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PROJECT TECHNICAL MEMORANDUM

JOB TITLE : Victoria Riverside Gym, Manchester

REF : HT: 31308/PTM2 Rev0

DATE : 12 December 2024

FROM : Nick Mitchell

ISSUED TO : Manchester City Council

RE: VICTORIA RIVERSIDE GYM FIT-OUT ACOUSTIC ASSESSMENT

1.0 Introduction

Hann Tucker Associates (Hann Tucker) has been appointed to undertake acoustic testing in relation to a proposed ground floor gymnasium space within Victoria Riverside, Manchester. Manchester City Council have requested for an acoustic assessment to be provided with a view to establishing that suitable acoustic control measures are being adopted.

Hann Tucker carried out airborne sound insulation and weight drop noise transfer tests within the second-floor residential dwelling (located directly above the proposed gymnasium space) on Thursday 1 August 2024.

This Project Technical Memorandum presents our findings and recommendations for the proposed gymnasium fit out.

2.0 Acoustic Terminology

For an explanation of the acoustic terminology used in this report please refer to Appendix A enclosed.

3.0 Proposed Criteria

3.1 Impact Noise from Weight Drops

The Employers Requirements set by ARUP do not have any specific guidance in relation to the operation of gyms. In addition, due to the time the site was granted planning permission, the 'ProPG: Gym Acoustics Guidance (GAG)' was not yet published (released March 2023) though this does now present a standardised methodology for assessing buildings and environments for the location of Gymnasiums, fitness and exercise spaces.



It is however important to note that whilst the ProPG Gym guide is not in circulation, this is a guidance document, and is intended to cover commercial gym operations in locality to residential dwellings. It is important to also consider that the ProPG Gym guide is open to interpretation, and requires considering to the context of the site/adjacency. As such, it has been agreed that from a planning perspective this document be considered, but as it does not set out definitive respective targets it is for reference only rather than being statutory.

Following consultation with the Client, it was agreed the recommended criteria for a residential amenity gym be designed with consideration to the following 'G-Curves' when assessing and implementing mitigation measures.

Receptor Type	Heavy Impact Sound $L_{max,F}$ (31.5Hz to 8KHz)
Residential Rooms	G30 – G35

It should be noted that the above criteria would be achievable up to an agreed weight or activity (ie knee height weight drops with weights as identified herein in the mock-up testing), and active management of the space would always be an expectation to ensure correct and proper use of equipment. The latter is however pertinent and achievable for residential amenity spaces which do often incorporate facilities management and/or concierge.

3.2 Maximum Noise Limits – Noise Transfer from Music

Noise limits for amplified music noise transfer into apartments are based on the MCC criteria for noise transfer. This is to achieve a level of 5 dB below background within the apartment:

Assessment to Residential Receptor	Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
NR20 Daytime Criteria (07 :00 – 23 :00)	47 ^[1]	41 ^[1]	31	24	20	17	14
NR15 Night-time Criteria (23 :00 – 07 :00)	47 ^[1]	41 ^[1]	26	18	15	12	9

¹ Based upon threshold of audibility.

3.3 Maximum Noise Limits – Noise Breakout from Music

MCC recommends that noise (L_{eq}) breaking out through the building frontage of any “commercial venue” should be limited to not exceed 5 dB below the background noise level (L_{90}) at all octave band frequencies at the nearest noise sensitive windows. For this development, the nearest proposed receptor boundary is 22m from the residential gym to the northeast of the site (North View Development). Although the gym is a residential amenity, this criteria is still considered applicable for off-site receptors.



Description	Entertainment Noise Level Limit (dB L _{90,15min}) at Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
L _{eq,5min} Criteria at nearest off-site receptor	47 ^[1]	41 ^[1]	38	37	39	32	23

¹ Based upon threshold of audibility.

4.0 Weight Drop Test Methodology

The weight drop testing involved dropping a range of weights on gym floor samples. It is proposed to install the Stravigym floor, however, for completeness, 2No other alternative floor systems were tested. The build ups tested are as set out below:

- Getzner g-fit 75mm w/ generic rubber floor finish 10mm (total 85mm).
- Pliteq GenieMat xFit100 Fusion (total 100mm).
- Stravigym Floor System (124mm) + Gympact layer (45mm) w/ generic rubber floor finish (10mm) – overall depth (total 179mm).

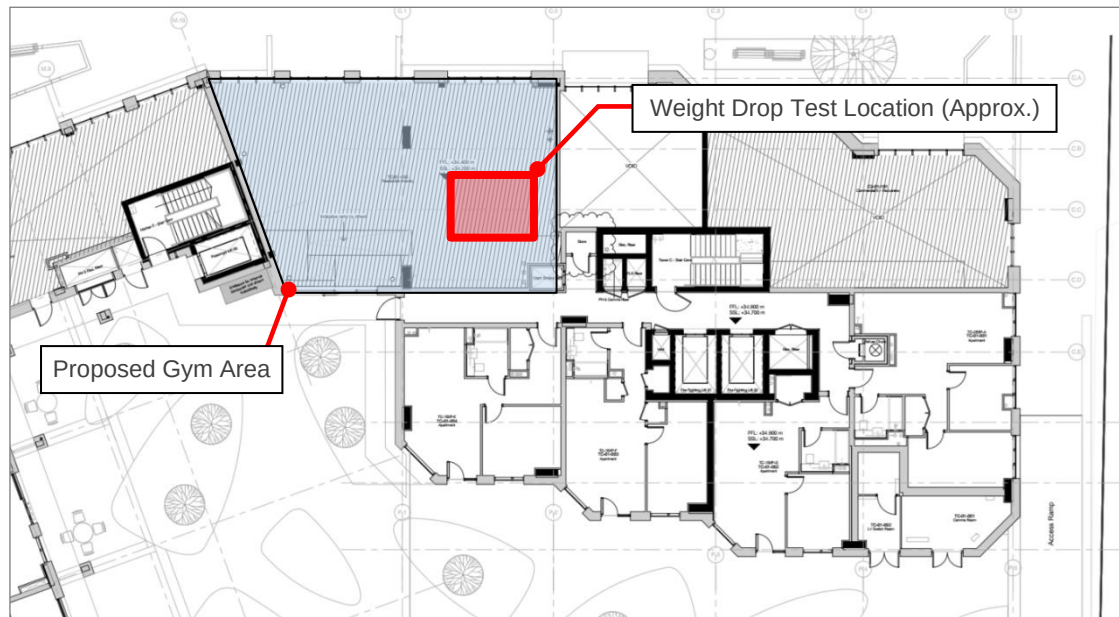
12 kg and 24 kg kettlebells were used to be representative of the intended gymnasium activities. Both the 12 kg and 24 kg kettlebells were solid cast iron in make-up (no casing or coating).

5No. weight drops were released from knee height per weight category per system. The worst-case representative result (of the 5No. drops) has been considered in our analyses. When a pad floor sample was used the engineer was stood directly on the sample and dropped the weight downwards.

Time synchronised sound level meters were set up in the following locations to log sound levels during the weight drop tests.

- In the residential amenity area of Tower C (Source Room) (proposed gymnasium space)
- In the residential apartment located directly above in Apartment 01 of the second floor (Receive Room)

The drop area within the residential amenity space is indicated on the plan overleaf.



Weight Drop Test Area (Drawing Provided by Hawkins\Brown)

The instrumentation used for the measurements is presented in the table below.

Location	Description	Manufacturer	Type	Serial Number	Calibration
Source Room	Type 1 Data Logging Sound Level Meter	Larson Davis	LxT	4568	Calibration on 30/05/2024
Receive Room	Type 1 Data Logging Sound Level Meter	Larson Davis	LxT	5104	Calibration on 30/05/2024

Each sound level meter was calibrated prior to and on completion of the measurements. No significant changes were found to have occurred (no more than 0.3 dB).

5.0 Sound Insulation Test Methodology

The residential amenity area was a shell with exposed slabs and unlined blockwork walls. We understand that the curtain wall spans across the slab edge in a similar way to the detail between apartments, with a unitized system installation.

The sound insulation tests were undertaken in general accordance with BS EN ISO-140 by generating a broad band, random diffuse sound field within the source room. A spatial average of the resulting 1/3 octave band noise levels was obtained within the source room from measurements undertaken over a period of a least 30 seconds. The measurement procedure was repeated in the receive room.



The receive levels were corrected for background noise and subtracted from the source levels to determine the level differences over the frequency range 100-3150Hz. The level differences for each source position are arithmetically averaged at each frequency band to give the level difference, D.

The 1/3 octave band results are then compared with a standard curve using the method described in BS EN ISO 717-1: 1997 to determine the single figure descriptor of airborne sound insulation, the Weighted Standardised Level Difference, or D_w .

The instrumentation used for the measurements is presented in the table below.

Equipment	Model	Serial Number	Calibration Date
Precision Sound Analyser Meter	Brüel & Kjær Type 2250	2271905	Calibration on 05/09/2023

The equipment was calibrated prior to and on completion of the survey. No significant deviations occurred.

6.0 Test Results

6.1 Airborne Sound Insulation Test

The results of the airborne sound insulation test from the Amenity to the residential unit located directly above are tabulated below.

Description	Level Difference (D dB) at Octave Centre Frequency (Hz)							$D_w (+C_{tr})$ (dB)
	63	125	250	500	1k	2k	4k	
Tower C Gymnasium to the residential unit	45	45	52	60	70	69	68	57

The above results will be used to assess the impact of airborne noise transfer between the Gym space and the apartments above.

6.2 Weight Drop Tests

The as-measured sound pressure levels within the apartment during the weight drop tests are tabulated below, presented in terms of L_{AFmax} and G-value. Note that these levels are not yet corrected for airborne noise transfer or reverberation time.



Test Ref.	Gym Floor Sample Arrangement (Directly on the floor slab)	Dropped Weight (kg)	Measured Sound Level in Receive Room	
			L _{AFmax} (dB)	G-Value (dB L _{max,F})
D1	Getzner g-fit 75mm w/ generic rubber floor finish 10mm (total 85mm)	12	34	34
D2			31	29
D3			30	28
D4			34	33
D5			35	35
D6		24	34	38
D7			34	36
D8			32	33
D9			34	34
D10			31	30
D11	Pliteq GenieMat xFit100 Fusion (total 100mm)	12	34	38
D12			36	37
D13			31	32
D14			35	36
D15*			-	-
D16		24	38	39
D17			37	37
D18			37	37
D19			38	38
D20			38	38
D21	Stravigym Floor nSystem (124mm) + Gympact layer (45mm) w/ generic rubber floor finish (10mm) – overall depth (total 179mm)	12	29	27
D22			29	27
D23			30	34
D24			32	32
D25			31	32



Test Ref.	Gym Floor Sample Arrangement (Directly on the floor slab)	Dropped Weight (kg)	Measured Sound Level in Receive Room	
			L _{AFmax} (dB)	G-Value (dB L _{max,F})
D26		24	31	29
D27			31	30
D28			33	33
D29			31	31
D30			30	31

*Test no.15 has been disregarded due to extraneous noise affecting the measurement.

Based on the results of the weight drop testing, the measured sound levels were a mix of structure-borne and airborne noise, with the structure-borne noise mainly below 1000 Hz. The measured results have been adjusted to remove the airborne noise path and account for a shorter reverberation time within the completed apartments, focusing on frequencies below 1000 Hz. The results are provided below:

Gym Floor Sample Arrangement (Directly on the floor slab)	Dropped Weight (kg)	Measured Sound Level in Receive Room	
		L _{AFmax} (dB)	G-Value (dB L _{max,F})
Getzner g-fit 75mm w/ generic rubber floor finish 10mm (total 85mm)	12	32	31
	24	31	31
Pliteq GenieMat xFit100 Fusion (total 100mm)	12	33	35
	24	39	35
Stravigym Floor nSystem (124mm) + Gympact layer (45mm) w/ generic rubber floor finish (10mm) – overall depth (total 179mm)	12	27	23
	24	29	27

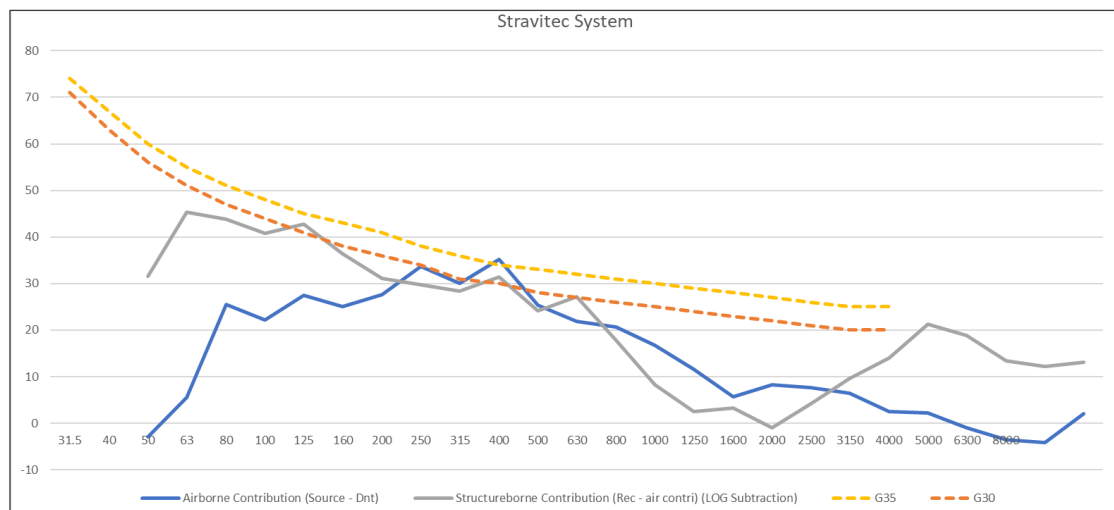
6.3 Results Discussion and Conclusions

The Stravigym floor system generally performed well and even considering the uncorrected noise levels has complied with the upper range of the suggested G30-G35 criteria. This indicates the Stravigym Floor is likely sufficient in mitigating the measured weight drops to the suggested criteria, provided the gym is properly managed.



It is important to note that the tests were conducted with weights up to 24 kg. If heavier weights, such as 50 kg, are used, the noise transfer could exceed the criteria, potentially leading to more frequent breaches of the G35 threshold during the day and a higher likelihood of disturbances. Therefore, managing gym activities, especially regarding the use of heavier weights, is crucial.

The graph below illustrates the contributions of both airborne and structure-borne sound energy under the current testing conditions:



The data in the graph above indicates that structure borne sound transfer is likely the primary contributor to noise levels in the receiver room below 125Hz, with airborne noise transfer contributing more at mid to higher frequencies. Given that the base build testing was undertaken in shell state, these mid-higher frequencies would be mitigated further once fit-out is progressed. Therefore, to mitigate the risk further the installation of a plasterboard ceiling (min 1no. layer of 12.5mm plasterboard, min 10kg/m²), is advised to enhance sound insulation performance and control airborne noise transfer below the suggested limit.

6.4 Additional Comments on Gym Management

The installation of the Stravigym floor system and proposed MF ceiling would go some way to controlling noise transfer between the proposed gym and the apartments above, and has shown in the early testing 24kg dropped from knee complies with the suggested criteria. However, heavy weight drops, for example deadlifts or heavy dumbbells, or miss-use of the gym would likely result in more noise transfer than has been measured in our testing.

The space shall therefore be actively managed, and occupants will be advised to place weights down rather than drop them from excessive height. Strict policies should be put in place with regards to miss-use of the gym with access being restricted to those who abide by the rules.



If music is to be played within the gym this should be at a moderate level as per the limits provided below in Section 7.1 and the final operational noise limit should be established through post completion testing and commissioning of electronic noise limiter.

7.0 Maximum Limiting Levels for Amplified Music

7.1 Noise Transfer Limiting Levels

Using the measured D values as presented in Section 6.1, we can add the performance to the MCC criteria to provide the maximum internal noise level limit for both daytime and night-time periods.

The assessment for daytime limiting levels is presented in the table overleaf.

Assessment to Residential Receptor	Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
NR20 Daytime Criteria (07 :00 – 23 :00)	47	41	31	24	20	17	14
Measured D (dB)	45	45	52	60	70	69	68
Maximum Internal noise level (dB L _{eq}) <i>SPL_{in}</i>	92	86	83	84	90	86	82

The assessment for night-time limiting levels is presented in the table below.

Assessment to Residential Receptor	Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
NR15 Night-time Criteria (23 :00 – 07 :00)	47 ^[1]	41 ^[1]	26	18	15	12	9
Measured D (dB)	45	45	52	60	70	69	68
Maximum Internal noise level (dB L _{eq}) <i>SPL_{in}</i>	92	86	78	79	85	81	77

7.2 External Breakout Limiting Levels

To inform our assessment of the spaces regarding noise break-out, we have drawn upon the calculated maximum operational noise levels to control noise breakout through the weakest element of the external façade, namely the glazing.

Drawing reference 'VRS-HBA-PB-00-DR-A-31_0101-C1 External Window & Door Types – Ground Floor Podium B', references 'DT-46' which corresponds to the relevant glazing schedule. The glazing schedule provides the 'Standard Acoustic' specification for the sliding access door with Glass/Filling 'Low E lam 6,8-15-4-15-6,8', a triple glazing system.



Test data from Guardian Glass has been provided. Calculations have been undertaken using the proposed podium glass data to demonstrate the ability to comply with the criteria.

The assessment of noise breakout to the nearest receptors based on standard calculation procedures for reverberant noise breakout and source noise levels as previously mentioned. The resultant external noise level has been calculated using the following equation detailed below.

$$SPL_{out} = SPL_{in} - SRI + 10\log_{10}\left(\frac{S}{r^2}\right) - 14$$

Where:

- a) SRI is the estimated sound reduction performance of the façade element.
- b) r is the distance from radiating element to receptors.
- c) S is the approximate surface area of radiating element.

Using noise level limits, as presented in Section 7.1, and the criteria as specified by MCC, the tables presented below outline summary calculations for the maximum internal level limit for operational use.

Assessment to Residential Receptor	Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
Maximum Internal noise level (dB L _{eq}) <i>SPL_{in}</i>	92	86	83	84	90	86	82
Composite sound reduction of glazing elements (dB) <i>SRI</i>	-20	-30	-40	-42	-40	-49	-58
Distance & radiating area propagation correction (dB) $10\log_{10}\left(\frac{S}{r^2}\right)$	-27	-27	-27	-27	-27	-27	-27
Internal diffuse field to external free-field hemispherical radiation correction (dB) <i>-14</i>	-14	-14	-14	-14	-14	-14	-14
External noise level at nearest receptor (dB L _{eq}) <i>SPL_{out}</i>	31	15	2	1	9	-4	-17
Criteria at nearest receptor (dB L _{eq})	47	41	38	37	39	32	23
Noise Impact at Receptor (dB)	-4	-26	-36	-36	-30	-36	-40

¹ Based upon threshold of audibility.

7.3 Summary of Noise Limits

As per the assessment of noise transfer to residential units above (internal), and noise breakout to off-site receptors (external), the limiting level to be set within the gymnasium and cannot be exceeded is based on the worst-case assessment.



In this instance, the limiting levels for noise transfer are more onerous than breakout. This is due to the structural connection between both spaces. The maximum level limits to be enforced are presented below.

Noise Limiting Level for Tower C Gymnasium	Octave Band Centre Frequency (Hz)						
	63	125	250	500	1k	2k	4k
Maximum Internal noise level (dB L _{eq}) <i>SPL_{in}</i>	92	86	78	79	85	81	77

8.0 Conclusion

As assessment of noise transfer from weight drops within the Tower C gymnasium, and airborne noise transfer has been assessed in accordance with the relevant guidance on gymnasiums.

The assessment demonstrates that a floating floor and MF ceiling are required to ensure compliance with the internal criteria for adjoining residential rooms. This is to be implemented into the fit-out of the space.

Additionally, maximum noise limiting levels have been provided for any amplified system within the unit. Validation measurements are to be undertaken by a suitable qualified acoustic consultant to ensure that the above set noise limits are complied with.

Yours sincerely,

Nick Mitchell | Senior Consultant

for HANN TUCKER ASSOCIATES

Appendix A – Acoustic Terminology

- dB** - Decibel - Used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level.
- dB(A)** - The human ear is more susceptible to mid-frequency noise than the high and low frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds roughly to the overall level of noise that is discerned by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted spectrum. The measured or calculated 'A' weighted noise level is known as the dB(A) level.
- Because of being a logarithmic scale noise levels in dB(A) do not have a linear relationship to each other. For similar noises, a change in noise level of 10dB(A) represents a doubling or halving of subjective loudness. A change of 3dB(A) is just perceptible.
- L_{Aeq}** - The concept of L_{Aeq} (equivalent continuous sound level) has up to recently been primarily used in assessing noise in industry but seems now to be finding use in defining many other types of noise, such as aircraft noise, environmental noise and construction noise.
- L_{Aeq} is defined as the (A-weighted) notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (30 minutes).
- L_{max}** - L_{max} is the maximum sound pressure level recorded over the period stated. L_{max} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the L_{eq} noise level.
- NR** - **Noise Rating (Curves)**
- A method of assessing the frequency dependent sound pressure levels within a space. Gives a single figure result based upon a weighting curve roughly in line with the equal loudness curves.
- G-Value** - **G-Curve Rating**
- G-Curves are based on interpretations of NR Curves. They provide single reference ratings which when one-third octave measurement data are plotted against the curves the value which is not broken by the data represents the G-Curve rating

Appendix B – Source Room Measurement Results

Test Ref.	Gym Floor Sample Arrangement (Directly on the floor slab)	Dropped Weight (kg)	Measured Sound Level in Source Room	
			L _{AFmax} (dB)	G-Value (dB L _{max,F})
D1	10mm Sportec Tile	6	80	79
D2		12	85	86
D3		24	90	92
D4	10mm Sportec Tile on 25mm Sylomer SR28	6	70	70
D5		12	71	75
D6		24	76	82
D7	40mm Sportec Style Tile on 2No. Acousticork U71	6	71	72
D8		12	75	76
D9		24	76	77
D10	Pliteq Fit70	6	79	86
D11		12	82	88
D12		24	84	90
D13	Pliteq Fit70 on 2No. Geniemat	6	78	76
D14		12	72	75
D15		24	70	71
D16	Getzner G-fit impact tile - 1 layer	6	71	68
D17		12	71	70
D18		24	66	76
D19	Getzner G-fit impact tile - 2 layers	6	70	70
D20		12	75	75
D21		24	73	73
D22	Getzner G-fit impact tile - 3 layers	6	62	61
D23		12	66	66
D24		24	65	64
D25	StraviGym Spring system with Roll W25 and a 30 tile	12	78	77
D26		24	82	82
D27	StraviGym Spring system with Roll W25 and a 70 tile	12	73	72
D28		24	78	77
D29	Pad-M50 with Roll W25 and a 70 tile	12	75	78
D30		24	74	78
D31	Pad-M50 with roll W25 and a 30 tile	12	75	74
D32		24	84	83
D33	20mm Sportec Tile	12	78	84
D34		24	84	91