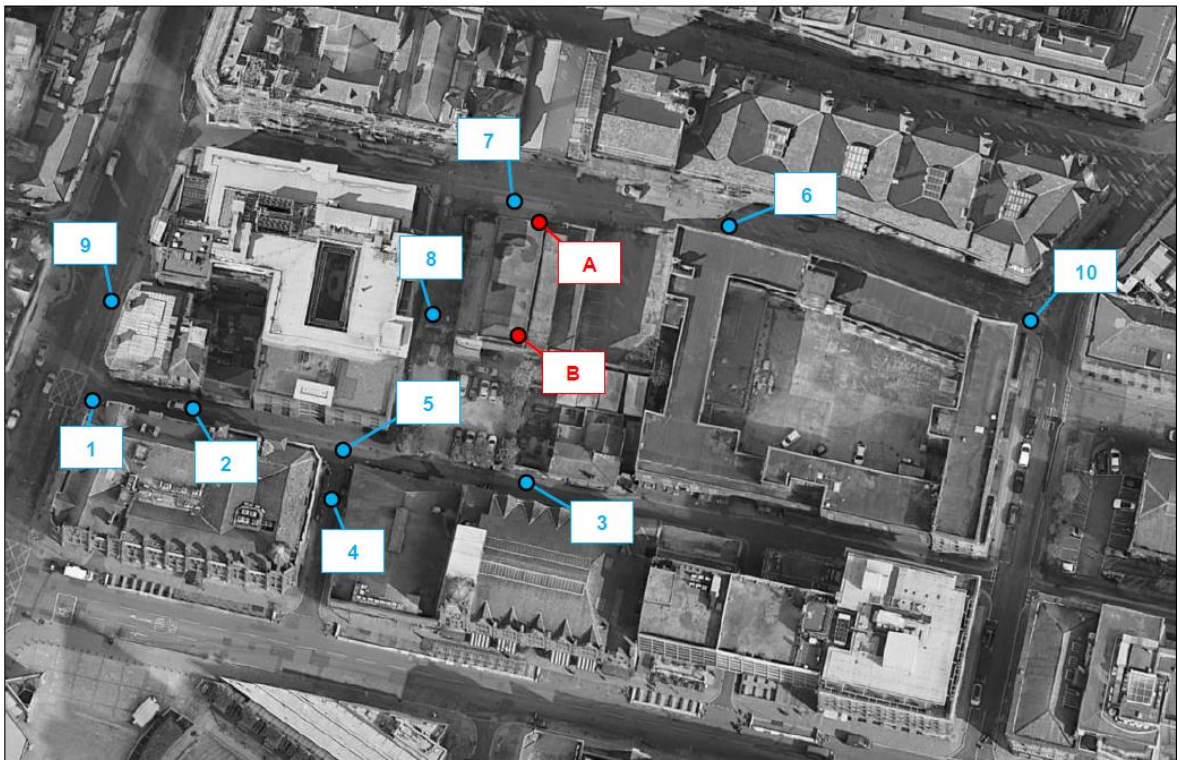
- Hann Tucker Stage 3 Residential Acoustic Design Report, Appendix D.
- Hoare Lea Planning Condition 32 & 35 Assessment Report Rev 01 (Phase 1 Sky Bar).

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.
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.

Position	Hann Tucker Measurement Description
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.

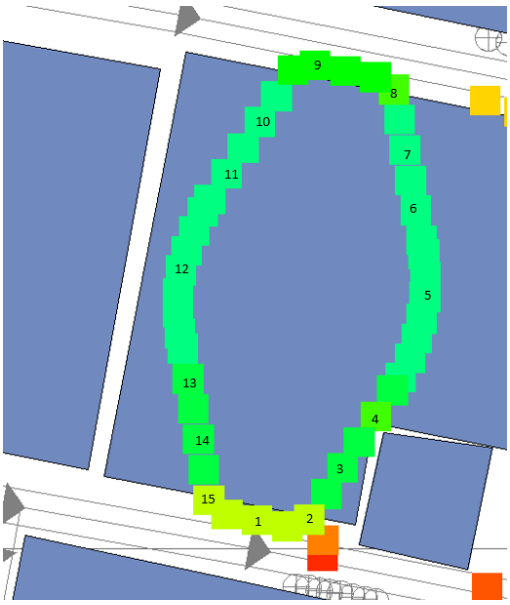
Frequency	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	L_{Aeq}
Internal noise limit, $L_{eq,1min}$ (dB)	94	96	89	88	83	81	81	79	90

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.

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.



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 (excluding music noise breakout from the Albert Hall venue) 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, 4, 5, 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	72	66	59	63	61	56	49
8	72	66	59	63	61	56	48
9	71	65	58	62	60	55	48
10	71	65	58	62	60	55	48
11	71	65	58	62	59	55	48
12	71	65	58	61	59	54	47
13	71	65	58	61	59	54	47
14	71	65	58	61	58	54	47
15	71	64	58	60	58	53	47
16	70	64	57	60	58	53	47
17	70	64	57	60	57	53	46
18	70	64	57	59	57	52	46
19	70	63	57	59	57	52	46
20	69	63	57	59	56	52	45
21	69	63	56	59	56	51	45
22	69	63	56	58	56	51	45
23	69	62	56	58	56	51	45
24	68	62	56	58	55	51	44
25	68	62	55	57	55	50	44
26	68	62	55	57	55	50	44
27	68	61	55	57	55	50	44
28	67	61	55	57	54	50	44
29	67	61	55	56	54	49	43
30	67	61	54	56	54	49	43
31	67	61	54	56	54	49	43
32	67	60	54	56	54	49	43
33	66	60	54	56	53	49	43
34	66	60	54	55	53	48	42
35	66	60	54	55	53	48	42
36	66	60	54	55	53	48	42
37	66	59	53	55	52	48	42
38	66	59	53	55	52	48	42
39	65	59	53	54	52	47	41
40	65	59	53	54	52	47	41
41	65	59	53	54	52	47	41
42	65	59	52	54	52	47	41

Façade Location 4 (dB $L_{eq,5min}$)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	67	63	56	59	58	53	46
8	67	63	57	59	57	53	46
9	67	63	57	59	57	53	46
10	67	63	58	59	57	53	46
11	67	63	58	59	57	52	46
12	66	64	58	59	57	52	47
13	67	64	59	59	57	52	47
14	67	64	59	59	57	52	47
15	67	64	59	59	56	52	47
16	67	64	59	59	56	52	47
17	67	64	58	58	56	52	47
18	67	64	58	58	56	51	47
19	66	64	58	58	56	51	46
20	66	63	58	58	55	51	46
21	66	63	58	57	55	51	46
22	66	63	57	57	55	50	46
23	65	63	57	57	55	50	45
24	66	63	57	57	55	51	46
25	65	62	57	57	55	50	45
26	65	62	57	57	55	50	45
27	65	62	56	57	54	50	45

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
28	65	62	56	56	54	50	45
29	64	61	56	56	54	49	44
30	64	61	56	56	54	49	44
31	64	61	55	56	53	49	44
32	64	61	55	55	53	49	44
33	64	61	55	55	53	48	43
34	63	60	55	55	53	48	43
35	63	60	54	55	52	48	43
36	63	60	54	55	52	48	43
37	63	60	54	54	52	48	43
38	63	59	54	54	52	47	42
39	62	59	54	54	52	47	42
40	62	59	53	54	51	47	42
41	62	59	53	53	51	47	42
42	62	59	53	53	51	47	42

Façade Location 5 (dB $L_{eq,5min}$)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	62	58	53	54	51	47	42
8	63	61	55	55	52	48	44
9	63	61	55	55	52	48	44
10	64	62	56	56	53	48	45
11	64	62	57	56	53	49	45
12	64	63	58	56	54	49	46
13	65	64	59	58	55	51	47
14	66	64	59	58	56	52	47
15	66	64	59	59	56	52	47
16	66	64	59	58	56	52	47
17	66	64	59	58	56	52	47
18	66	64	58	58	56	51	47
19	66	63	58	58	55	51	46
20	65	63	58	57	55	51	46
21	65	63	58	57	55	51	46
22	65	63	57	57	55	50	46
23	65	62	57	57	54	50	45
24	64	62	57	56	54	50	45
25	64	62	57	56	54	49	45
26	64	62	56	56	53	49	45
27	64	61	56	56	53	49	44
28	64	61	56	56	53	49	44
29	63	61	56	55	53	49	44
30	63	61	56	55	53	48	44
31	63	61	55	55	53	48	44
32	63	60	55	55	52	48	43
33	63	60	55	55	52	48	43
34	62	60	55	54	52	48	43
35	62	60	54	54	52	47	43
36	62	60	54	54	52	47	43
37	62	59	54	54	52	47	43
38	62	59	54	54	51	47	42
39	62	59	54	54	51	47	42
40	61	59	54	54	51	47	42
41	61	59	53	53	51	46	42
42	61	58	53	53	51	46	42

Façade Location 8 (dB $L_{eq,5min}$)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	64	60	56	58	55	49	45
8	64	60	57	58	55	49	45
9	64	60	57	58	55	49	45
10	64	62	57	58	55	50	46

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
11	64	62	58	58	55	50	46
12	64	62	58	58	55	50	46
13	64	62	58	57	55	50	46
14	64	63	58	58	55	50	46
15	64	63	58	57	54	50	46
16	64	62	58	57	54	50	46
17	64	62	58	57	54	49	46
18	64	62	57	57	54	49	46
19	63	62	57	56	54	49	45
20	63	62	57	56	53	49	45
21	63	62	57	56	53	48	45
22	63	61	57	56	53	48	45
23	63	61	56	56	53	48	45
24	63	61	56	55	53	48	44
25	63	61	56	56	53	48	44
26	63	61	56	55	53	48	44
27	62	61	56	55	52	48	44
28	62	60	55	55	52	48	44
29	62	60	55	55	52	47	43
30	62	60	55	54	52	47	43
31	62	60	55	54	52	47	43
32	62	59	55	54	51	47	43
33	61	59	54	54	51	47	43
34	61	59	54	54	51	46	42
35	61	59	54	53	51	46	42
36	61	59	54	53	50	46	42
37	61	58	53	53	50	46	42
38	60	58	53	53	50	46	42
39	60	58	53	53	50	45	41
40	60	58	53	52	50	45	41
41	60	58	53	52	49	45	41
42	60	57	52	52	49	45	41

Façade Location 10 (dB $L_{eq,5min}$)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	61	55	50	51	49	44	39
8	61	55	50	51	49	44	39
9	61	55	50	51	49	44	38
10	61	55	50	51	48	44	38
11	61	55	50	51	48	43	38
12	61	55	50	51	48	43	38
13	60	55	49	50	48	43	38
14	60	55	49	50	48	43	38
15	60	55	49	50	48	43	38
16	60	55	49	50	48	43	38
17	60	54	49	50	47	43	37
18	60	54	49	50	47	42	37
19	60	54	49	49	47	42	37
20	60	54	49	49	47	42	37
21	60	54	49	49	47	42	37
22	60	54	49	49	47	42	37
23	60	54	49	49	47	42	37
24	60	54	50	49	47	42	37
25	60	54	50	49	47	43	37
26	60	55	50	49	47	43	37
27	60	54	50	49	47	42	37
28	60	54	50	49	46	42	37
29	60	54	50	48	46	42	37
30	60	54	50	48	46	42	37
31	59	54	50	48	46	42	37
32	59	54	50	48	46	42	37

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
33	60	54	50	48	46	42	37
34	60	54	50	48	46	42	37
35	61	54	49	49	46	42	37
36	60	54	49	49	46	42	36
37	60	54	49	48	46	42	36
38	60	54	49	48	46	41	36
39	60	54	49	48	46	41	36
40	61	54	49	49	46	42	36
41	61	54	49	49	47	42	36
42	62	55	49	50	47	42	37

Façade Location 14 (dB $L_{eq,5min}$)

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
7	58	51	54	51	47	40	58
8	57	51	53	51	46	40	57
9	58	52	54	52	47	41	58
10	61	54	56	54	48	42	61
11	61	54	57	54	49	43	61
12	61	54	57	54	49	43	61
13	61	54	57	54	49	43	61
14	61	54	57	54	49	43	61
15	61	54	57	54	49	43	61
16	61	54	56	54	49	43	61
17	61	54	56	54	48	43	61
18	61	54	56	53	48	42	61
19	60	54	56	53	48	42	60
20	60	53	55	53	48	42	60
21	60	53	55	52	47	42	60
22	60	53	55	52	47	41	60
23	60	53	55	52	47	41	60
24	59	53	55	52	47	41	59
25	59	53	54	52	47	41	59
26	59	53	54	51	46	41	59
27	59	52	54	51	46	41	59
28	59	53	54	51	46	40	59
29	59	53	54	51	46	40	59
30	58	53	53	51	46	40	58
31	58	52	53	51	46	40	58
32	58	52	53	50	45	40	58
33	58	52	53	50	45	40	58
34	58	52	53	50	45	40	58
35	58	52	52	50	45	39	58
36	57	52	52	50	45	39	57
37	57	51	52	49	45	39	57
38	57	51	52	49	44	39	57
39	57	51	52	49	44	39	57
40	57	51	51	49	44	39	57
41	56	51	51	49	44	38	56
42	56	51	51	49	44	38	56

Appendix C – Environmental Noise Calculation Sheets

Level 7 Worst-Case Hotel Room – Daytime $L_{eq,16hr}$

External Building Fabric Calculation

$$Lp(int) = Lp(ext) + 10 \times log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_W}{S}10^{\frac{-R_W}{10}} + \frac{S_g}{S}10^{\frac{-R_g}{10}} + \frac{S_r}{S}10^{\frac{-R_r}{10}}\right) + 10 \times log_{10}(\frac{S}{A})+3$$

external noise level (free-field)		63	dB					
	size/no.							
wall		0.00	m2	0	%			
glazing		14.85	m2	1	%			
roof		0.00	m2					
vent		1.00	No.					
room	w (façade)/	4	l/	5	h/	2.7		
reverberation	T (s)	0.5						

		63	125	250	500	1k	2k	4k
normalised spectrum	day	2	0	-2	-5	-5	-8	-12
shifted spectrum		65	63	61	58	58	55	51
Wall:	none	0	0	0	0	0	0	0
Glazing:	A	28	28	34	41	44	46	46
Roof:	none	0	0	0	0	0	0	0
Vent:	D	45	50	54	59	62	62	67
Internal Noise Levels		39	37	29	19	16	11	7

Rw+Ctr	Glazing Config:
38	Orange Spec
Dn,e,w+Ctr	Vent config:
61	MVHR (unatten)
26	(63-4kHz)

Level 7 Worst-Case Hotel Room – Night-time $L_{eq,16hr}$

External Building Fabric Calculation

$$Lp(int) = Lp(ext) + 10 \times log_{10}\left(\frac{A_0}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_W}{S}10^{\frac{-R_W}{10}} + \frac{S_g}{S}10^{\frac{-R_g}{10}} + \frac{S_r}{S}10^{\frac{-R_r}{10}}\right) + 10 \times log_{10}(\frac{S}{A})+3$$

external noise level (free-field)		60	dB					
	size/no.							
wall		0.00	m2	0	%			
glazing		14.85	m2	1	%			
roof		0.00	m2					
vent		1.00	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		61	61	57	56	56	53	49
Wall:	none	0	0	0	0	0	0	0
Glazing:	A	28	28	34	41	44	46	46
Roof:	none	0	0	0	0	0	0	0
Vent:	D	45	50	54	59	62	62	67
Internal Noise Levels		35	35	25	17	14	9	5

Rw+Ctr	Glazing Config:
38	Orange Spec
Dn,e,w+Ctr	Vent config:
61	MVHR (unatten)
23	(63-4kHz)

Level 7 Worst-Case Hotel Room – Night-time L_{max}

External Building Fabric Calculation

$$Lp(int) = Lp(ext) + 10 \times log_{10}\left(\frac{A_S}{S}10^{\frac{-D_{n,e}}{10}} + \frac{S_W}{S}10^{\frac{-R_W}{10}} + \frac{S_g}{S}10^{\frac{-R_g}{10}} + \frac{S_r}{S}10^{\frac{-R_r}{10}}\right) + 10 \times log_{10}\left(\frac{S}{A}\right)+3$$

external noise level (free-field)		78	dB					
	size/no.							
wall		0.00	m2	0	%			
glazing		14.85	m2	1	%			
roof		0.00	m2					
vent		1.00	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		79	79	75	74	74	71	67
Wall:	none	0	0	0	0	0	0	0
Glazing:	A	28	28	34	41	44	46	46
Roof:	none	0	0	0	0	0	0	0
Vent:	D	45	50	54	59	62	62	67
Internal Noise Levels		53	53	43	35	32	27	23

Rw+Ctr	Glazing Config:
38	Orange Spec
Dn,e,w+Ctr	Vent config:
61	MVHR (unatten)

41 (63-4kHz)

Noise intrusion through unattenuated MVHR façade grilles & ceiling mounted ductwork

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**

	Value	63	125	250	500	1k	2k	4k	dBA	Notes
Normalised spec shape		0	0	0	0	0	0	0		arbitary
Incident external Lp	100	100	100	100	100	100	100	100		
duct opening width (m)	0.11									125mm circ. diameter apeture
duct opening height (m)	0.11									125mm circ. diameter apeture
Lw into duct (+10*log10A-6)		75	75	75	75	75	75	75		
Silencer loss										none
ceiling void duct width (m)	0.21									
ceiling void duct width (m)	0.06									
length of duct in room, L (m)	4									
number of duct runs	1									Always one duct per room
Transmission coefficient duct -10lg(1/T)		-21.0	-24.0	-25.0	-25.0	-25.0	-25.0	-30.0		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		6.0	6.0	6.0	6.0	6.0	6.0	6.0		
Lw breakout of duct, LwB:		**60**	**57**	**56**	**56**	**56**	**56**	**51**		
Room width (m)	4									
Room length (m)	3									
Room height (m)	2.5									
Receiver distance (m)	1									
Reverberation time (s)	0.5									
Ceiling loss:		-7	-9	-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((2r/L)tan-1(L/2r))		-2.6	-2.6	-2.6	-2.6	-2.6	-2.6	-2.6		
+10lgN		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Direct Lp:		53.3	48.3	44.3	39.3	36.3	36.3	31.3		
*+10*log(T/V)+14*		-3.8	-3.8	-3.8	-3.8	-3.8	-3.8	-3.8		
+10lgN		0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Reverb Lp:		49.1	44.1	40.1	35.1	32.1	32.1	27.1		
Total Lp in Room:		54.7	49.7	45.7	40.7	37.7	37.7	32.7		
Outside to Inside		45.3	50.3	54.3	59.3	62.3	62.3	67.3		
Dn,e Performance of Vent Route (to 0dp)		**45**	**50**	**54**	**59**	**62**	**62**	**67**		

ASHRAE rectangular duct transmission loss calculation

Lp		
delta LTLio (min) =	33	dB
duct L =	200	duct length (mm)
duct W =	60	duct width (mm)
a =	7.87402	duct length (inches)
b =	2.362206	duct width (inches)
l =	4	length of duct in room (m)
l (in feet) =	157.4804	length of duct in room (feet)
mass of duct wall	2.9216	kg/m2 (3.2mm of 913 kg/m3 PVC)
conversion	0.608666667	lb/sqft
Cross Over		
fL =	1297	cross over freq from stiffness to mass

	63	125	250	500	1000	2000	4000
delta LTLio (< fL)	21	24	27	30	33		
delta LTLio (> fL)					22	28	34
Taken	**21**	**24**	**25**	**25**	**25**	**25**	**30**

Appendix D – 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 $L_{eq,5min}$

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 $L_{eq,5min}$)

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

Floor	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
40	43	36	26	19	14	7	1
41	43	36	26	19	14	7	1
42	43	36	25	19	14	7	1

Façade Location 4 (dB $L_{eq,5min}$)

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

Façade Location 5 (dB $L_{eq,5min}$)

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

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

Façade Location 8 (dB $L_{eq,5min}$)

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

Façade Location 10 (dB $L_{eq,5min}$)

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	38	31	22	15	9	3	-3
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	38	31	23	13	8	2	-3
31	37	31	23	13	8	2	-3
32	37	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 $L_{eq,5min}$)

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