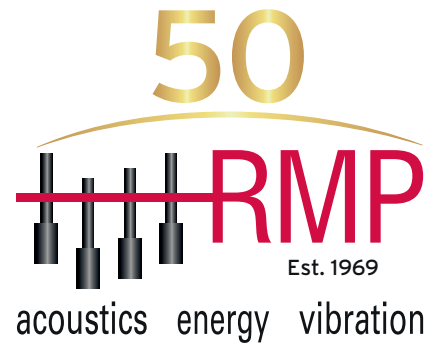




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BRIEF FOR CONSULTANCY:

To conduct a noise impact assessment in relation to the proposed change of use development and to offer advice as necessary to facilitate compliance with the relevant standards and guidelines.

Noise Impact Assessment:
9 South King Street,
Manchester
M2 6DG
140585/FO/2024

Technical Report No. R-10088-MP-RGM
21st October 2024

PREPARED FOR:

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1.0 Introduction

- 1.1 RMP (Edinburgh Napier University) were instructed by Simon Birnbaum of SMB Town Planning Ltd. on behalf of India Browne-Wilkinson of Bull Riders of Montana Ltd. to undertake a noise impact assessment for to the proposed change of use development situated at 9 South King Street, Manchester, M2 6DG in support of the planning application no. 140585/FO/2024.
- 1.2 The proposed change of use is from an existing retail shop (Class E) to a Tattoo Studio (Sui Generis). The planning application number for the proposed development is 140585/FO/2024. The site location is shown in Figure 1.



Figure 1.1. Photo of the existing retail shop where the proposed Tattoo Studio will be located. The internal ambient sound level measurement location inside a first floor room is also indicated.

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- 1.3 The proposed Tattoo Studio will be open between 10 a.m. and 6 p.m. Monday to Sunday (inclusive).
- 1.4 The proposed internal layouts are provided in Rock + Poppins drawing RP0003_Rev_F (June 2023) which shows a reception area on the ground floor and 8 No. treatment couches on basement level-2. There are no treatment couches on basement level-1 and this floor is allocated as an area for showcasing past works of the resident tattoo artists. Basement level-1, therefore, will be used by the clients to learn about the works of the tattoo artists during the proposed opening times. Existing and proposed plans are provided in Figure A1.1 to A1.3 in Appendix 1.
- 1.5 It is understood that there will be audio playback via 1 No. Marshall Acton III Bluetooth loudspeaker in the basement level-2 area. There will be no entertainment equipment in the Basement Level-1 area.
- 1.6 RMP has been to the proposed development site and undertaken Sound Insulation (SI) tests between the ground floor and first floor and basement level-1 and first floor areas of the building to quantify SI performance of the separating floor constructions.
- 1.7 The first floor above the proposed development is currently empty office space. RMP understand that planning permission has been granted for the first floor to be converted to residential accommodation in the future and therefore the first floor is being treated as a noise sensitive receptor for this noise impact assessment.
- 1.8 Internal Ambient Noise Levels (IANL) inside a first floor room facing Ridgefield were also measured to establish ambient noise levels.
- 1.9 To quantify the likely activity sound levels due to the proposed Tattoo Studio operations, sample sound levels at another site considered to be representative of the proposed Tattoo Studio were measured and will be used as the activity sound level when noise break-in calculations to the first floor rooms are carried

out. The sample measurements included both operational sound during a tattooing session and background music playback sound.

Proposed Tattoo Studio tattoo guns

- 1.10 It is understood that wireless battery powered handheld 'Rotary Tattoo Guns' will be used.

2.0 Planning Criteria

2.1 Manchester City Council (MCC) Planning, Building Control & Licencing department responded to SMB Town Planning Ltd. on Friday, 30/08/2024 in relation to application no: 140585/FO/2024 stating that due to the reasons, which are quoted below, the proposed Tattoo Studio application should be supported by a Noise Impact Assessment. The following, which is taken from the above-mentioned correspondence issued by Julie Roscoe (Director of Planning, MCC) details the information that should be provided in support of the proposed development.

- 1) *An acoustic study identifying ambient noise levels during daytime, night time and weekends along with details of the noise levels that are currently achieved within the accommodation at various times during operating hours. The study should identify the acoustic treatment and measures necessary to limit the breakout of noise in accordance with a noise study of the premises and a scheme of acoustic treatment. The scheme proposed shall include measures such as acoustic lobbies at access and egress points of the premises, acoustic treatment of the building structure, sound limiters linked to sound amplification equipment, details of the acoustic glazing and acoustically treated ventilation you have installed/propose to use and specified maximum internal noise levels.*
- 2) *An operating statement of how the event space would be used, how it relates to the main use and what operating hours would be required for this.*

2.2 Therefore, to ensure that the amenity of the potential residential areas located above the ground floor Tattoo Studio are not compromised during the proposed operating hours and days, design criterion given in Table 2.1, which is widely used by Local Authorities (LA) to assess the likely noise impact of operational activity noise comprising music and speech programmes, and considered to be a representative sound spectrum to achieve inaudibility will be used.

- 2.3 The adopted assessment criterion NR15, which is considered to be the standard criterion for assessing this type of noise sources, will help to provide acoustic environments in habitable rooms where the potential for sleep disturbance, annoyance and disturbance from any task requiring concentration would be minimised.

Table 2.1: Adopted room noise break-in criterion for operational activity noise impact during the proposed operating times 10 a.m. to 6 p.m. Monday to Sunday (inclusive).								
Description	Frequency in Hz							NR
	63	125	250	500	1k	2k	4k	
Noise Rating (NR) curve octave band centre frequency values in dB (ref. 20 μ Pa)	47	35	26	19	15	12	9	15

- 2.4 To confirm compliance with the adopted activity noise limit criterion inside the habitable rooms located above the proposed Tattoo Studio, the octave band centre frequency values given in Table 2.1 for the NR15 curve shall not be exceeded by the intruding source sound spectrum.
- 2.5 NR 15 is a stringent criteria often used for the control of music noise and controls noise breakout from the source to a level that would be inaudible in the receiver, therefore having no impact on the residential amenity.

3.0 Acoustic Measurements

Airborne SI tests

- 3.1 The first floor office rooms that are located directly above the footprint of the proposed ground floor Tattoo Studio were considered to be the appropriate assessment locations. Therefore, airborne SI tests between the ground floor retail area and the two first floor rooms directly located above were carried out on Friday, 20/09/2024 by Richard Mackenzie (BSc, FIOA, MInstSCE) in order to establish current acoustic performance of the existing floor constructions.
- 3.2 Three sample airborne SI tests were carried out. Two of them were between the ground and first floor areas and the third one was between the basement level-1 area and the first floor room facing Ridgefield. Details of source and receiver rooms used are given in Table 3.1.

Table 3.1. Sound insulation test locations: existing floors.			
Source Room	Volume (m ³)	Receiver Room	Volume (m ³)
Ground floor retail area	110	First floor office room facing Ridgefield	37
Ground floor retail area	110	First floor office room facing South King Street	109
Basement Level-1	107	First floor office room facing Ridgefield	37

- 3.3 The assessment of noise break-in to the existing first floor office space (potential future residential flats) above will, therefore, be based on the measured field SI test results.
- 3.4 The floor construction as tested was unknown in detail but is assumed to be a traditional timber joist party floor with timber joists supported by steel frame.
- 3.5 Airborne SI tests were carried out following the guidance given in BS EN ISO 140 *Measurement of sound insulation in buildings and of building elements Part 4:*

Field measurements of airborne sound insulation between rooms (1998) and the Building Regulations 2003 (amendments 2004, 2010, 2013 and 2015).

Ambient noise level measurements

- 3.6 Internal Ambient Noise Levels (IANL) were measured inside the smaller first floor room facing Ridgefield and located directly above the proposed ground floor Tattoo Studio. The single glazed sash and case windows were closed during the IANL measurements. Figure 3.1 shows the IANL measurement set up.



Figure 3.1. Ambient noise level measurements carried out inside the first floor room facing Ridgefield. Room windows are closed.

- 3.7 The noise climate in the region comprised road traffic noise from the nearby and distant roads, noise from mechanical plant serving nearby buildings and people noise.

Sample Tattoo Studio operational level measurement

- 3.8 Sample operational sound levels were measured in an existing Tattoo Studio by Conor McLean (BSc(Hons), MSc, PGDip, AMIOA) on Saturday, 21/09/2024 and will be used as the representative operational sound level for the proposed Tattoo Studio. The sample Tattoo Studio measurements were carried out during a single client tattooing session shown in Figure 3.2 and the measured sound level spectrum provided in Figure 4.1.



Figure 3.2. Sample Tattoo Studio operational sound level measurement during a single client session. The tattoo artist and his client are obscured with yellow squares.

- 3.9 The equipment used to measure sample Tattoo Studio activity noise levels and ambient noise levels inside the first floor room facing Ridgefield conformed to the requirements of BS 7445: “Description and measurement of environmental noise. Part 1 (2003): Guide to quantities and procedures”, “Part 2 (1991): Guide to the acquisition of data pertinent to land use” and “Part 3 (1991): Guide to application of noise limits.”



Field calibration of measurement equipment

- 3.10 The sound level meters were calibrated before and after the measurements at the calibration level of 94.0 dB (ref. 20 μ Pa) at 1000 Hz. The deviation between calibration levels was insignificant and within the tolerance for Class 1 sound level meters.
- 3.11 During the measurements Class 1 Sound Level Meters (SLM) were used. Further information on the details of the measurement equipment used is given in Appendix 2.

4.0 Sound Insulation Test Results

SI test results

- 4.1 The airborne SI test results were analysed in accordance with the guidance given in BS EN ISO 717-1:1997 *Acoustics - Rating of sound insulation in building and of building elements Part 1: Airborne sound insulation*.
- 4.2 Results of the airborne SI tests are given in Table 4.1 as octave band centre frequency performance values (D_{nT}) and the single-number quantity weighted standardised sound level difference including the spectrum adaptation term C_{tr} ($D_{n,Tw} + C_{tr}$) as set out in Part E of the Building Regulations.

Table 4.1: Airborne sound insulation performance of separating floors in dB (ref. 20 μ Pa).								
Description	Frequency in Hz							$D_{n,Tw} + C_{tr}$
	63	125	250	500	1k	2k	4k	
Ground floor retail to first floor Ridgefield façade room	25	32	36	44	42	46	53	43
Ground floor retail to first floor South King Street façade room	27	43	44	48	44	55	67	49
Basement level-1 to first floor Ridgefield façade room	33	51	54	59	57	63	68	59

- 4.3 The sound test results were limited by the background noise on site and therefore the measurement results represent a worst case and the floor performance may be better than reported.
- 4.4 It was noted during the airborne SI tests of the floor separating ground and first floors that strong flanking paths have been formed at the floor and external wall junctions.

- 4.5 The results of the measurements were found to exceed the requirements of Part E of the Building Regulations for floors in historic buildings.

IANL measurement results

- 4.6 The IANLs measured between Friday, 20/09/2024 and Monday, 23/09/2024 inside the first floor room facing Rigdefield are given in Table 4.2.

Table 4.2: Internal Ambient Noise Levels (IANL) measured inside the small first floor room facing Ridgefield with windows closed (Figure 3.1) during the proposed operational times. The ranges are provided in brackets and the IANL (L_{Aeq}) are in dB (ref. 20 μ Pa).		
Date	Period	$L_{Aeq,T}^{(1)}$
Friday, 20/09/2024	10 a.m. to 6 p.m.	40 (36 - 48)
Saturday, 21/09/2024	10 a.m. to 6 p.m.	38 (35 - 41)
Sunday, 22/09/2024	10 a.m. to 6 p.m.	36 (34 - 42)
Monday, 23/09/2024	10 a.m. to 6 p.m.	43 (34 - 49)
(1) T represents 15 minute samples for the lower and upper range values presented inside the brackets. Whereas the values given outside of the brackets are for 8 hour logarithmic averages.		

- 4.7 The lowest measured IANL spectrum is provided in Table 4.3 and it will be used to compare against the adopted NR15 noise break-in criterion to confirm if the NR 15 criteria is appropriate.

Table 4.3: The lowest IANL spectrum measured inside the first floor room facing Ridgefield in dB (ref. 20 µPa).								
Description	Frequency in Hz							L _{Aeq,15min}
	63	125	250	500	1k	2k	4k ⁽¹⁾	
IANL spectrum measured between 17:45 and 18:00 hours on Sunday 22/09/24 (L _{eq} in dB)	36	42	36	30	29	24	-	34
(1) At the 4000 Hz octave band centre frequency, the ambient noise level was below the 20 dB lower boundary setting of the measurement equipment, therefore, no result was provided by the equipment.								

Sample Tattoo Studio operational sound level measurement result

4.8 In Figure 4.1, the highest sample Tattoo Studio operational sound level spectrum, which was measured during a single tattooing session (Figure 3.2), is shown. Therefore, during the Noise Impact Assessment (NIA) the number of the proposed tattoo couches will be taken into account and the operational sound spectrum, based on the highest measured 5 minute sample, given in Figure 4.1 will be adjusted using the formula '+10xlog₁₀(n)' where 'n' is the number of the proposed tattoo couches.

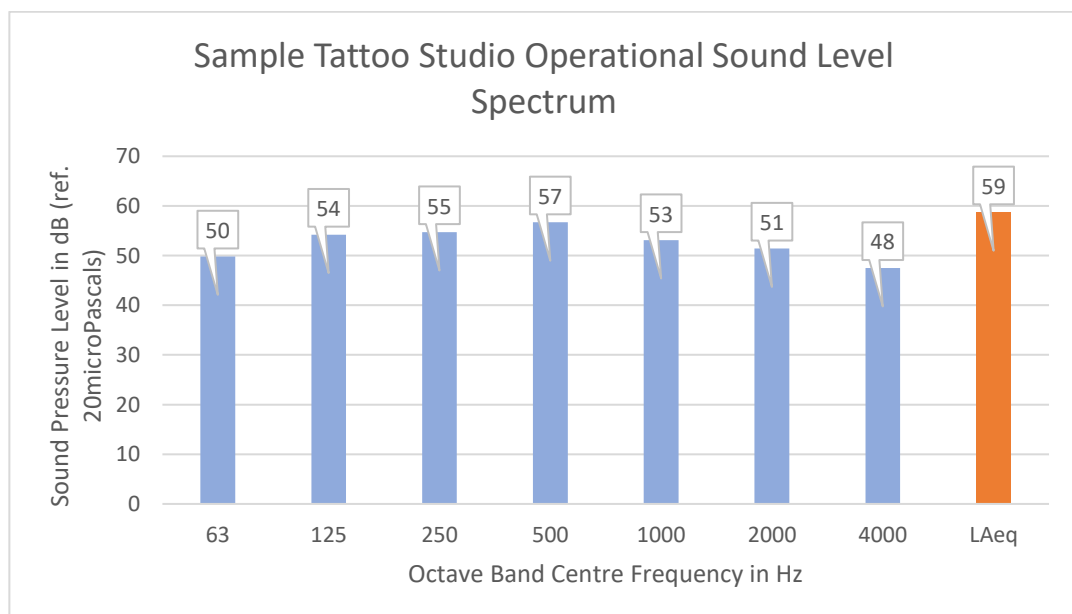


Figure 4.1. The highest measured 5-minute sample Tattoo Studio operational sound level spectrum.

5.0 Noise Impact Assessment

- 5.1 The separating floor constructions between the proposed ground floor Tattoo Studio and the existing office space with planning permission for change to residential flats above need to provide adequate SI so that the adopted NR15 assessment criterion is satisfied inside habitable rooms of the proposed flats above when the proposed Tattoo Studio is operating normally.
- 5.2 Meeting the adopted NR15 assessment criterion inside the first floor flat that is directly above the proposed ground floor Tattoo Studio would imply that inside the second and third floor flats the NR15 criterion would also be satisfied as there will be additional sound energy losses as a result of sound having to travel longer distances to reach the higher floor levels. Therefore, the first floor flat habitable rooms would be the critical receivers.
- 5.3 For this reason, noise break-in level inside a first floor room facing Ridgefield will be carried out with the source as the basement level-2 tattoo couches area.

Noise break-in calculations between basement level-2 and first floor

- 5.4 Calculations to determine the noise break-in level inside the small first floor room facing Ridgefield when the source is the basement level-2 are presented in Table 5.1. It is assumed that there would be 8 No. tattooing sessions occurring simultaneously. Therefore, in row 2 of Table 5.1, the operational sound levels are increased by 9 dB ($+10 \times \log_{10}(n=8 \text{ couches})$) to account for 8 No. simultaneous tattooing sessions.

Table 5.1 Predicted first floor room (Ridgefield facade) noise break-in levels in dB (ref. 20 µPa).								
Row	Description	Octave band centre frequency in Hz						
		63	125	250	500	1k	2k	4k
1	Typical tattooing session linear octave band (L_{eq}) sound pressure levels (Figure 4.1), $L_{Aeq} = 59$ dB	50	54	55	57	53	51	48
2	Adjusted source spectrum for 8 No. simultaneous tattooing sessions on basement level-2, $L_{Aeq} = 68$ dB	59	63	64	66	62	60	57

Table 5.1 Predicted first floor room (Ridgefield facade) noise break-in levels in dB (ref. 20 µPa).								
Row	Description	Octave band centre frequency in Hz						
		63	125	250	500	1k	2k	4k
3	Basement level-2 to first floor octave band sound reduction values ⁽¹⁾ ($D_{nT,w} + C_{tr} = 64$ dB)	38	56	59	64	62	68	73
4	Receiver noise level (row 2 – row 3)	21	7	5	2	0	-8	-16
5	Assessment criterion NR15	47	35	26	19	15	12	9
6	Exceedance (row 4 – row 5)	-26	-28	-21	-17	-15	-20	-25

(1) Derived by adding 5 dB to the octave band sound reduction values given in the last row of Table 4.1 for basement level-1.

5.5 As it can be seen from Table 5.1, the calculated octave band centre frequency noise break-in levels lie below the NR15 curve, therefore, the adopted NR15 assessment criterion is satisfied. The calculated octave band centre frequency room noise break-in levels given in Table 5.1 (row 4) are plotted in Figure 5.1 together with the NR15 curve and the lowest measured IANL given in Table 4.3 to provide visual context.

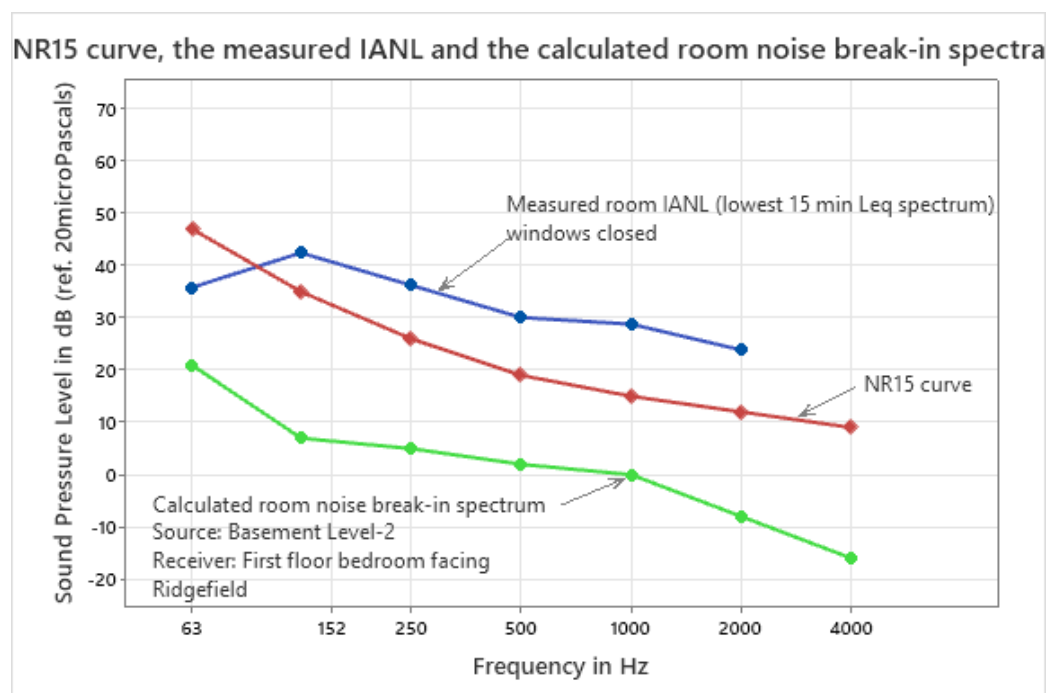


Figure 5.1. Sample Tattoo Studio operational sound level spectrum.

5.6 As it can be seen from Figure 5.1, the calculated first floor room octave band noise break-in levels lie below the NR15 curve while the lowest measured room IANL spectrum lies above the NR15 curve at the 125 Hz octave band centre frequency and above.

5.7 This noise breakout assessment in Table 1 and Figure 1 confirms that the proposed Tattoo Studio operational sound will be inaudible inside first floor rooms and will not cause any noise impact.

Maximum allowed operational sound levels on each Tattoo Studio floor level

5.8 As the sample Tattoo Studio operational sound levels measured resulted in very low octave band noise break-in levels inside the first floor room facing Ridgefield, it would be inappropriate to limit the operational sound level to such a low level in the basement level-2 area.

5.9 Therefore, using the NR15 assessment criterion as the starting point, for each Tattoo Studio floor level, a maximum L_{eq} operational sound level spectrum has been derived and they are given in Table 5.2. They should not be exceeded, when measured at a distance of 1 m from room boundaries, to ensure compliance with the adopted NR15 criterion inside the first floor flat room facing Ridgefield.

Table 5.2: The highest allowable Tattoo Studio operational octave band sound levels (L_{eq}) when measured at 1 m from the room ceiling or perimeter walls in dB (ref. 20 μ Pa).								
Location	Frequency in Hz							$L_{Aeq,T}$
	63	125	250	500	1k	2k	4k	
Ground floor reception	58 ⁽¹⁾	64	59	60	54	55	59	64
Basement level-1	62	77	71	69	63	66	68	73
Basement level-2 tattoo couches	67	82	76	74	68	71	73	78
(1) Limited to 3 dB below the lowest measured IANL spectrum's value at 63 Hz (36 – 3 = 33 dB inside room). Therefore, at 63 Hz, 58 dB – 25 dB SI = 33 dB inside room, which lies 14 dB below the NR15 spectrum value.								

6.0 Recommendations

Operational sound levels

- 6.1 During the sample Tattoo Studio operational sound level measurements, it was observed that there was a flat screen TV inside the tattoo couch area (Figure 3.2) that provided ambient programmes.
- 6.2 Therefore, to ensure that there is no structure borne sound transmission to the other parts of the building from the proposed Tattoo Studio areas, it is recommended that all entertainment equipment that has integrated loudspeakers or individual loudspeakers of entertainment equipment are isolated from the building structure using resilient vibration isolation systems having a natural frequency of $f_n = 10$ Hz or lower.
- 6.3 It is also recommended that the maximum operational octave band centre frequency sound levels given in Table 5.2 for each floor level of the proposed Tattoo Studio are not exceeded to ensure compliance with the adopted NR15 criterion when measured inside the first floor room facing Ridgefield (considered to be the most critical receptor).

Tattoo Studio equipment noise and vibration

- 6.4 It is recommended that operational noise levels from individual tattooing equipment is limited to levels that are below the maximum allowable operational octave band centre frequency sound levels given in Table 5.2 when measured at a distance of 1 m from the equipment. Therefore, it is recommended that low noise equipment is used.
- 6.5 Ensure that all tattoo equipment are regularly maintained and if any loose parts are observed, they should be tightened to prevent increased equipment noise.
- 6.6 Ensure that tattoo workstations are adequately dampened against vibration so that their large surfaces do not radiate sound as a result of equipment vibrations transferred to them.

Doors and windows

- 6.7 It is recommended that the ground floor main entrance door is fitted with good acoustic perimeter seals and kept closed when not in use for access.
- 6.8 There is a fire escape door in the basement level-1 area. If this door is leading directly to outside or to a part of the building that has connection to the existing office space (potential residential flats) above, then it is recommended that it provides a minimum of 30 dB R_w sound reduction and is kept closed when not in use.
- 6.9 The fire escape door in the basement level-2 area is lobbied. It is recommended that this fire exit door is rated at a minimum of 25 dB R_w . Both the fire escape door and the inner lobby door should be kept closed when not in use.
- 6.10 All external windows, where applicable, should be kept closed during the proposed operational times.
- 6.11 The integrity of the proposed Tattoo Studio ground floor ceiling constructions should be checked to ensure that there are no weaknesses such as perimeter gaps or damaged/exposed ceiling areas. If such weaknesses are found, they should be treated using building materials having similar density to the rest of the ceiling. If any ceiling/perimeter wall junction is found to be weak, then they should be treated using dense building material that is similar to the rest of the building construction.

Ventilation louvres

- 6.12 If there will be any ventilation louvres between the Tattoo Studio floors and the outside environment, then adequate sound attenuators or acoustic louvres should be installed to ensure that they do not form uncontrolled sound flanking paths.

7.0 Conclusions

- 7.1 RMP (Edinburgh Napier University) were instructed by Simon Birnbaum of SMB Town Planning Ltd. on behalf of India Browne-Wilkinson of Bull Riders of Montana Ltd. to undertake a noise impact assessment for the proposed change of use development situated at 9 South King Street, Manchester, M2 6DG in support of the planning application no. 140585/FO/2024.
- 7.2 Sound Insulation (SI) tests across the party floors separating the sample first floor office rooms (potential future residential flats) and the ground floor retail areas have been undertaken. In addition to this, sample operational sound levels inside another Tattoo Studio were measured. Data from these measurements were used to determine noise break-in level inside the first floor room facing Ridgefield and it was found that the adopted NR15 criterion would be met comfortably with margin.
- 7.3 Internal Ambient Noise Levels (IANL) inside the first floor room facing Ridgefield were also measured with the room window closed and it was found that the lowest measured IANL spectrum would lie above the NR15 curve at the 125 Hz octave band and above suggesting a good level of noise masking when the calculated Tattoo Studio operational noise break-in spectrum was considered.
- 7.4 A maximum operational sound level (L_{eq}) spectrum was derived for each Tattoo Studio floor level and they are given in Table 5.2. They should not be exceeded to ensure compliance with the adopted NR15 criterion when measured inside the first floor room facing Ridgefield that is considered to be most critical receiver.

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Appendix 1: EXISTING AND PROPOSED LAYOUT PLANS

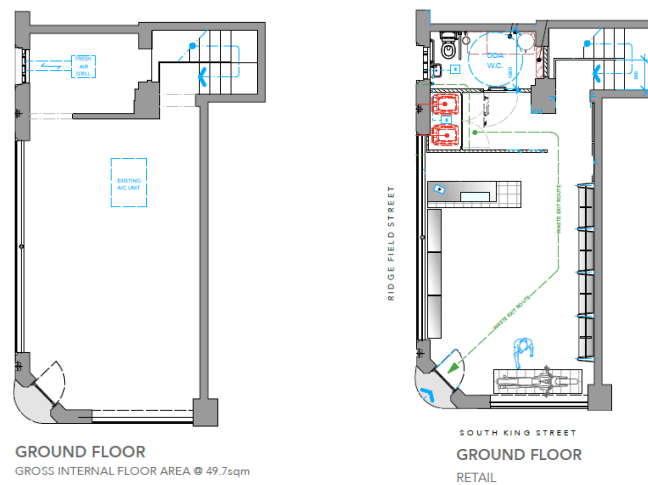


Figure A1.1. Existing (left) and proposed (right) ground floor layouts (RP003 Rev F).

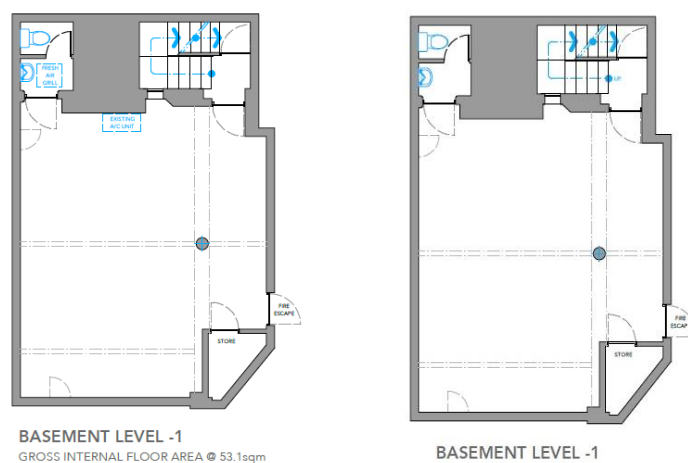


Figure A1.2. Existing (left) and proposed (right) basement L-1 layouts (RP003 Rev F).

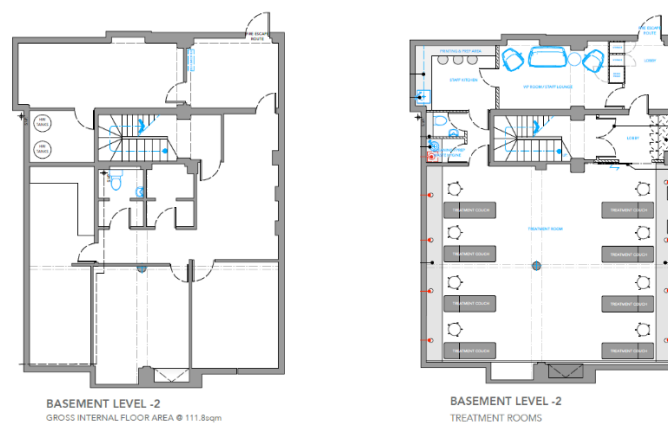


Figure A1.3. Existing (left) and proposed (right) basement L-2 layouts (RP003 Rev F).

Appendix 2: EQUIPMENT DETAILS

Table A1.1 Equipment details used during the environmental noise survey			
Description	Serial no.	Calibration expiry date	Calibration certificate no.
B&K2260 (Irvine): SI testing and ambient noise level measurements			
Brüel & Kjær Modular Precision Sound Level Meter Type 2260 running Brüel & Kjær Building Acoustics Software BZ7204 Version 2.7 and Brüel & Kjær Enhanced Sound Analysis Software BZ7206 and FFT software BZ7208	2370475	06/11/25	TCRT23/1799
Brüel & Kjær Prepolarised Condenser Microphone Type 4189	2345353	06/11/25	TCRT23/1799
Brüel & Kjær Pre-amplifier ZC0026	-	06/11/25	TCRT23/1799
Brüel & Kjær Calibrator type 4231	3001182	03/11/25	TCRT23/1797
B&K2260 (Napier): Sample Tattoo Studio operational sound level measurements			
Brüel & Kjær Modular Precision Sound Level Meter Type 2260 running Brüel & Kjær Building Acoustics Software BZ7204 Version 2.7 and Brüel & Kjær Enhanced Sound Analysis 20 kHz Software BZ7206	2120171	26/10/25	TCRT23/1774
Brüel & Kjær Prepolarised Condenser Microphone Type 4189	2431002	26/10/25	TCRT23/1774
Brüel & Kjær Pre-amplifier ZC 0026	2891	26/10/25	TCRT23/1774
Brüel & Kjær Calibrator type 4230	2393980	26/10/25	TCRT23/1771
Loudspeaker: SI testing			
JBL EON 610 Active Sound Source	15055116887	N/A	N/A
Sound Source: SI testing			
SanDisk MP3 Player	BH1634CPJK	n/a	n/a



Appendix 2: GLOSSARY OF ACOUSTICAL TERMINOLOGY

- 1) Decibel (dB): Bel is a unit of logarithmic power ratio and decibel is one tenth of a Bel. Therefore, decibel is 10 times the logarithm to base 10 of the ratio of two sound powers, or 20 times the logarithm to base 10 of the ratio of two sound pressures. The human hearing mechanism is capable of detecting a wide range of sound pressures, approximately between 20 μPa representing the threshold of hearing and 200 Pa representing the threshold of pain. This is a ratio range of 10,000,000 having 7 orders of magnitude which is a very large quantity to deal with. Using decibel notation makes it possible to represent this very large range in a more manageable form between 0 dB and 140 dB.
- 2) Frequency (Hz): The number of cycles per second, this is subjectively perceived as pitch.
- 3) Frequency Spectrum: Analysis of the relative contributions of different frequencies that make up a sound.
- 4) Pitch: Pitch is primarily influenced by frequency although waveform and intensity are also influential.
- 5) Octave Bandwidth: A range of frequencies defined by an upper limit which is twice the lower limit. Octave bandwidths are identified by their centre frequency.
- 6) "A" Weighting (dB(A) or dBA): The human ear does not respond uniformly to different frequencies. "A" weighting is commonly used to simulate the frequency response of the ear.
- 7) Noise: *Undesired sound. By extension, noise is any unwarranted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device (ANSI 1994).*
- 8) Noise Level: This is the level of *undesired sound*.
- 9) L_{AE} : The A-weighted sound exposure level in decibel (dB), previously known as SEL, is given by $10 \times \log_{10}(E_A/E_0)$ where E_A is the A-weighted sound exposure in pascal-squared seconds and E_0 is the reference sound exposure $((20\mu\text{Pa})^2 \times 1 \text{ s} = 400 \times 10^{-12} \text{ in Pa}^2\text{s})$. L_{AE} is also related to a corresponding measurement of time averaged A-weighted sound level $L_{Aeq,T}$ by $L_{Aeq,T} + 10 \times \log_{10}(T/T_0)$ where $T_0 = 1 \text{ s}$ and T is the measurement period in seconds.
- 10) $L_{A,T}$: The specific sound level plus any adjustment for the characteristic features of the sound.
- 11) $L_{Aeq,T}$: The equivalent continuous sound level. It is that steady sound level which would produce the same energy over a given time period T as a specified time varying sound.

-
- 12) L_{AF1} : The sound level (dB) exceeded for 1% of the measurement period, this is considered in BB93 for the assessment of aircraft noise. 'A' and 'F' subscripts denote 'A weighting' and fast time weighting (125ms), respectively.
- 13) L_{AF10} : The sound level (dB) exceeded for 10% of the measurement period, this is considered in CRTN for the assessment of road traffic noise. 'A' and 'F' subscripts denote 'A weighting' and fast time weighting (125ms), respectively.
- 14) L_{AF90} : The sound level (dB) exceeded for 90% of the measurement period, this may be considered to be the background noise level. 'A' and 'F' subscripts denote 'A weighting' and fast time weighting (125ms), respectively.
- 15) R_w : The weighted sound reduction index which has been measured in accordance with the BS EN ISO 140 series of standards and rated in accordance with BS EN ISO 717-1: 1997. It is the sound insulation performance of the tested component, independent of its acoustic environment.
- 16) R'_w : The weighted apparent sound reduction index which has been measured in accordance with the BS EN ISO 140 series of standards and rated in accordance with BS EN ISO 717-1: 1997. It is the field sound insulation performance of the tested component and takes into account the influence of the acoustic environment.

$$R' = D + 10 \times \log_{10} (S) - 10 \times \log_{10} (V) + K \quad \text{in dB} \quad [\text{Eq. A2.1}]$$

where:

D is the energy averaged sound pressure level difference between the source and receiving rooms.

S is the separating partition surface area (in m²) that is common to both the source and receiving rooms.

V is the volume (in m³) of the receiving room.

K is a constant which is approximately equal to + 5 for $T_0 = 0.5$ seconds and + 7 for $T_0 = 0.8$ seconds.

T_0 is the reference reverberation time in seconds; for dwellings it is taken as $T_0 = 0.5$ seconds and for new build secondary school classrooms or for meeting room, interviewing/counselling room it is taken as $T_0 = 0.8$ seconds.

- 17) R_{TRA} : An indication of the road traffic noise attenuation in dB(A) for a given window.
- 18) D_{nTw} : The weighted standardised sound pressure level difference which has been measured in accordance with the BS EN ISO 140 series of standards and rated in accordance with BS EN ISO 717-1: 1997. It is a measure of the airborne sound insulation performance of the tested component. The direction of the sound transmission influences the resultant D_{nTw} value if the volumes of the rooms on either side of the tested separating construction are different.

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- 19) C_{tr} : The spectrum adaptation term C_{tr} was introduced in the second addition of ISO 717-1 1996 to account for road traffic noise spectra weighting (spectrum No. 2). It is also relevant for noise sources such as low speed railway traffic, aircraft as well as disco music and low and medium frequency factory noise emissions. It is reported as a separate single number quantity to distinguish it from the reference curve based main single number quantity. If no frequency range is indicated after C_{tr} , it is assumed to correspond to 100 Hz to 3150 Hz one-third octave bands. Its unit is dB.
- 20) D_w : The weighted sound level difference. It is measured in accordance with BS EN ISO 140-4.
- 21) $D_{n,e,w}$: The weighted element normalised level difference. It is measured in accordance with BS EN ISO 140-10 and rated in accordance with BS EN ISO 717-1: 1991.
- 22) $D_{n,f,w}$: The weighted normalised flanking level difference. It is measured in accordance with BS EN ISO 10848-2: 2006 and rated in accordance with BS EN ISO 717-1: 2013. It is a single-number quantity that provides information on the laboratory *flanking transmission of one or several building components*. There is dependence of the measured quantity $D_{n,f}$ on the test specimen dimensions.
- 23) D_w : The weighted sound level difference. It is measured in accordance with BS EN ISO 140-4.
- 24) $L'_{nT,w}$: The weighted standardised impact sound pressure level. It is measured in accordance with BS EN ISO 140-7: 1998 and rated in accordance with BS EN ISO 717-2: 1997.
- 25) Sabine reverberation time equation is used to determine reverberation time inside a room from the information of sound absorption coefficients of room surfaces, room volume, total room surface area and speed of sound. Reverberation time is defined as the sound energy to reduce to one millionth of its initial value after the sound source is turned off. This equates to 60 dB reduction in sound pressure level inside a room. It is an important parameter providing information about the acoustic characteristics of a room.

The following reverberation time equation which is written with A (*the equivalent sound absorption area*) being the subject has been when room noise break in levels was determined.

$$A := \frac{0.161 \cdot V_{room}}{T_{60}}$$

where:

T_{60} is the reverberation time in seconds;



V_{room} is the room volume in m^3 ;

A is the equivalent sound absorption area and is equal to the product of the total room surface area in m^2 , S_{total} , and the average sound absorption coefficient of the room surfaces, α .

0.161 is the constant obtained by considering the drop of the sound energy inside the room tested to one millionth of its original value after the sound source is turned off. Also considered are the time constant

$$\tau_E = \frac{4 * V_{\text{room}}}{A * c}, \text{ where, } c \text{ is the speed of sound in the room in m/s,}$$

that governs the growth of sound energy in the room.

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