

LORETO COLLEGE, MANCHESTER - NEW CLASSROOM BLOCK

STAGE 4 DESIGN REVIEW

On behalf of:

Caddick Construction (NW) Ltd

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1.0 INTRODUCTION

- 1.1 Hepworth Acoustics Ltd was commissioned by Caddick Construction (NW) Ltd to provide acoustic consultancy services in connection with a new classroom block at Loreto College, Manchester.
- 1.2 This acoustic design review has been prepared as part of RIBA Stage 4 of the design process, with respect to the following considerations:
- Upper internal ambient noise levels, due to break-in of external noise;
 - Airborne sound insulation of walls and floors, and impact sound insulation of floors, within the extension; and,
 - Control of reverberation of sound within relevant spaces.
- 1.3 Furthermore, an assessment of external rooftop plant has been carried out in relation to a planning condition.
- 1.4 The plans and drawings on which this acoustic design review are based, have been provided by Caddick Construction (NW) Ltd and 10 Architect.
- 1.5 All recommendations in this report are provided with respect to acoustic performance only and compliance with other requirements (e.g. fire, structural and ventilation etc.) should be checked by others.
- 1.6 The various noise units and indices referred to in this report are described in Appendix I. All noise levels mentioned in the text have been rounded to the nearest decibel, as fractions of decibels are imperceptible.

2.0 CONTROL OF EXTERNAL FIXED PLANT NOISE

Planning Condition

- 2.1 Planning permission for the classroom block has the following condition relating to the assessment and control of externally mounted fixed plant noise:

“a) Externally mounted ancillary 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 5dB (LAeq) below the typical background (LA90) level at the nearest noise sensitive location. Prior to commencement of the use hereby approved the scheme shall be submitted to and approved in writing by the City Council as local planning authority in order to secure a reduction in the level of noise emanating from the site. The scheme shall be implemented in full before the use commences or as otherwise agreed in writing by the City Council as local planning authority.

b) Prior to the operation of the scheme a verification report shall be submitted to and approved in writing by the City Council as local planning authority to validate that the work undertaken throughout the development conforms to the recommendations and requirements in the approved acoustic report. The report shall also undertake post completion testing to confirm that the noise criteria have been met. Any instances of non-conformity with the recommendations in the report shall be detailed along with any measures required to ensure compliance with the agreed noise criteria.”

- 2.2 This assessment forms part of an application to discharge part a of the condition.
- 2.3 The typical background noise levels were determined from the results of a 24 hour noise survey as detailed in Hepworth Acoustics Report P23-075-R01v2.
- 2.4 The representative background noise values were 45 dB $L_{A90,T}$ for the evening period and 40 dB $L_{A90,T}$ for the night-time value wa period. Therefore, based on requirements of the condition the adopted noise limits are 40 dB $L_{Aeq,T}$ daytime and 35 dB $L_{Aeq,T}$ at night outside the nearest dwellings. The nearest dwellings are considered to be Chichester House opposite the site and approximately 35 metres from the rooftop plant.
- 2.5 The following noise emission data for the proposed plant have been provided by Waterman, the project M&E consultant. The broadband noise emission levels for the various items of plant have been standardised into sound power levels and shown in Table 1 below. Octave band values have

been provided for some items of plant which indicate there are no tonal elements to the noise emissions.

Table 1: Plant & Equipment Sound Power Levels (dB L_{WA})

Number	Description	Noise Level for single item
12	Air Source Heat Pumps	55
1	Comms Room condenser	63
2	VRF condensers	61
3	Overdoor Heat Pump	71
1	Heat Recovery Unit	53

- 2.6 The calculation of the resulting noise rating level outside the nearest dwellings is shown in Table 2 below. The likely resulting plant noise level outside the upper floor windows of these dwellings has been calculated, with appropriate allowances for directivity, distance attenuation and any screening provided by the parapet/building. The equipment will all operate steady continuous manner, therefore given the low calculated noise level outside the nearest dwelling no acoustic feature correction is warranted. The representative background sound level is also shown and an initial assessment of noise impact in accordance with BS 4142 is presented.

Table 2: Initial BS 4142 Assessment of extract plant noise at nearest dwellings (dB)

Description	Dwelling
Calculated Specific Sound Level outside Dwelling	29
Acoustic feature correction	0
Rating Level of Sound at Dwelling	29
Adopted Noise Limit	40
Difference	-11

- 2.7 The results in Table 2 show that the combined rating noise level at the nearest dwellings is well below the adopted noise limit during the night-time period.

Conclusion

- 2.8 Therefore, the proposed equipment will not result in any unacceptable impact on residential amenity and will meet the requirements of Condition 3 of the planning permission without any specific noise mitigation measures.

3.0 CONTROL OF INDOOR AMBIENT NOISE LEVELS (IANL)

Break In of External Noise

- 3.1 The building envelope of the proposed new classroom block will consist of the following elements.

External Walls

- 3.2 External walls will be of cavity masonry construction with outer facing 102mm clay brickwork and 140mm dense blockwork inner leaf with plaster finish.

Spandrel Panels

- 3.3 Opaque back-painted glazed units with a 90mm thick stone wool slab insulation bonded to the rear. Panels to be enclosed with plasterboard and cavity filled with mineral wool. It is recommended that the panels are enclosed with two layers of 15mm Gyproc SoundBloc.

Glazing

- 3.4 Standard well-fitted thermal double glazing (4mm glass - 4mm glass) i.e. windows with a sound reduction performance of 25 dB $R_w + C_{tr}$ when the windows are closed is to be installed in teaching spaces away from Chichester Road South and Moss Lane West.
- 3.5 Enhanced acoustic glazing of minimum 8 mm glass – 12 to 20 mm cavity – 4 mm glass i.e. having a typical sound reduction performance of 30 dB $R_w + C_{tr}$ is to be installed in teaching spaces overlooking Chichester Road South and Moss Lane West.

Ventilation

- 3.6 It is understood that natural/passive ventilation is proposed within teaching spaces via appropriately acoustically attenuated louvres. The ventilation ductwork runs within the void between the raft ceiling and the concrete deck.
- 3.7 We have reviewed the proposals for the glazing and ventilation within the context of achieving the indoor ambient noise level targets, based on the external noise level data presented in Section 3 of the Stage 3 acoustic design review (report ref: P23-075-R02v2).

- 3.8 On this basis it is considered that the proposed building envelope including the glazing will meet the requirements for the sound insulation performance of the extension.

Rain Noise

- 3.9 In line with the BB93 design criteria, rain noise within the second floor classrooms should be controlled to be no higher than 25 dB above the IANL criteria 35 dB $L_{Aeq,30mins}$ as set out in the acoustic stage 3 design report. Therefore, the criterion for rain noise is no higher than 60 dB $L_{Aeq,30mins}$.
- 3.10 We understand a lightweight profile metal deck PIR roof construction is proposed and provided by IKO. The roof is to be constructed as follows:
- Bitumen membrane outer layer with between 180-240mm PIR Warm Deck roof insulation with a vapour control layer all mechanically fixed to the Tata D60 metal deck.
- 3.11 There is no test data available for this construction, however based on test data for similar constructions it is likely to exceed the 60 dB $L_{Aeq,30mins}$ in classrooms. It is therefore, recommended that the roof is underdrawn with an acoustic barrier mass ceiling to control rain noise in these spaces.
- 3.12 The build up of the acoustic barrier mass ceiling is set out in Section 4 of this report and will control rain noise and flanking transmission.

4.0 SOUND INSULATION BETWEEN SPACES

Airborne Sound Insulation of Separating Walls

- 4.1 The minimum required laboratory sound insulation performance values for walls separating teaching spaces and other spaces are detailed in our Stage 3 report (ref: P23-075-R02v2). Walls that provide these sound insulation performance values (R_w) as a minimum will be required to achieve the sound insulation performance criteria ($D_{n,T,w}$).
- 4.2 The proposed wall types are detailed in drawings LCNP-10A-V3-00-DR-A-3110, LCNP-10A-V3-00-DR-A-3111 and LCNP-10A-V3-00-DR-A-3112.
- 4.3 Wall types are based on the following constructions:
- Type P7 – 140mm blockwork wall (45 dB R_w)
 - Type P8 – 140mm blockwork wall lined with 2 layers of 15mm Duraline on an independent frame and 35mm cavity with 25mm acoustic insulation (51 dB R_w)

Airborne and Impact Sound Insulation of Separating Floors

- 4.4 The proposals for the floor construction are for a 140mm thick composite floor concrete on metal profiled deck with vinyl or carpet floor tiles on top.
- 4.5 Proposals for the ceiling are currently for a lay-in grid metal frame and mineral tile ceiling, but the exact ceiling tile and grid is not currently specified. The ceiling will cover approximately 90% of the floor area with gaps around the edges.
- 4.6 Typically in order for a ceiling to improve sound insulation performance by a demonstratable amount, it must fully enclose the floor deck. The required airborne sound insulation criterion of 45 dB $D_{nT,w}$ between the majority of spaces may just be achieved, however with no margin of safety and depending on the improvement provided by the raft ceiling. However, at this stage it is not clear what improvement the open raft ceiling will provide to concrete metal deck.
- 4.7 The required airborne sound insulation criterion of 45 dB $D_{nT,w}$ between the Assembly Space and the Study Centre will likely be achieved as an enclosed lay-in grid metal frame and mineral tile ceiling is proposed within the Assembly Space. It is recommended that mineral tile provide a sound insulation performance of at least 20 dB R_w .

- 4.8 The required sound insulation criterion of $60 \text{ dB } L'_{nT,w}$ within rooms from impact noise generated on the floor above will be achieved by incorporating an appropriate acoustic underlay above the proposed floor finishes, which are as follows:
- Milliken Free Flow Thread Carpet tile;
 - Forbo Marmoleum decibel Vinyl tile ($18 \text{ dB } \Delta L_w$).
- 4.9 The appropriate acoustic underlay should provide a combined improved impact sound insulation performance of at least $21 \text{ dB } \Delta L_w$. It is likely that Regupol Sonus Eco 5 would be a suitable product however this should be confirmed with the manufacturer.

Ventilation Grilles Above Doorsets

- 4.10 In order to meet the sound insulation requirements for corridor walls, in-duct silencers should be incorporated into the ventilation ductwork of each teaching space (where present) that achieve a performance of $40 \text{ dB } R_w$ and should be located adjacent to the corridor wall in order to be effective.
- 4.11 Proposals provided to date do not indicate any passive ventilation grilles above door sets situated between teaching rooms and corridors, however if going forward any are to be incorporated into the design, they should be selected to achieve a minimum of $32 \text{ dB } D_{n,e,w} + 10 \log_{10} N$, where N is the number of grilles (e.g. if there are to be two grilles, the requirement for each would be a minimum of $35 \text{ dB } D_{n,e,w}$).

Flanking Sound Transmission

- 4.12 The direct sound transmission paths between separated spaces have been covered above in this section, however the resulting in-situ sound insulation performance between spaces can be compromised by transmission via common flanking elements if not adequately addressed.
- 4.13 The lightweight roof should be underdrawn with two layers of 15mm Gyproc Duraline/SoundBloc (minimum 12.5 kg/m^2 per layer of plasterboard) mounted on a MF ceiling frame with 100mm void and 50mm mineral wool in the cavity. This will reduce flanking noise transmission via the lightweight roof.
- 4.14 The ceiling of adjacent spaces should be broken by the separating wall - i.e. ceilings must be installed after any separating walls and be broken by the walls, such that the suspended ceiling is not common to any adjacent spaces.

- 4.15 Walls should be built to full height, from structural floor to soffit. Where the separating walls abut a profiled soffit, suitable deflection head details in line with the manufacturer's instructions ensuring a tight fit and airtight seal at the junction should be installed. Breads should be cut to fit the profile of the deck and the void filled with mineral wool.
- 4.16 Structural steel to encased with two layers of 15mm Gyproc Duraline/SoundBloc (minimum 12.5 kg/m² per layer of plasterboard) mounted on an independent frame with mineral wool in void.
- 4.17 Where separating walls are to have a laboratory sound insulation performance of 50 dB R_w or more, depending on the mass of the floor, flanking sound transmission via the continuous floor between the spaces has the potential to reduce the sound insulation performance.
- 4.18 Ideally, this flanking path would be controlled with a suitably dense floating floor, however this is not possible on this project. However, it is understood from the Architect that an acceptable performance has been achieved on similar projects using similar wall and floor constructions. We have not been provided with any further detail or test reports indicating that on site performance with this construction was achieved.

General Advice on Acoustic Detailing

- 4.19 Care should be taken to ensure that all works are carried out in accordance with the manufacturer's installation instructions.
- 4.20 Plasterboard layers should have staggered joints (where multiple) and be well sealed at the joints and perimeter with high density non-setting acoustic mastic.
- 4.21 Electrical and other sockets in any separating walls should be avoided but where they are necessary they would ideally be surface mounted. If surface mounting of sockets is not possible, then back boxes/pattresses should be done fully in line with manufacturers recommendations for the partition specification to ensure that the sound insulation of the wall is not affected.
- 4.22 Where possible, penetrations in separating walls should be avoided as this will reduce the overall sound insulation performance of the wall. However, where holes made for cabling or pipework are unavoidable, they should be carefully cut/drilled and sealed to minimise gaps around the pipes.
- 4.23 Soil pipes must be wrapped in mineral wool and encased with two layers of 15mm Gyproc Duraline/SoundBloc mounted on an independent frame.

- 4.24 Doors should be fitted in accordance with the manufacturer's installation instructions to ensure a good seal is achieved around the full perimeter of the door. The doors will only meet the required sound insulation performance if the door sets are installed with the appropriate edge seals as specified by the manufacturer. Doors between classrooms and circulation spaces should be specified as 30 dB R_w . The doorset to the Assembly space and circulation being 35 dB R_w .
- 4.25 All internal glazing should be well fitted such that an effective seal is achieved around the perimeter of any window frame and any openings.
- 4.26 Where any corridor door sets to the teaching spaces will have glazed side lights/side vision panels, the composite sound insulation performance will need to be considered. The composite sound insulation of the corridor walls and glazed areas (including any glazed side panels) will need to achieve at least 40 dB R_w .
- 4.27 All internal glazing should be well fitted such that an effective seal is achieved around the perimeter of any window frame and any openings.
- 4.28 All building service plant and equipment must be appropriately isolated from the building structure to ensure that residual vibration and re-radiated noise is adequately controlled. Necessary measures may include Air Handling Units (AHUs) located on anti-vibration pads with flexible connectors either side of the unit (including roof top AHUs), isolation pads to boilers, open spring or rubber mounts for pump sets with flexible connectors either side of the units.

5.0 CONTROL OF REVERBERATION

- 5.1 Suitable control of reverberation of sound within circulation spaces can be achieved by covering a surface area equal to the surface area of the floor with a Class C acoustic absorber. This is generally done by installing a ceiling tile with Class C acoustic absorption.
- 5.2 For the teaching and learning spaces, the minimum coverage areas based on a specified acoustic absorption class for the ceiling tiles is provided in our Stage 3 report.
- 5.3 We understand that the proposals are for a single type of ceiling tile to be used throughout the extension including teaching spaces and circulations spaces. The proposals are to use a Gyptone ceiling tile with Class C absorption.
- 5.4 Due to the height of the space (6.5 metres), it is also recommended that at least 30% of the wall area is covered with Class A acoustic absorption. The proposed wall covering should be in the lower section of the walls (i.e. closer to occupants) and otherwise be evenly distributed throughout the space.
- 5.5 The target reverberation times will be provided by the currently proposed ceiling surface finishes and recommended wall panels as appropriate along with the indicative floor surface finishes described by the architect.

6.0 SUMMARY

- 6.1 Hepworth Acoustics Ltd was commissioned by Caddick Construction (NW) Ltd to provide acoustic consultancy services in connection with the new classroom block at Loreto College, Manchester.
- 6.2 An assessment was undertaken for the external roof top plant in relation to a planning condition.
- 6.3 We have provided advice on achieving the BB93 performance requirements based on the details available at this stage for the following aspects of the design:
- Upper internal ambient noise levels, due to noise break-in;
 - Airborne (walls and floors) and impact (floors) sound insulation within the extension; and,
 - Control of reverberation time within relevant spaces.

Appendix I: Noise Units & Indices

Sound and the decibel

A sound wave is a small fluctuation of atmospheric pressure. The human ear responds to these variations in pressure, producing the sensation of hearing. The ear can detect a very wide range of pressure variations. In order to cope with this wide range of pressure variations, a logarithmic scale is used to convert the values into manageable numbers. Although it might seem unusual to use a logarithmic scale to measure a physical phenomenon, it has been found that human hearing also responds to sound in an approximately logarithmic fashion. The dB (decibel) is the logarithmic unit used to describe sound (or noise) levels. The usual range of sound pressure levels is from 0 dB (threshold of hearing) to 120dB (threshold of pain).

Due to the logarithmic nature of decibels, when two noises of the same level are combined together, the total noise level is (under normal circumstances) 3 dB(A) higher than each of the individual noise levels e.g. 60 dB(A) plus 60 dB(A) = 63 dB(A). In terms of perceived 'loudness', a 3 dB(A) variation in noise level is a relatively small (but nevertheless just noticeable) change. An increase in noise level of 10 dB(A) generally corresponds to a doubling of perceived loudness. Likewise, a reduction in noise level of 10 dB(A) generally corresponds to a halving of perceived loudness.

The ear is not equally sensitive to sound at all frequencies. It is less sensitive to sound at low and very high frequencies, compared with the frequencies in between. Therefore, when measuring a sound made up of different frequencies, it is often useful to 'weight' each frequency appropriately, so that the measurement correlates better with what a person would actually hear. This is usually achieved by using an electronic filter called the 'A' weighting, which is built into sound level meters. Noise levels measured using the 'A' weighting are denoted dB(A) or dBA.

Frequency and Hertz (Hz)

As well as the loudness of a sound, the frequency content of a sound is also very important. Frequency is a measure of the rate of fluctuation of a sound wave. The unit used is cycles per second, or hertz (Hz). Sometimes large frequency values are written as kiloHertz (kHz), where 1 kHz = 1000 Hz.

Young people with normal hearing can hear frequencies in the range 20 Hz to 20 kHz. However, the upper frequency limit gradually reduces as a person gets older.

Glossary of Terms

When a noise level is constant and does not fluctuate, it can be described adequately by measuring the dB(A) level. However, when the noise level varies with time, the measured dB(A) level will vary as well. In this case it is therefore not possible to represent the noise climate with a simple dB(A) value. In order to describe noise where the level is continuously varying, a number of other indices can be used. The indices used in this report are described below.

- C_{tr} This is an A-weighted urban traffic noise spectrum, which can be added to $D_{nT,w}$ or R_w in some standards to take into account different source spectra such as low frequency sound.
- R This is the 'Sound Reduction Index' as measured in a laboratory, and is a measure of the sound insulation properties of an building element in a stated frequency band.
- R_w This is the 'Weighted Sound Reduction Index', and is a single figure quantity of R , the laboratory measured Sound Reduction Index.
- $D_{n,e,w}$ This is the weighted element normalized level difference as measured in a laboratory, and is a measure of the sound insulation properties of small building elements such as ventilators.
- D This is the Level Difference and is a field measurement of the airborne sound insulation between adjacent spaces. As well as being field measurement, this term and all other D terms below therefore include on-site conditions other than direction noise transmission through, for example, a wall (flanking transmission).
- D_n This is the Normalized Level Difference and is a field measurement of the airborne sound insulation between adjacent spaces.
- D_{nT} This is the Standardised Level Difference, which is equivalent to the measured D_n and corrected to a standardised reverberation time of 0.5s.
- $D_{nT,w}$ This the Weighted Standardised Level Difference, is a single figure value of D_{nT} , and is the field measurement of airborne sound transmission

$D_{nT,w} + C_{tr}$ This is the Weighted Standardized Level Difference with Spectrum Adaption Term C_{tr}

$L_{Aeq,T}$ This is the A-weighted 'equivalent continuous noise level' which is an average of the total sound energy measured over a specified time period. In other words, $L_{Aeq,T}$ is the level of a continuous noise which has the same total (A-weighted) energy as the real fluctuating noise, measured over the same time period. It is increasingly being used as the preferred parameter for all forms of environmental noise.

$L_{A1,T}$ This is the A-weighted noise level exceeded for 1% of the time period. $L_{A1,T}$ is usually used as a measure of peak noise in the assessment of noise break-in in BB93.

$L_{A90,T}$ This is the A-weighted noise level exceeded for 90% of the time period. $L_{A90,T}$ is used as a measure of background noise.

L_W This is the Sound Power Level and is a Logarithmic measure of the sound power as a relation to the threshold of hearing.

L_{WA} This is the A-weighted 'Sound Power Level' and is a Logarithmic measure of the sound power as a relation to the threshold of hearing.