

Project

Co-op Live
Acoustic Validation Testing

Prepared for

BAM Construction Ltd
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Additional information:	

Version History

Version	Date	Comments	Approved by
P01	08/04/2024	-	Dave Clarke

Summary

BAM Construction appointed SRL Technical Services Ltd to measure breakout noise from installed building services plant and entertainment at the new Co-op Live Arena to determine whether they meet the requirements of Condition 22 (plant noise) and Condition 23 (entertainment noise). The closest and most affected noise sensitive receptor is a block of flats at 2 Stuart Street.

Building Services Plant Noise

The survey results show no significant variations between the measured noise levels when the plant is either on or off at the measurement locations. Any variations were due to other noise sources in the area.

The final set of measurements at the Ground Floor location have plant ON L_{A90} levels which are 1 dB higher than the plant OFF L_{A90} levels. This is evidence that the plant noise is at least 5 dB(A) below the background noise levels which meets the planning condition requirements. In some instances, the ON measurements were lower than the OFF measurement which is evidence that the plant noise is at least 10 dB(A) below the background noise levels and is therefore quieter than planning condition 22 requires.

Our objective conclusions also correspond with our subjective assessment where we noted that plant noise was inaudible at all times at the Stuart Street receptor location. In addition there were no acoustically distinguishing characteristics, e.g. tonality.

Entertainment Noise

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 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.

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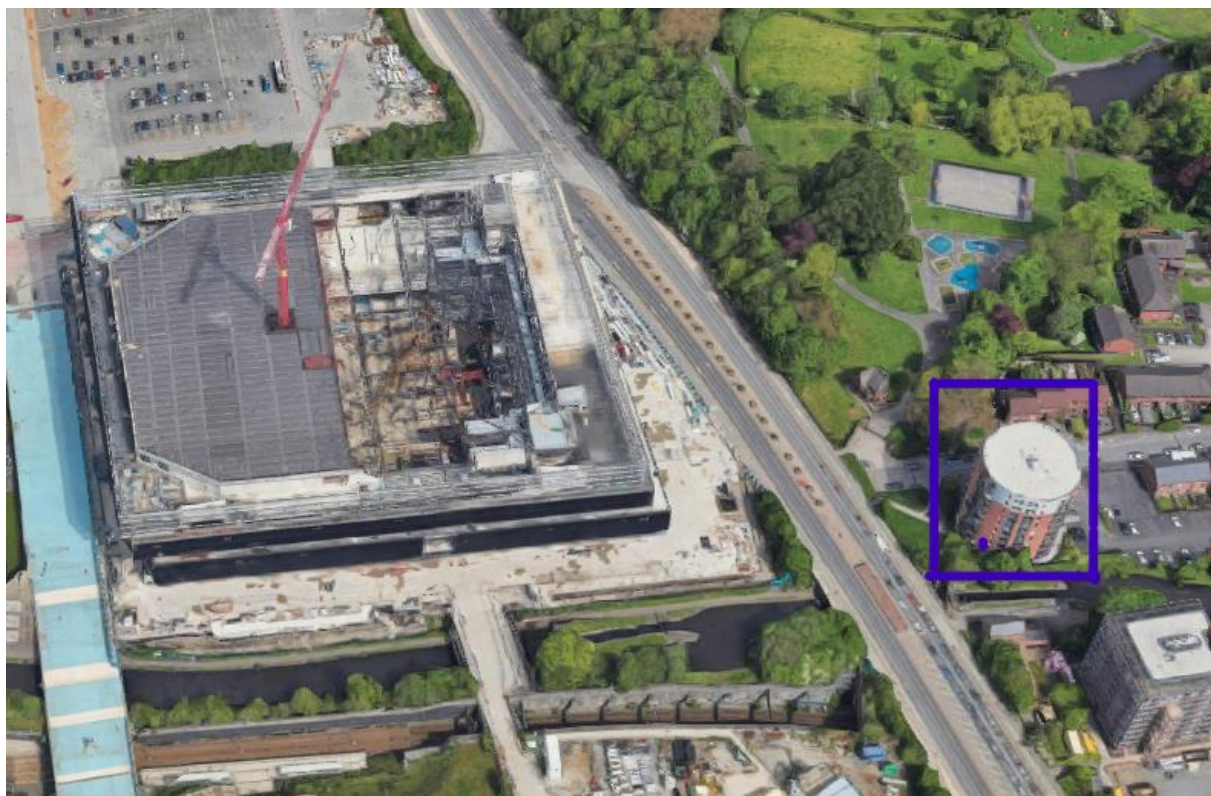
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1.0 Introduction

BAM Construction Limited is constructing the Co-op Live arena in Manchester and planning conditions have been attached to the consent which relate to control of noise from externally mounted plant and from entertainment noise during events.

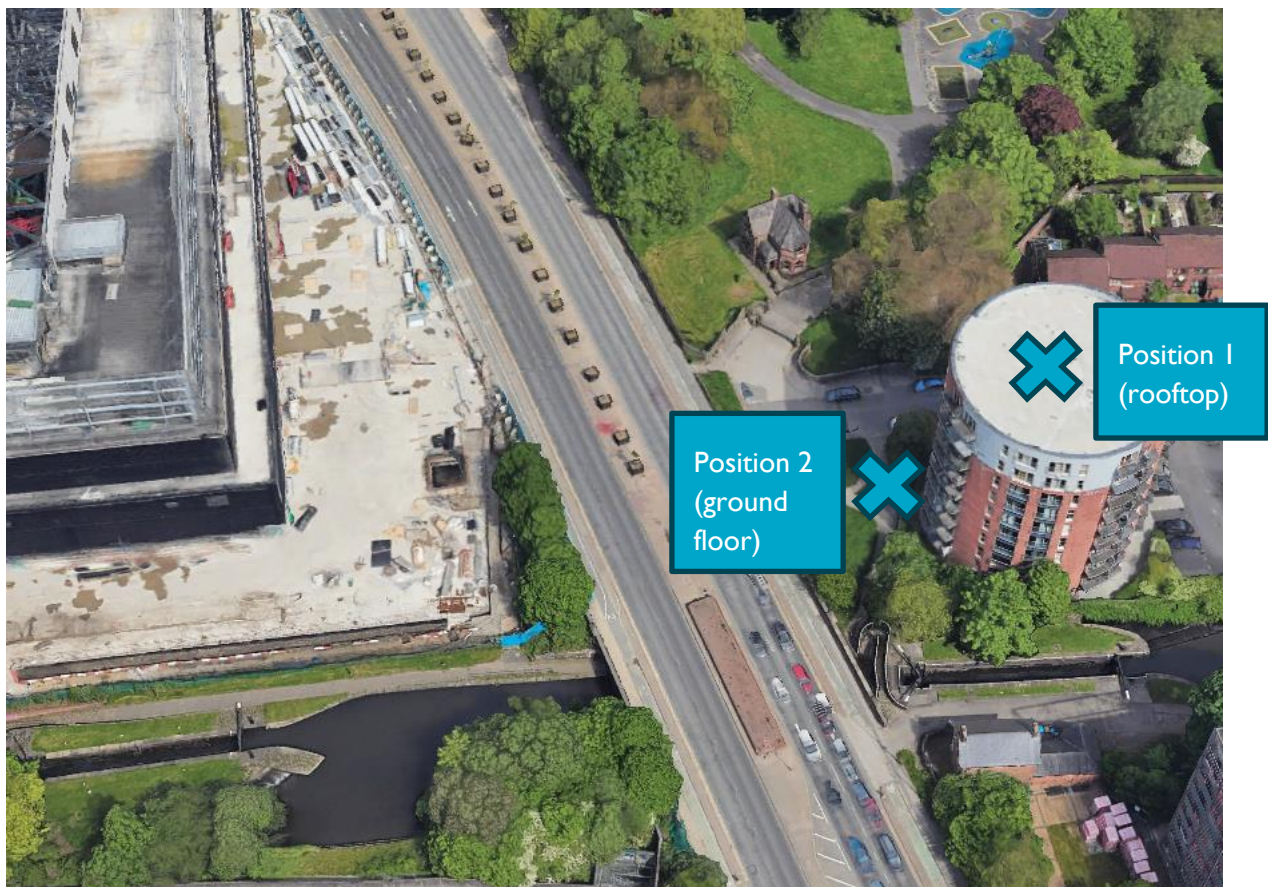
For both conditions, the closest and most affected noise sensitive receptor is the residential tower at No. 2 Stuart Street which is located approximately 100m to the east of the site on the other side of Alan Turing Way and highlighted with blue borders in Figure 1.

Figure 1 - Stuart Street Receptor



The 'worst-case' predicted noise levels are at No. 2 Stuart Street for both plant and entertainment noise. We have therefore taken separate measurements of entertainment noise and plant noise 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 1 was free-field at 1.5 above the roof (approximately 28.5m above ground level).

Figure 3 – Measurement position 1



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

Figure 4 – Measurement position 2



2.0 Planning Conditions

The noise-related planning conditions attached to consent ref. 126431/FO/2020 are reproduced below.

2.1 Condition 22 – Building Services Noise

Condition 22a states:

“Prior to the first use of the development hereby approved, details of any externally mounted ancillary plant, equipment and servicing shall be submitted for approval. For the avoidance of doubt, externally mounted plant, equipment and servicing shall be selected and/or acoustically treated in accordance with a scheme designed so as to achieve a rating level of 5 dB (LAeq) below the typical background (LA90) level at the nearest noise sensitive location.”

Condition 22b states:

“The approved scheme shall be implemented and 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 under 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”.

2.2 Condition 23 – Entertainment Noise Breakout

Condition 23a states:

“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 (Leq) should be controlled so as not to exceed (in habitable rooms) 47dB and 41dB (Leq), 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 3. Events within the bowl will not take place beyond 11pm and therefore only the daytime noise limits for entertainment noise are relevant.

Table 3: 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 grid and bass bins placed on the arena floor.

Figure 5 – Arena PA system

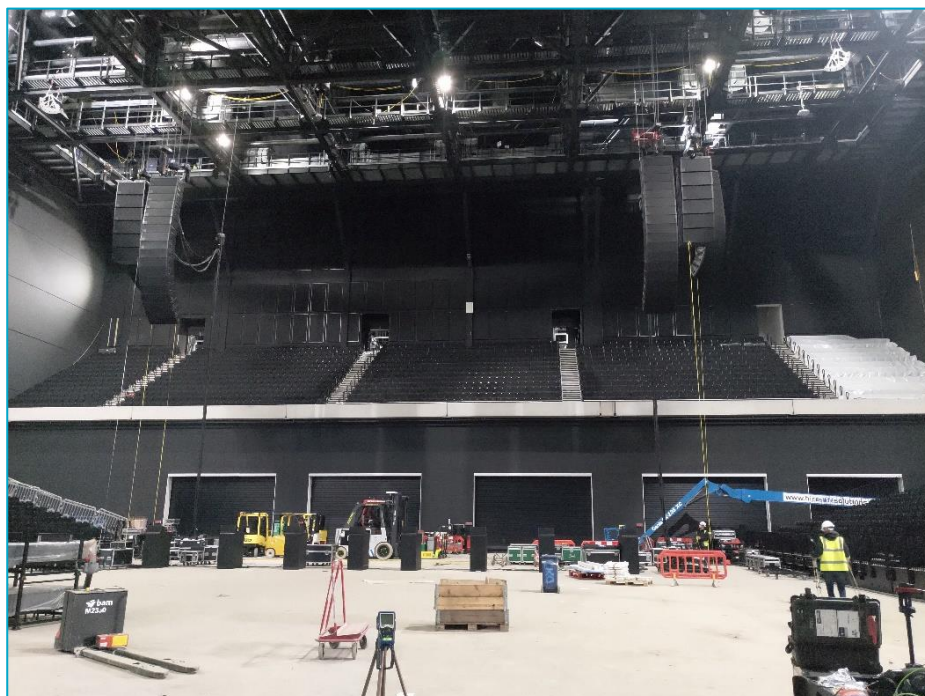


Table 1 – Arena bowl internal noise levels during measurements ($L_{eq,5mins}$)

Location	Octave band centre frequency, Hz							dBA
	63	125	250	500	1k	2k	4k	
Golden circle (level 0)	121	117	104	104	101	101	97	108
FOH desk (level 0)	116	115	103	101	100	99	94	106
VIP centre (level 3)	116	115	105	105	100	101	97	108
Rear wall (level 4)	108	107	103	99	97	100	95	105
Side wall (level 4)	110	109	105	98	95	97	91	103
Design concert levels	116	110	104	101	100	92	88	104

3.2 Noise Measurements

Measurements were taken between 00:00hrs and 00:30hrs on Wednesday 3rd April 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.

3.3 Assessment of Music Noise Levels

The requirement is to demonstrate a noise level from music noise alone at the receptor locations. The receptor measurements include existing ambient noise in addition to the 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 by approximations, especially as the ambient noise varies over time. To allow more accurate measurements we have deliberately increased the music source level and have 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 - 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.

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

3.4 Results - Stuart Street Rooftop

Noise measurements on the Stuart Street receptor rooftop are presented in Table 2. At all times noise levels were dominated by noise from sources other than plant; road traffic, Metrolink trams and occasional aircraft. During measurements with music on, noise from the music was only just audible during lulls in road traffic. Even so, it was only audible when listened for it. It is likely that a member of the public walking past the 2 Stuart Steet building on Alan Turing Way would not have been aware that music was being played within the arena.

Table 2 - 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	59	54	48	44	46	40	29	49
Music OFF	00:05	56	50	46	44	46	41	30	49
Music ON	00:10	58	52	47	43	44	38	27	48
Music OFF	00:15	58	51	47	44	46	40	28	49
Music ON	00:20	59	52	47	43	44	38	27	47
Music OFF	00:25	63	53	48	44	46	40	32	49

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 is allowed to be. In reality, the music noise levels are likely to be lower, particularly at higher frequencies where ambient noise levels are masking the music noise:

Table 3 – 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)	≤ 48	≤ 43	≤ 38	≤ 34	≤ 36	≤ 30	≤ 18	≤ 39
Entertainment noise limits ($L_{eq,5mins}$, dB)*	52	46	42	41	42	32	19	44
Minimum difference (dB)	-4	-3	-5	-7	-6	-2	-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 3.

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

3.5 Results - Stuart Street Ground Floor

Noise measurements at the Stuart Street ground floor, taken 1m from the building façade are presented in Table 4. At all times noise levels were dominated by noise from sources other than plant; road traffic, Metrolink trams and occasional aircraft. During measurements with music on, noise from the music was not audible, even during lulls in road traffic.

Table 4 - 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	60	59	56	52	56	50	42	59
Music OFF	00:05	56	55	55	51	56	50	41	58
Music ON	00:10	60	57	56	51	53	48	36	56
Music OFF	00:15	59	55	56	53	54	49	37	57
Music ON	00:20	58.4*	54.6*	54	50	51	46	34	54
Music OFF	00:25	56.6*	54.3*	56	52	54	49	36	57

* Values reported to 1 decimal place to allow calculation of music noise where receptor L_{eq} noise level (ambient noise plus “music” noise from the source) is greater than the ambient L_{eq} noise level but not by more than 3dB.

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 **blue** show that the receptor L_{eq} noise level (ambient noise plus “music” noise from the source) is greater than the ambient L_{eq} noise level but not by more than 3dB.

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 highest levels that the music noise can be. In reality, the music noise levels are likely to be lower, particularly at higher frequencies where ambient noise levels are masking the music noise.

Table 5 – 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)	≤ 54	≤ 43	≤ 46	≤ 42	≤ 44	≤ 39	≤ 26	≤ 47
Entertainment noise limits ($L_{eq,5mins}$, dB)*	55	49	45	44	45	35	22	47
Minimum difference (dB)	-1	-6	1	-2	-1	4	4	0

* 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 below the entertainment noise limits at all frequencies, except potentially at 250Hz, 2kHz and 4kHz.

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 inaudible.
- 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 as shown in Table I.
- An acoustic weakness was discovered in the south façade when subjective listening tests were done. The cause of this weakness are two MVHR intake louvres located in the level 04 south hangout bar which is open to the arena bowl (and is therefore exposed to high levels of music noise). The MVHR ductwork had not been connected to the louvres when the validation tests were done and instead only had a layer of a board material to cover the louvre. Once the ductwork is installed, and is appropriately sealed 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.

4.0 Building Services Noise

Planning Condition 22 requires the rating noise from all externally mounted plant associated with the development, to be at least 5 dB(A) lower than the existing L_{A90} background noise when measured at the nearest existing noise sensitive location. Rating level is defined in BS 4142:2014+A1:2109. Please note these are not the exact words of the condition but are an appropriate summary of the technical language.

As the noise level from the plant must be lower than the measured background noise level, the most reliable way of measuring this is to measure with the plant operating and not operating. The “ON” measurements and the “OFF” measurements can then be compared to estimate the noise level due to the plant alone, which can then be compared to the background level. The background level is the L_{A90} noise metric (i.e. the level that is exceeded for 90% of the measurement period), with the plant turned off.

4.1 Noise Measurements

We took two sets of 5-minute noise level measurements at the two measurement locations shown in Figure 2. The first set of measurements was taken between 22:55hrs and 23:45hrs on Tuesday 2nd April 2024 and consisted of:

- All plant operating (including emergency generator)*
- All plant operating (excluding emergency generator)*
- No plant operating (to establish the background noise levels)

The second set of measurements was taken between 00:50hrs and 01:20hrs on Wednesday 3rd April 2024 and consisted of:

- All plant operating (including emergency generator)*
- No plant operating (to establish the background noise levels)

* We were advised by the building services contractor that all plant was operating during our tests except for the emergency smoke extract fans and internally located plant, including the MVHRs.

4.2 Results

During both sets of measurements, noise from plant was inaudible at all times. Noise levels at this time were dominated by noise from sources other than plant; road traffic, Metrolink trams and occasional aircraft.

Table 6 and Table 7 summarise the measured noise levels. I have reported both L_{Aeq} and L_{A90} noise parameters. I consider the noise parameter L_{A90} to be the value which is most representative of the noise from plant because it provides a better representation of continuous noise than the L_{Aeq} parameter. The OFF measurements represent the background noise level without the plant operating and therefore the

difference between ON and OFF measurements can be used to demonstrate whether the noise level with the plant ON is higher than when it was OFF.

Table 6 – Plant noise measurements at Position 1 (Stuart Street Rooftop)

Scenario	Start Time	L _{Aeq} , dB	L _{A90} , dB
All plant ON (including emergency generator)	22:55	50	47
	23:00	49	46
All plant ON (excluding emergency generator)	23:10	49	46
	23:15	49	47
All plant OFF	23:35	49	46
	23:40	50	46
All plant ON (excluding emergency generator)	00:50	48	45
	00:55	46	44
All plant OFF	01:10	46	44
	01:15	47	44

Table 7 – Plant noise measurements at Position 2 (Stuart Street Ground Floor)

Scenario	Start Time	L _{Aeq} , dB	L _{A90} , dB
All plant ON (including emergency generator)	22:55	59	46
	23:00	59	47
All plant ON (excluding emergency generator)	23:10	57	45
	23:15	58	46
All plant OFF	23:35	57	47
	23:40	58	49
All plant ON (excluding emergency generator)	00:50	55	44
	00:55	55	44
All plant OFF	01:10	53	42
	01:15	55	43

The survey results show no significant variations between the measured noise levels when the plant is either on or off at both measurement locations. Any variations were due to other noise sources in the area. In fact, the ON measurements were often equal to or below the OFF measurement which is evidence that the plant noise is at least 10 dB(A) below the background noise levels and is therefore quieter than the planning condition requires.

The final set of measurements at the Ground Floor location have plant ON L_{A90} levels which are 1 dB higher than the plant OFF L_{A90} levels. This is evidence that the plant noise is at least 5 dB(A) below the background noise levels which meets the planning condition requirements.

Our objective conclusions also correspond with our subjective assessment where we noted that plant noise was inaudible at all times at the Stuart Street receptor location. In addition there were no acoustically distinguishing characteristics, e.g. tonality.

4.3 BREEAM Pol 05

BREEAM UK New Construction (2018) credit Pol 05 can be awarded where the plant noise rating level is at least 5 dB lower than the background noise level when assessed in accordance with BS 4142:2014+A1:2019.

The results of our plant noise measurements demonstrate that the requirements of credit Pol 05 have been achieved and the credit can be awarded.

Appendix A - Survey Details

A1. Location of Survey

2 Stuart Street, Manchester M11 4DG

A2. Date & Time of Survey

22:55h on 2nd April to 01:15h on 3rd April 2024.

A3. Personnel Present During Survey

Chris Wright MIOA and Alex Clark MIOA (SRL)

A4. Weather Conditions during Survey

9-10°C, wind speeds varied from 4-7mph. Light rainfall at times.

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

Bruel & Kjaer - Noise Meter AE2 (used for Stuart Street ground floor measurements)

Description	SRL No.	Make	Type	S/N
Sound Level Meter (AE2, Purple)	853	Brüel & Kjaer	2250	3007896

Description	SRL No.	Make	Type	S/N
Pre-amp	516	Brüel & Kjaer	ZC0032	22195
Microphone	516	Brüel & Kjaer	4189	2978188
Calibrator	698	Brüel & Kjaer	4231	2482655
All weather kit	518	Brüel & Kjaer	UA 1404	-

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

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

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 Sound Level Calibrator. The Calibrator produces a sound pressure level of 94.1 dB re 2×10^{-5} Pa at a frequency of 1 kHz. Calibration certificates are available upon request.

Acoustics

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