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Civic Centre Middlesex Suite Uxbridge

RIBA 3 Acoustic Design Review
Report 28909.ADR.01

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1.0 INTRODUCTION

KP Acoustics Ltd has been appointed to develop the acoustic design for the proposed library development at Civic Centre Middlesex Suite, Uxbridge. The proposed development comprises the redevelopment of an existing building.

The primary aim of this report is as follows:

- Set out the acoustic requirements for the project, with reference to the Employer's Brief and any statutory requirements.
- Develop the design such that the key acoustic design considerations are incorporated within the design packages prepared by others.

The degree of coordination and design included in this report is considered appropriate for this stage of the design, with a primary focus on architectural items at this stage. Where there are outstanding areas of coordination that will be developed as the design progresses, guidance has been provided on suitable specifications.

2.0 GENERAL REQUIREMENTS

2.1 Relevant Standards & Legislation

All design, works, materials, installations and tolerances are to be fully in accordance with the following key documents, amongst other relevant standards/guidelines:

- National & local planning requirements (NPPF, EPU & Planning Conditions)
- Statutory noise nuisance legislation
- BS 8233:1999 *'Sound insulation and noise reduction for buildings - Code of practice'*
- BS 8233:2014 *'Guidance on sound insulation and noise reduction for buildings'*
- BS 4142:2014 *'Methods for rating and assessing industrial and commercial sound'*
- BB93: acoustic design of schools - performance standards (for atria spaces)
- ANC Guidelines *'Measurement of Sound Levels in Buildings'* (June 2020)
- CIBSE Guides issued by the Chartered Institution of Building Services Engineers
- Manufacturer's installation instructions
- Employer's Brief

2.2 Employer's Brief

It is understood there are no specific Client requirements over and above that which would be expected of a typical library use.

2.3 Planning Requirements

The site falls within the jurisdiction of the London Borough of Hillingdon and has been granted planning permission with conditions (ref. 14805/APP/2024/956). There are no conditions relating to acoustics associated with the planning permission.

3.0 ACOUSTIC DESIGN CRITERIA

3.1 Building Envelope

There are no works proposed to the building envelope, therefore it is not appropriate to set acoustic criteria for noise intrusion.

3.2 Internal Building Fabric

3.2.1 Airborne Sound Insulation

Internal building elements separating the library use from adjacent uses are to be retained as existing without amendments, therefore there shall be no criteria set for airborne sound insulation to adjacent uses.

Internally, most areas are connected by doors (which will inevitably reduce any sound insulation provided by the wall) so it is not reasonable to set on-site sound insulation criteria for such spaces. The acoustic design of sound insulation shall therefore adopt a 'sensible' approach by uplifting the sound insulation of any elements where this would be deemed to have a reasonable effectiveness as to the final operation.

3.3 Reverberation Control (Acoustic Finishes)

There is limited quantitative guidance on target reverberation times, therefore the criteria for reverberation control have been set based on a pragmatic review of the guidance contained within the following documents:

- BS 8233:1999 *'Sound insulation and noise reduction for buildings - Code of practice'*
- BB93: acoustic design of schools - performance standards (for atria spaces)

The following reverberation time targets are proposed across the development. The below should be considered as reasonable targets, rather than absolute limits.

Room Type	Maximum Reverberation Time, T_{mf} (Seconds)
Children's Library	0.8
Library, Information Point, Easy Seating, Shelving Areas	1.2
Entrance Area	1.5

Table 3.1 Reverberation time targets

We understand there are no emergency announcement systems, therefore there is no requirement for speech intelligibility criteria to be imposed.

3.4 Building Services Noise & Vibration Control

3.4.1 Internal Building Services Noise

Noise transfer (including as a result of vibration) from mechanical services plant shall be controlled to the following noise limits.

Area	MEP Noise Design Target (Upper Limit)
Children's Library	NR 35
Library, Information Point, Easy Seating, Shelving Areas, Entrance Area	NR 40
WC	NR 45
Plantrooms	NR 65

Table 3.2 MEP noise design targets

The above should be targeted to within 5 dB (i.e. it is undesirable to have noise levels lower than 5 dB below these levels, but should not exceed the limits as shown) to maintain privacy between spaces.

No noise source shall give rise to audible tones or rattles.

Any measurements of the above shall be measured in accordance with ANC Guidelines *'Measurement of Sound Levels in Buildings'* (June 2020), at a distance of 1.5 m from any service grille or opening, at least 1 m from any reflecting surface, under typical plant operational duties in unoccupied rooms.

Smoke extract systems shall be designed to be at least 10 dB below the level of the fire alarm in any internal occupied area, which could result in a limit as low as 55 dB(A). Elsewhere, no limit would apply but there would still be a need to maintain suitable audibility of emergency announcements.

3.4.2 External Plant Noise Emissions

There are no statutory requirements for controlling external plant noise emissions, however it would be sensible at this stage to limit external plant noise emissions to 55 dBA at 1.5 m from any external duct/louvre.

3.4.3 Vibration Control

All plant should be provided with suitable vibration isolators to control structure-borne noise. The specifications for isolators will vary depending on plant type, size and location. Items such as chillers and cooling towers may require large static deflections. Pumps may need to be installed on inertia bases isolated on steel springs.

Vibration transfer from building services plant to office floors should not exceed 0.01 m/s^2 peak acceleration, based on W_b weighting as defined in Clause 3.3 of BS 6472-1:2008 '*Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting'*.

3.5 Notes on Acoustic Performance Specification

Where items are required to achieve specific levels of in-situ sound insulation then this shall be in terms of the standardised level difference D_{nT} in accordance with BS EN ISO 16283-1: 2014+A1: 2017 *'Field measurement of sound insulation in buildings and of building elements Part 1: Airborne sound insulation'* and weighted in accordance with BS EN ISO 717-1 2020 *'Rating of sound insulation in buildings and of building elements Part 1: Airborne sound insulation'*.

Where items are required to achieve specific levels of laboratory performance then this shall be in terms of the weighted sound reduction index R_w in accordance with BS EN ISO 10140-2:2021 *'Laboratory measurement of sound insulation of building elements Part 2 Measurement of airborne sound insulation'* and weighted in accordance with BS EN ISO 717-1 2020 *'Rating of sound insulation in buildings and of building elements Part 1: Airborne sound insulation'*.

Where items are required to achieve acoustic absorption classification then this is as defined in BS EN ISO 11654:1997 *'Sound absorbers for use in buildings. Rating of sound absorption'* and completed in accordance with BS EN ISO 354:2003 *'Measurement of sound absorption in a reverberation room'*.

4.0 INTERNAL BUILDING FABRIC

4.1 Separating Floors

There is a currently unused space below the proposed library which we understand is to be refurbished in future into a wedding venue / registry office. Although outside of the scope of this report, it is important to raise at this stage that extremely significant acoustic measures would be required to facilitate simultaneous use of the space below as a wedding venue (with live band / DJ) and the library above.

Where the existing parquet flooring is to be exposed, there is no opportunity for resilient floor finishes to control noise impacts to below and this would need to be addressed by significant acoustic measures in the future fit out of the space below.

Where new flooring is proposed, it is recommended that a dedicated resilient layer is incorporated to impact noise to the future wedding venue / registry office below. The resilient floor system/covering should achieve a weighted reduction in impact sound pressure level (ΔL_w) of not less than 15 dB when measured in accordance with BS EN ISO 10140-3:2021 and calculated in accordance with BS EN ISO 717-2: 2020.

4.2 Walls / Internal Glazing

The only new internal partitions proposed are between the Children's Library and the general library area. For this adjacency, it is important to understand that there will inevitably be some noise transfer from the Children's Library into the library area because of the door connecting the spaces. This noise transfer is unavoidable without extremely high performance acoustic door sets and lobby arrangements, which we understand is not desired.

A reasonable approach would be to specify the glazed (and non-glazed) partitions to the Children's Library to be rated at no less than R_w 50 dB. This may require a specialist glazed partition, therefore this may be reduced to R_w 45 dB should this specification prove to be prohibitive for a glazed product, but this would result in increased noise transfer.

The above should provide a reasonable level of protection against some noise transfer, but the Client should be made aware that this would still result in noise transfer from the Children's Library into the library area if noise levels are not actively controlled.

The new partition proposed between the WC areas should be rated at no less than R_w 45 dB.

Partitions should be built full height slab to slab.

Services should be routed through corridors and into rooms over doors. Where room-to-room service routing is unavoidable, they should occur above ceilings and be appropriately treated. Letterbox openings should be sealed with a dense (min 140 kg/m^3) mineral wool firebat, e.g., Corofil C144, to the full partition depth and made airtight with mastic. Cable trays should be cut at the point of penetration.

Manufacturer's instructions should be followed for installation (e.g. two layers of board installed with staggered joints, etc.). Linings can be either taped and skimmed or fully skimmed.

A continuous bead of non-setting mastic should be applied to all studwork/boards before they are fixed to the building structure, and to all board junction interfaces above the ceiling. Below the ceiling, a skim plaster finish throughout is preferred over taped jointing.

Penetrations for electrical sockets will inevitably increase the risk of failures and must be avoided in acoustically rated walls where possible. Where unavoidable, sockets should be kept to the minimum size and be boxed in or treated with acoustically rated putty pads to a specification that maintains acoustic integrity. Back-to-back sockets/switches are to be avoided by staggering horizontally by at least 300 mm.

Large penetrations, e.g. for recessed AV boxes, TV's, speakers etc., should not be permitted in acoustically rated walls, and any wall mounted TVs should be fixed using acoustically resilient pads and washers.

4.3 Doors

The following table presents acoustic ratings for doors to sensitive rooms.

Location	Minimum Sound Reduction Index (R_w)
Children's Library	35 dB

Table 4.1 Acoustic ratings for doors

The above are to be achieved by the entire door set (i.e. frame, door, seals, fittings).

As doors to WCs are often undercut for ventilation purposes no acoustic rating has been provided however, it is recommended that these doors achieve a mass per unit area at least 25 kg/m^2, fit well within their frame and are undercut by no more than 20 mm. Where they do not need to be undercut, R_w 30 dB doors shall be provided.

A minimum R_w 35 dB performance shall be provided to riser doors. These shall be side hung rather than pivoted to allow for effective perimeter seals. Where double doors are proposed, a rebated meeting stile shall be provided.

If glazed doors are to be used, then the following should be considered:

- Glazed doors which use bubble type seals can achieve R_w 30 dB but can be stiff to use and the performance can degrade quickly over time, therefore, it is recommended that these are avoided.
- Frameless doors typically have sound insulation performance in the region of R_w 20 dB which will result in conversations taking place on one side of the door being audible and intelligible on the other
- It is recommended that all glazed doors include rebated door frame which includes seals to the head, jambs and threshold

5.0 REVERBERATION CONTROL (ACOUSTIC FINISHES)

5.1 Overview

All guidance contained herein is based on the quantities, coverage and location of acoustic finishes as shown in the latest drawings (M9556-HUN-MS-02-23-2320 Rev P05 & M9556-HUN-MS-02-23-2321 Rev P02).

Absorptive finishes are needed to control the reverberation time to provide a suitable environment for the proposed room use. The area of treatment needed depends on the geometry of the room and the performance of the absorber proposed.

The performance of absorptive finishes is rated in terms of the Weighted Absorption Coefficient, αw, in accordance with BS EN ISO 11654:1997 *'Acoustics – Sound absorbers for use in buildings – Rating of sound absorption'*, varying from α=0.0 to α=1.0. Alternatively, it is given in terms of an absorption class (A-E). The Weighted Absorption Coefficient varies from α=0.0 (for minimal absorption) to α=1.0 (for very effective absorption). Generally, most proprietary absorbent treatments have αw values between 0.60 (Class C) and 0.90 (Class A).

In all cases the reverberation time criteria are defined as the T_{mf} (s) which is the arithmetic average of the reverberation times in the 500 Hz, 1k Hz and 2k Hz octave bands.

5.2 Location of Acoustic Finishes

The location of sound absorbent treatment within a room is important, particularly where the room may be used for video/audio conferencing. Unwanted reflections between surfaces can make it difficult for someone joining a meeting remotely to understand what is being said and who is speaking within the room.

Where sound absorbent treatment is located on walls, it is most effective if it is located on at least two adjacent walls, to limit unwanted reflections between parallel surfaces. The wall treatment should be located from around seated head to standing head height (≈1m to 2m above finished floor level).

In all cases the acoustic absorption should be spread as evenly as possible across the space.

5.3 Initial Review of Acoustic Finishes

5.3.1 General Library Area

The general library / entrance spaces are to be provided with a mixture of new vinyl flooring and refurbished parquet flooring, with discrete areas of acoustic rafts on the soffit and limited areas of acoustic wooden panelling to some walls. There will also be some acoustic panels provided at high level to the rear wall of the Easy Seating area.

The acoustic rafts shall achieve Class A absorption and the wood panelling shall achieve at least Class C absorption (or better).

It is recommended that any panels to the wall of the Easy Seating area (at high level) achieve Class A absorption. Although the reverberation time targets would be achieved without the need for further absorption on this wall, it is recommended that as much absorption is added as is feasible, to help enhance the acoustic comfort of the space, there is no fixed quantity requirement, however.

5.3.2 Children's Library

The floor to the Children's Library is to be carpeted, with additional acoustic absorption provided by acoustic rafts to the soffit and acoustic panelling to some walls. There will also be extra acoustic absorption added as decorative elements, however the exact quantities for these are unknown and therefore has not been considered in this assessment to enable a worst-case consideration.

As with the general library area, the acoustic rafts shall achieve Class A absorption and any wood panelling shall achieve at least Class C absorption (or better).

5.3.3 Main Entrance

The entrance will be provided with follow a similar approach as for the general library area, with the acoustic rafts to be rated at Class A absorption. Although the specification may be reduced here to a Class C product, it may be sensible to keep the acoustic rafts rated at Class A to reduce the risk of noise spilling from the main entrance and disturbing the library areas.

6.0 BUILDING SERVICES NOISE & VIBRATION

6.1 General

The key aims of the acoustic input to the building services design at this stage are to identify the significant cost and space issues relating to compliance with the acoustic performance standards.

Noise from the building services shall be controlled such that the total internal and external noise levels, when operating at design duty, are compliant with the performance standards set out in Section 4.4. Vibration from building services shall also be controlled in line with the guidance set out in 4.4.3.

General guidance regarding the acoustic design of building services is provided in the following sections.

Any changes to the layouts and/or noise data could result in non-compliance with the performance standards and as such, the project acoustic consultant should be informed of any change.

At this stage, the building services design has not been finalised, therefore this section is provided for information to the building services engineer and can be updated upon receipt of details of building services items.

6.2 Crosstalk Attenuators

Attention should be given to the potential for the transfer of noise via common ductwork serving multiple rooms. In such instances we would recommend crosstalk attenuators are installed on each room branch (i.e. always two attenuators in the duct route between rooms).

At this stage, it would be sensible to make allowance for crosstalk attenuators to achieve the following typical insertion loss values.

Crosstalk Attenuator Minimum Insertion Loss (dB) at Octave Band Centre Frequency (Hz)					
125	**250**	**500**	**1k**	**2k**	**4k**
7	13	19	23	23	16

Table 6.1 Crosstalk attenuator requirements

The face velocity across the attenuator should not exceed 3.0 m/s and the pressure drop should not exceed 10 Pa.

6.3 Internal Building Services Noise Levels

The criteria for internal building services noise levels are set out in Section 3, against which units should be selected.

As acoustic privacy is a function of both airborne sound insulation and background noise levels, it is desirable that mechanical services are designed to meet as close to the NR levels by design.

Furthermore, systems should be designed such that the above NR limits are achieved throughout the space in a diffuse manner, in order to promote good acoustic privacy.

6.4 Guidance on System Generated Noise

6.4.1 Maximum Velocities

Airflow regenerated noise break-out from ducts is a common cause of excessive noise in occupied spaces. In this respect, our recommendations for limiting air velocities within ducts are set out below.

Low Velocity Systems	Internal Noise Criterion		
	NR 40	**NR 35**	**NR 30**
Riser	9 m/s	7.5 m/s	6 m/s
Main Branch	6 m/s	5 m/s	4 m/s
Grille	3.4 m/s	3 m/s	2.5 m/s
Diffuser	2.8 m/s	2.5 m/s	2.2 m/s
Extract stub ducts (above ceiling)	4 m/s	3 m/s	2.5 m/s

Table 6.2 Maximum velocities in ductwork

6.4.2 Vibration Isolation

To control the transmission of vibration to the building, suitable anti-vibration mountings will need to be installed along with flexible couplings to vibration generating plant and ductwork/pipework, where appropriate. Ductwork/pipework connected to this plant should be supported from resilient brackets.

Vibration in all locations outside of plant rooms or decks shall comply with the following:

- Vibration transfer from building services plant to occupied floors should not exceed 0.01 m/s^2 peak acceleration, based on W_b weighting as defined in Clause 3.3 of BS 6472-1:2008 *'Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting'*.
- Vibration transfer from building services plant shall not exceed a Vibration Dose Value (VDV) of 0.4 $m/s^{1.75}$ as given in BS 6472-1:2008 in all occupiable areas
- Vibration transfer from building services plant shall not exceed a RMS vibration limit of 0.406 mm/s with reference to the 8 to 80 Hz curve set out in ASHRAE Handbook (2015), Chapter 48, Figure 42.
- Vibration transfer from building services plant shall not be of a magnitude which causes the maximum noise criteria to be exceeded as set out in Table 3-2.

Suitable anti-vibration mounts shall be provided to all plant. Anti-vibration measures shall be submitted by equipment suppliers, for review by the acoustic consultant.

Flexible connector shall be used to connect ducts, pipes and conduits to any plant located on anti-vibration mounts.

6.4.3 Pipework

It is unlikely that the piped services associated with the building services plant will, if designed in accordance with HVCA/CIBSE recommendations produce any flow generated noise problems. It is worth noting, however, that the overall friction loss in pipework should be limited to 280 Pa/m across the range of pipes to be used.

Pipework shall be supported in a manner which prevents structure borne noise transmission to walls and floors. This shall be achieved by:

- Supporting via unistrut which is fully independent of all walls (minimum 10 mm clearance).
- Using oversized brackets containing neoprene inserts.
- Incorporating acoustic dampeners where pipework is suspended from floor slabs.

- Using rubber lined pipe brackets.

6.5 Service Penetrations

6.5.1 Duct, Pipe and Cable Tray Penetrations

Ducts should be distributed along circulation areas with penetrations being made in the corridor wall. Penetrations must not be made between acoustically sensitive spaces (i.e. those which have an on-site performance target).

Where services pass through twin, staggered or resilient stud wall constructions a resilient connector should be provided to ensure that the cavity between the two leaves are not bridged.

In partitions which have R_w < 50 dB, gaps around penetrations should be kept small (< 15 mm) and the remaining void filled with mineral wool and sealed with mastic which does not set hard.

If the gap is any larger than 15 mm then the following applies:

- Lightweight partitions - gaps bigger than 15 mm will require a plasterboard pattress. The pattress should include the same number and type of plasterboard layers as the partition. The remaining gap (no greater than 5 mm) sealed with mastic which does not set hard.
- Block partitions - gaps bigger than 15 mm will require a plasterboard pattress. The pattress should be constructed from 2 layers of 15 mm dense (12.8 kg/m2) plasterboard. The remaining void (no greater than 5 mm) sealed with mastic which does not set hard

6.5.2 Electrical Conduit

Where electrical conduit passes through partitions then the penetration should be as small as possible with the gaps around the conduit being less than 5 mm. The remaining gap and open end of the conduit must be sealed with mastic that does not set hard.

6.5.3 Sockets, Switches and Fittings

All sockets and switches should be surface or furniture mounted to avoid the acoustic performance of separating partitions being reduced. Alternatively, if they are to be recessed they will need to be fitted with suitable backing boxes or pads. In drywalls, recessed sockets and switches should not be back-to-back and should be staggered at least 600 mm.

6.5.4 SVP & Vertical Services

Rainwater, soil and waste pipework should be located within dedicated risers and not run through noise sensitive spaces. Where this is unavoidable, the pipework should be wrapped with 25 mm mineral fibre and independently boxed with 2 x 12.5 mm plasterboard (or equivalent).

Drainage routes shall not be routed through space with an internal noise criterion of NR 30 or less.

Syphonic systems should be avoided wherever possible. If they are used, they will need to be independently boxed in to reduce noise break-out.

7.0 CONCLUSION

KP Acoustics Ltd has been appointed to develop the acoustic design for the proposed library development at Civic Centre Middlesex Suite, Uxbridge. The proposed development comprises the refurbishment of an existing building.

The degree of coordination and design included in this report is considered appropriate for this stage of the design, with a primary focus on architectural items at this stage. There are outstanding areas of coordination that will be developed as the design progresses; where this is the case, guidance has been provided on suitable specifications.

APPENDIX A

GENERAL ACOUSTIC TERMINOLOGY

Decibel scale - dB

In practice, when sound intensity or sound pressure is measured, a logarithmic scale is used in which the unit is the 'decibel', dB. This is derived from the human auditory system, where the dynamic range of human hearing is so large, in the order of 10^{13} units, that only a logarithmic scale is the sensible solution for displaying such a range.

Decibel scale, 'A' weighted - dB(A)

The human ear is less sensitive at frequency extremes, below 125Hz and above 16Khz. A sound level meter models the ears variable sensitivity to sound at different frequencies. This is achieved by building a filter into the Sound Level Meter with a similar frequency response to that of the ear, an A-weighted filter where the unit is dB(A).

L_{eq}

The sound from noise sources often fluctuates widely during a given period of time. An average value can be measured, the equivalent sound pressure level L_{eq}. The L_{eq} is the equivalent sound level which would deliver the same sound energy as the actual fluctuating sound measured in the same time period.

L_{10}

This is the level exceeded for no more than 10% of the time. This parameter is often used as a "not to exceed" criterion for noise.

L_{90}

This is the level exceeded for no more than 90% of the time. This parameter is often used as a descriptor of "background noise" for environmental impact studies.

L_{max}

This is the maximum sound pressure level that has been measured over a period.

Octave Bands

In order to completely determine the composition of a sound it is necessary to determine the sound level at each frequency individually. Usually, values are stated in octave bands. The audible frequency region is divided into 11 such octave bands whose centre frequencies are defined in accordance with international standards. These centre frequencies are: 16, 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 16000 Hertz.

Environmental noise terms are defined in BS7445, *Description and Measurement of Environmental Noise*.

APPENDIX A

APPLIED ACOUSTIC TERMINOLOGY

Addition of noise from several sources

Noise from different sound sources combines to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3dB higher than a single source and 4 sources produce a 6dB higher sound level.

Attenuation by distance

Sound which propagates from a point source in free air attenuates by 6dB for each doubling of distance from the noise source. Sound energy from line sources (e.g. stream of cars) drops off by 3dB for each doubling of distance.

Subjective impression of noise

Hearing perception is highly individualised. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound and psychological factors such as emotion and expectations. The following table is a guide to explain increases or decreases in sound levels for many scenarios.

Change in sound level (dB)	Change in perceived loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	About twice as loud

Transmission path(s)

The transmission path is the path the sound takes from the source to the receiver. Where multiple paths exist in parallel, the reduction in each path should be calculated and summed at the receiving point. Outdoor barriers can block transmission paths, for example traffic noise. The effectiveness of barriers is dependent on factors such as its distance from the noise source and the receiver, its height and construction.

Ground-borne vibration

In addition to airborne noise levels caused by transportation, construction, and industrial sources there is also the generation of ground-borne vibration to consider. This can lead to structure-borne noise, perceptible vibration, or in rare cases, building damage.

Sound insulation - Absorption within porous materials

Upon encountering a porous material, sound energy is absorbed. Porous materials which are intended to absorb sound are known as absorbents, and usually absorb 50 to 90% of the energy and are frequency dependent. Some are designed to absorb low frequencies, some for high frequencies and more exotic designs being able to absorb very wide ranges of frequencies. The energy is converted into both mechanical movement and heat within the material; both the stiffness and mass of panels affect the sound insulation performance.