

Project

Co-op Live
Acoustic Validation Testing

Prepared for

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Version History

Version	Date	Comments	Approved by
P01	13/05/2024	-	Dave Clarke

Summary

BAM Construction appointed SRL Technical Services to measure music noise breakout from the Co-op Live arena bowl to determine whether the requirements of Condition 23 have been achieved. The closest and most affected noise sensitive receptor is a block of flats at 2 Stuart Street.

Previous noise breakout measurements highlighted an acoustic weakness in the south façade of the arena where two MVHR intake louvres located in the level 04 south hangout bar (which is open to the arena bowl and exposed to high levels of music noise) were not connected to the louvres by ductwork.

The permanent works to connect the ductwork to the louvre and lag the ductwork are now complete so SRL has repeated the noise breakout measurements on the roof of No. 2 Stuart Street and at ground floor level, 1m from the façade of No. 2 Stuart Street.

When we took our previous measurements music breakout was just audible during lulls between traffic at the No. 2 Stuart Street ground floor measurement locations. Now the permanent works are complete, music breakout was completely inaudible at all measurement locations at all times. We did subjective listening tests with two representatives of Manchester City Council's Licensing Out of Hours Team around the perimeter of the arena building and at the No. 2 Stuart Street receptor location whilst music was playing in the arena bowl at the design levels. They agreed that music was completely inaudible at the building perimeter and the No. 2 Stuart Street receptor location.

The derived entertainment noise levels at the upper-storey receptors of 2 Stuart Street are below the noise limits at all frequencies. This demonstrates that the requirements of Condition 23 (a) and (b) have been achieved at this location.

The derived music noise levels at the ground floor receptors of 2 Stuart Street are below the entertainment noise limits at all frequencies, except potentially at 2kHz and 4kHz, as it is not possible to demonstrate categorically that the levels have been met due to the relatively high ambient noise at these frequencies. We had similar issues at these frequencies when we took our previous noise measurements. I consider that Condition 23 (a and b) has been achieved at this location for the following reasons:

- Music was completely inaudible at all measurement locations and immediately outside the building.
- The measured noise levels were very consistent with music on and music off. This consistency demonstrates that the ambient noise levels are dominant.
- Low frequency noise is much more difficult to control, and therefore as it's been possible to demonstrate that the low frequency noise breakout levels are below the noise limits, it's most likely that the high frequency breakout is also significantly below the noise limits.
- The ambient noise levels are around 20dB higher than the music breakout noise limits and it is not possible to say categorically that one noise source is 20 dB lower than another noise source.

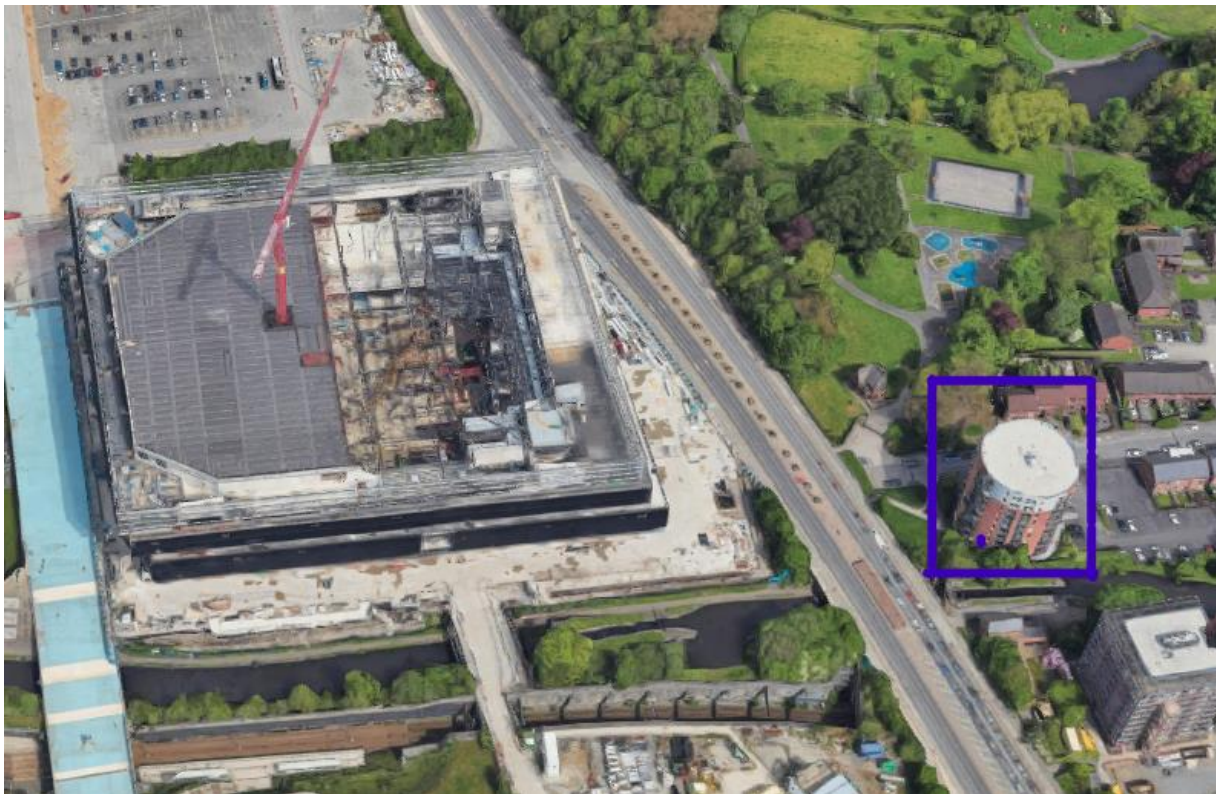
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1.0 Introduction

SRL has previously measured noise breakout from the Co-op Live arena to determine whether the requirements of Condition 23 (entertainment noise) have been achieved at the closest and most affected noise sensitive receptor at No. 2 Stuart Street, which is located approximately 100m to the east of the site on the other side of Alan Turing Way and highlighted with blue borders in Figure 1.

Figure 1 – Stuart Street Receptor



The conclusions from our previous measurements were as follows:

“The derived entertainment noise levels at the upper-storey receptors of 2 Stuart Street were below the noise limits at all frequencies. This demonstrates that the requirements of Condition 23 (a) and (b) have been achieved at this location.

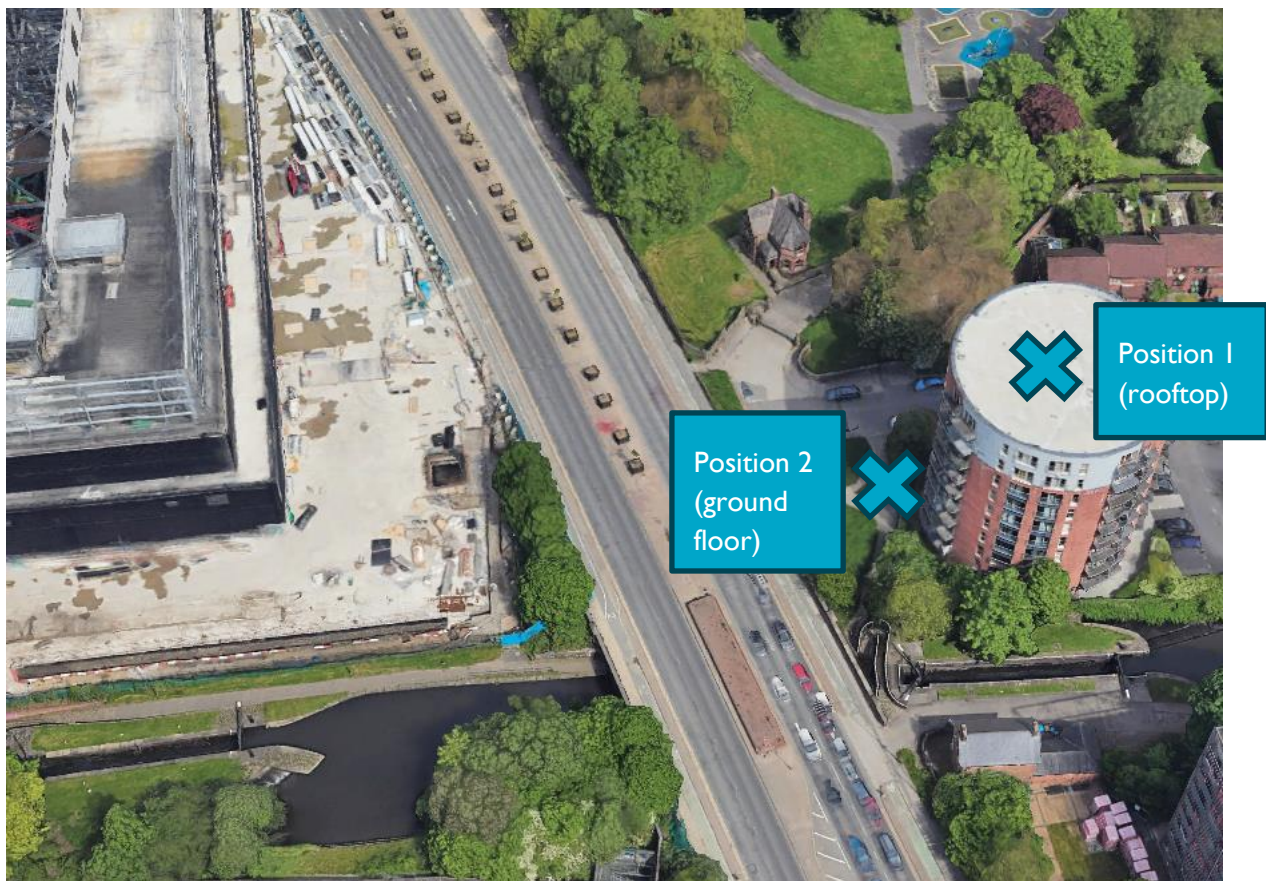
The derived music noise levels at the ground floor receptors of 2 Stuart Street were below the entertainment noise limits at all frequencies, except at 250Hz, 2kHz and 4kHz. Despite these exceedances, I consider that Condition 23 (a and b) has been achieved at this location for the following reasons:

- The ambient noise levels (particularly at higher frequencies) were masking the music noise levels and therefore the actual music noise levels are expected to be lower than the derived levels.
- The music source noise levels within the arena were set higher than the internal levels which will be used for concerts.
- An acoustic weakness was discovered in the south façade when subjective listening tests were done. Two MVHR intake louvres located in the level 04 south hangout bar (open to the arena bowl and exposed to high levels of music noise) were not connected to the louvres by ductwork. Once the ductwork is installed, sealed appropriately to the louvres and lagged with a dense barrier material (with a minimum mass per unit area of 10 kg/m²) to reduce music noise breaking into the ducts, I expect the music noise will be further reduced at the receptor locations”.

Manchester City Council has requested additional noise breakout measurements once the permanent works to the louvre are completed to address the acoustic weakness in the south façade.

The permanent works are now complete so SRL has repeated the noise breakout measurements on the roof of No. 2 Stuart Street and at ground floor level, 1m from the façade of No. 2 Stuart Street.

Figure 2 – Noise Measurement Positions



Measurement position I was free-field at 1.5 above the roof (approximately 28.5m above ground level).

Figure 3 – Measurement position I



Measurement position 2 was 1m from the façade at 1.5m above ground level).

Figure 4 – Measurement position 2



(Note - Photos above were taken during our original testing. The same measurement positions were used for our repeated testing).

2.0 Planning Condition 23 - Entertainment Noise Breakout

The noise breakout-related planning condition attached to consent ref. I26431/FO/2020 is reproduced below.

Condition 23a:

“The acoustic insulation of the arena building hereby approved shall be implemented in accordance with the following documents:

- Appendix 10 of the Environmental Statement (Noise survey results) stamped as received by the City Council, as Local Planning Authority, on the 30 March 2020;*
- Acoustic response prepared by BuroHappold stamped as received by the City Council, as Local Planning Authority, on the 17 June 2020; and*
- Technical Note ‘Noise and Vibrations’ stamped as received by the City Council, as Local Planning Authority, on the 3 July 2020”.*

Buro Happold and Vanguardia have agreed noise limits with MCC which are based on MCC noise and planning guidance for low frequency entertainment noise within dwellings:

“Music noise levels in the 63Hz and 125Hz octave centre frequency bands (L_{eq}) should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB (L_{eq}), respectively”.

The noise limits for the other octave bands above these frequency ranges (250Hz upwards) are 10dB below the baseline L_{90} noise levels.

The proposed entertainment noise limits at 1m from the façade of the nearest noise sensitive receptors are summarised in Table 1. Events within the bowl will not take place beyond 11pm and therefore only the daytime noise limits for entertainment noise are relevant.

Table 1 – External entertainment noise limits at residential receptors

	Octave band centre frequency							dB(A)
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
L_{eq}, dB Day (07:00 – 23:00)	52*	46*	42	41	42	32	19	44
L_{eq}, dB Night (07:00 – 23:00)	52*	46*	34	32	32	22	16	35

* Noise limits include an assumed attenuation of 5dB at these frequencies for a façade containing an open window.

Should an assessment of noise break-out levels be subject to façade reflections (e.g. the windows are closed on the NSR) then the noise level limits detailed above are subject to a 3 dB addition in all octave band frequencies.

Condition 23(b) of the planning approval requires validation measurements to demonstrate with the requirements of Condition 23(a).

“(b) Prior to the first use of the development, a verification report will be required to validate that the work undertaken conforms to the recommendations and requirements approved within part (a) of this planning condition. The verification report shall include post completion testing to confirm the noise criteria has been met. In instances of non conformity, these shall be detailed along with mitigation measures required to ensure compliance with the noise criteria. Any mitigation measures shall be implemented in accordance with a timescale to be agreed with the City Council, as Local Planning Authority, and thereafter retained and maintained in situ”.

3.0 Music Noise Breakout

3.1 Arena Noise Levels

A large PA system was set up within the arena bowl which is typical of the system that touring artists would bring to the arena. The system consisted of multiple line arrays suspended from the arena gantry and bass bins placed on the arena floor.

Figure 5 – Arena PA system

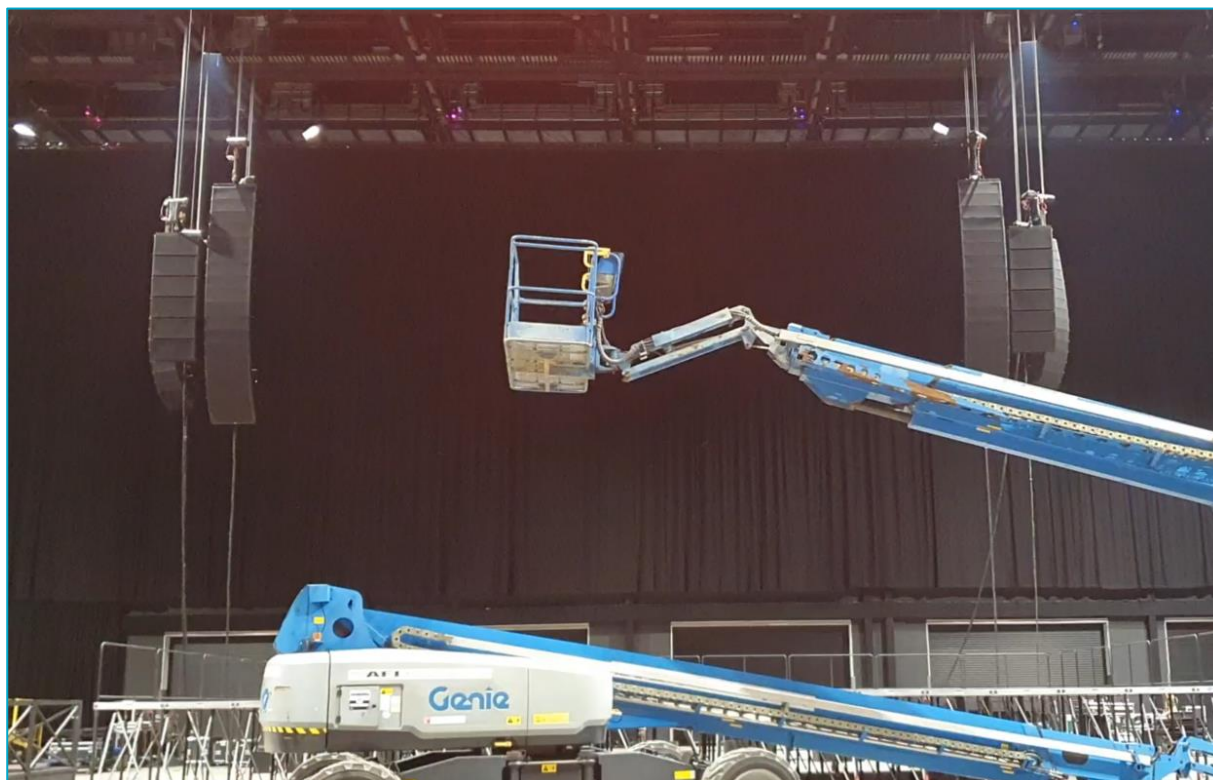


Table 2 – Arena bowl internal noise levels during measurements ($L_{eq,5mins}$)

Location	Octave band centre frequency, Hz							dBA
	63	125	250	500	1k	2k	4k	
FOH desk (level 0)	116	106	101	103	100	96	94	105
<i>Design concert levels</i>	<i>116</i>	<i>110</i>	<i>104</i>	<i>101</i>	<i>100</i>	<i>92</i>	<i>88</i>	<i>104</i>

These levels generated for our noise breakout tests represent the highest (“worst-case”) levels which will be generated within the arena.

3.2 Works to Address Previously Discovered Acoustic Weakness in Building Envelope

The ductwork connecting two MVHRs to intake louvres located in the level 04 south hangout bar (which is open to the arena bowl and exposed to high levels of music noise) has now been installed. In accordance with the acoustic design requirements the ductwork has been appropriately sealed to the louvres and lagged with a dense barrier material to reduce music noise breaking into the ducts.

Music breakout is now completely inaudible in locations where it was previously audible following the completion of these works, even during lulls in road traffic.

The installed ductwork can be seen in Figure 6.

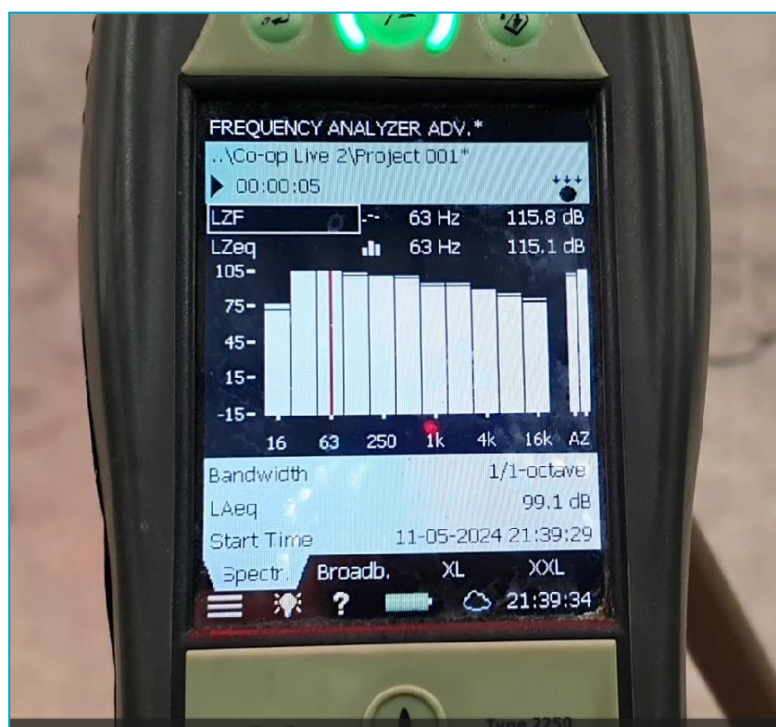
Figure 6 – Installed ductwork, including dense lagging



3.3 Subjective Listening

Two representatives of Manchester City Council's Licensing Out of Hours Team joined us during our visit. We showed them the PA system within the arena bowl and demonstrated music being played at the design levels using the sound pressure levels displayed on our sound level meter which we'd used to calibrate the music levels (see Figure 7).

Figure 7 – Sound level meter calibration of music levels



We walked around the perimeter of the arena building together between 10pm and 11pm whilst music was playing in the arena bowl at the design levels. It was agreed by all parties that music was completely inaudible at the building perimeter and the No. 2 Stuart Street receptor location, even during lulls in road traffic.

3.4 Noise Measurements

Measurements were taken at the No. 2 Stuart Street receptor between 00:00hrs and 00:30hrs on Saturday 13th May 2024. We took 5-minute noise level measurements over a 30-minute period at the two measurement locations shown in Figure 2 alternately with music on and music off.

3.5 Assessment of Music Noise Levels

The requirement is for music noise alone to meet the stated limits at the receptor locations. The receptor noise measurements also include existing ambient noise, which is louder than noise from the sound source, so the music noise level must be derived from the measurements. For example, as the music breakout levels at the receptor locations are lower than the ambient noise levels, the music level can only be determined approximately, especially as the ambient noise varies over time. To allow more accurate measurements we have deliberately taken the measurements later at night when the ambient noise levels were lower.

Measurements have been assessed by the most relevant Scenario for each octave band from 63Hz to 4kHz.

Where the receptor L_{eq} noise level with music playing is the same (or less than) the ambient L_{eq} noise level without any music, then the music L_{eq} noise level is **at least** 10dB below the ambient L_{eq} noise level, however you cannot say with certainty how much below.

Where the receptor L_{eq} noise level with music playing is up to 3 dB higher than the ambient L_{eq} noise level alone, then it is possible to estimate the music noise level as follows.

Increase in measured noise level when music is playing	The “music” noise level alone is the measured noise level, minus
3 dB	3 dB
2 dB	4 or 5 dB
1 dB	6 to 9 dB

The calculation is:

$$\text{Music noise level } L_{eq} = 10 \log_{10} (10^{L_R/10} - 10^{L_B/10})$$

Where:

- L_R is the measured receptor L_{eq} noise level (background noise plus “music” noise from the source)
- L_B is the measured ambient L_{eq} noise level

3.6 Results - Stuart Street Rooftop

Noise measurements on the Stuart Street receptor rooftop are presented in Table 3. At all times noise from music breakout was inaudible, even during lulls in road traffic. Noise levels were dominated by other local sources; road traffic, Metrolink trams, occasional aircraft, distant fireworks and use of the passenger lift within the Stuart Street building.

Table 3 – Music noise breakout measurements at Position 1 (Stuart Street Rooftop), dB $L_{eq,5mins}$

Scenario	Start time	Octave band centre frequency, Hz							dBA
		63	125	250	500	1k	2k	4k	
Music ON	00:00	61	57	50	45	47	40	29	51
Music OFF	00:05	60	55	50	46	47	40	28	50
Music ON	00:10	60	56	50	44	45	37	25	49
Music OFF	00:15	66	57	49	45	47	41	30	50
Music ON	00:20	62	55	48	44	46	39	28	49
Music OFF	00:25	64	56	49	45	47	42	29	50

The values highlighted green show that the receptor L_{eq} noise level (ambient noise plus “music” noise from the source) is no higher than the ambient L_{eq} noise level, and therefore the music L_{eq} noise level is **at least** 10dB less than the ambient L_{eq} noise level. The levels are also very consistent with music on and music off. This consistency demonstrates that the ambient noise levels are dominant.

The values highlighted above have been used to derive the music noise level (without ambient noise) using the methods described in Section 3.3 above. Please note that these are the highest levels that the music noise could potentially be.

Table 4 – Derived music noise levels at Position 1 (Stuart Street Rooftop)

	Octave band centre frequency, Hz							dBA
	63	125	250	500	1k	2k	4k	
Music noise level at Stuart St Rooftop ($L_{eq,5mins}$, dB)	≤ 50	≤ 45	≤ 38	≤ 34	≤ 35	≤ 27	≤ 18	≤ 39
Entertainment noise limits ($L_{eq,5mins}$, dB)*	52	46	42	41	42	32	19	44
Minimum difference (dB)	-2	-1	-4	-7	-7	-5	-1	-5

Our acoustic models used to calculate noise breakout from the arena bowl shows that the noise levels on the Stuart Street rooftop are equal to or greater than the noise levels at 1m from the façade of the ninth-floor flats at No. 2 Stuart Street. Therefore, the noise levels at 1m from the façade of the ninth-floor flats at No. 2 Stuart Street are expected to be equal to or lower than the derived noise levels given in Table 4.

The derived music noise levels at the upper-storey receptors are either below or equal to the entertainment noise limits at all frequencies. This demonstrates that the requirements of Condition 23 (a) and (b) have been achieved at this location.

3.7 Results - Stuart Street Ground Floor

Noise measurements at the Stuart Street ground floor, taken 1m from the building façade are presented in Table 5. At all times noise from music breakout was inaudible, even during lulls in road traffic. Noise levels were dominated by other local sources; road traffic, Metrolink trams, occasional aircraft, distant fireworks and use of the passenger lift within the Stuart Street building.

Table 5 – Music noise breakout measurements at Position 2 (Stuart Street Ground Floor), dB $L_{eq,5mins}$

Scenario	Start time	Octave band centre frequency, Hz							dBA
		63	125	250	500	1k	2k	4k	
Music ON	00:00	62	62	57	51	56	55	43	60
Music OFF	00:05	60	59	56	50	55	54	42	59
Music ON	00:10	60	58	55	50	54	54	41	58
Music OFF	00:15	60	59	55	50	55	55	43	59
Music ON	00:20	61	58	54	49	55	54	42	59
Music OFF	00:25	60	60	59	51	55	55	43	60

The values highlighted green show that the receptor L_{eq} noise level (ambient noise plus “music” noise from the source) is no higher than the ambient L_{eq} noise level, and therefore the music L_{eq} noise level is at least 10dB less than the ambient L_{eq} noise level.

The values highlighted above have been used to derive the music noise level (without ambient noise) using the methods described in Section 3.3 above. Please note that these are the highest levels that the music noise could potentially be. In reality, the music noise levels are likely to be lower, particularly at higher frequencies where ambient noise levels are more than 10 dB higher than the criteria.

Table 6 – Derived music noise levels at Position 2 (Stuart Street Ground Floor)

	Octave band centre frequency, Hz							dBA
	63	125	250	500	1k	2k	4k	
Music noise level at Stuart St Ground Floor ($L_{eq,5mins}$, dB)	≤ 50	≤ 48	≤ 44	≤ 39	≤ 44	≤ 44	≤ 31	≤ 48
Entertainment noise limits ($L_{eq,5mins}$, dB)*	55	49	45	44	45	35	22	47
Minimum difference (dB)	-5	-1	-1	-5	-1	9	9	1

* Noise limits include a 3 dB addition as the measured noise levels were subject to façade reflections.

The derived music noise levels at the ground floor receptors are shown to be below the entertainment noise limits at all frequencies except 2kHz and 4kHz. We had similar exceedances at these frequencies when we took our previous noise measurements where the derived music breakout noise levels were only 4dB higher than limits due to slightly quieter ambient noise. The music breakout noise levels must now be quieter now due to the permanent works to the louvres on the south façade being complete and therefore the reported exceedances can only be due to the higher ambient noise levels.

I consider the requirements of Condition 23 (a) and (b) have been achieved at this location despite these “exceedances” for the following reasons:

- Music was completely inaudible at all measurement locations and immediately outside the building.
- The measured noise levels were very consistent with music on and music off. This consistency demonstrates that the ambient noise levels are dominant.
- Low frequency noise is much more difficult to control, and therefore as it’s been possible to demonstrate that the low frequency noise breakout levels are below the noise limits, it’s very likely that the high frequency breakout levels are significantly below the noise limits.
- The ambient noise levels are around 20dB higher than the music breakout noise limits and it is not possible to say categorically that one noise source is 20 dB lower than another noise source.

Appendix A - Survey Details

A1. Location of Survey

2 Stuart Street, Manchester M11 4DG

A2. Date & Time of Survey

00:00h to 00:30h on 12th May 2024.

A3. Personnel Present During Survey

Chris Wright MIOA and Alex Clark MIOA (SRL)

A4. Weather Conditions during Survey

16°C, wind speeds varied from 4-6mph. No precipitation.

A5. Instrumentation

Bruel & Kjaer - Noise Meter AT2 (used for Stuart Street rooftop measurements)

Description	SRL No.	Make	Type	S/N
Sound Level Meter (AT2, Green)	814	Brüel & Kjaer	2250	2575775
Pre-amp	814	Brüel & Kjaer	ZC0032	5843
Microphone	814	Brüel & Kjaer	4189	2573767
Calibrator	815	Brüel & Kjaer	4231	2575525

Norsonic - Noise Meter HLI (used for Stuart Street ground floor measurements)

Description	SRL No.	Make	Type	S/N
Sound Level Meter (HLI, Green)	777	Norsonic	Nor 140	1404560

Description	SRL No.	Make	Type	S/N
Calibrator	753	Brüel & Kjaer	Type 4231	2545771
Pre-amp	777	Norsonic	Type 1209	13927
Microphone	777	Norsonic	Type 1225	157421
De-humidifier	777	Norsonic	Type 1284	255

Norsonic - Noise Logger HL2 (used for arena bowl measurements)

Description	SRL No.	Make	Type	S/N
Sound Level Meter (HL2, Purple)	779	Norsonic	Nor 140	1404737
Calibrator	169	Brüel & Kjaer	Type 4230	1541905
Pre-amp	779	Norsonic	Type 1209	13919
Microphone	779	Norsonic	Type 1225	128712
De-humidifier	779	Norsonic	Type 1284	422

A6. Calibration Procedure

Before and after the survey the measurement apparatus was check calibrated to an accuracy of ± 0.3 dB using the type 4231/4230 Sound Level Calibrator. The type 4231 calibrator produces a sound pressure level of 94.1 dB re 2×10^{-5} Pa at a frequency of 1 kHz. The type 4230 calibrator produces a sound pressure level of 93.9 dB re 2×10^{-5} Pa at a frequency of 1 kHz. Calibration certificates are available upon request.

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