

SANDY BROWN

Consultants in Acoustics, Noise & Vibration

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Hello Oriental, Circle Square Pavilion

Stage 4 acoustic design report

London, Manchester, Edinburgh, Birmingham, Belfast

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Version	Date	Comments	Author	Reviewer
A	28 Sep 20		Daniel Shaw	James Atha
B	2 Dec 20	Plant noise egress assessed	Daniel Shaw	Jake Mroz

Summary

Sandy Brown has been appointed by Hello Oriental Ltd to provide acoustic design advice in relation to the fit-out of the Pavilion, Circle Square for Hello Oriental.

The project spans over three levels of ground, lower mezzanine and basement.

Stage 4 guidance is provided relating to:

- Building envelope: The control of noise ingress/egress via the building facade to acceptable levels within spaces and at nearby receptors.
- Sound insulation: Internal walls, floors, ceilings and doors will need to adequately reduce sound transmission. Impact sound transmission through floors will also need to be considered in specific locations.
- Sound absorbent finishes: The acoustic environment within each space will need to be compatible with the proposed uses, in particular the control of reverberation and noise build-up.
- Building services: Noise and vibration from building services plant and systems will need to be controlled by suitable attenuation and isolation measures both inside and outside the development.

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1 Introduction

Sandy Brown has been appointed by Hello Oriental Ltd to provide acoustic design advice in relation to the fit-out of the Pavilion, Circle Square for Hello Oriental.

This report provides guidance at RIBA Stage 4 of the design in relation to the building envelope, internal sound insulation, acoustic finishes, and building services.

2 Basis of design

2.1 Design information

This report is based on:

- Bowker Sadler architectural layouts, received September 2020
- Mechanical services layouts, received November 2020
- Sandy Brown technical memos.
- Sandy Brown base-build design reports.

2.2 Performance criteria

The proposed acoustic design criteria are from the following documents:

- BS 8233:2014 *Sound insulation and noise reduction for buildings – code of practice*
- BS 4142:2014 *Method for rating and assessing industrial and commercial sound*
- BS 6472-1:2008 *Evaluation of Human Exposure to Vibration in Buildings – Part 1: Vibration from sources other than blasting*
- The Control of Noise at Work Regulations 2005
- The Disability Discrimination Act 2004.

2.3 Sound insulation

2.3.1 Calculation of rating values

Laboratory and site sound insulation performance parameters referred to in this report shall be calculated in accordance with BS EN ISO 717-1:2013 *Acoustics – rating of sound insulation in buildings and of building elements – part 1: airborne sound insulation*.

2.3.2 Laboratory sound insulation

Measurements of the laboratory sound insulation of building elements shall be carried out in accordance with BS EN ISO 10140-2: 2010 *Acoustics – laboratory measurement of sound insulation of building elements, Part 2: Measurement of airborne sound insulation*.

2.3.3 Site sound insulation

In-situ sound insulation performances shall be measured in according to BS EN ISO 140-4: 1998 *Acoustics – Measurements of sound insulation in buildings and of building elements* or BS EN ISO 16283-1: 2014 *Acoustics – Field measurements of sound insulation in buildings and of building elements*.

2.4 Sound absorption

Sound absorbent finishes shall be rated in accordance with BS EN ISO 11654: 1997 *Acoustics – Sound absorbers for use in buildings – Rating of sound absorption*.

2.5 Site tolerances

The following minimum tolerances set out in Table 1 shall be used when selecting elements based on weighted sound reduction index (R_w) values measured under laboratory conditions:

Table 1 Site tolerances

Element	Sound insulation site tolerance
Masonry walls	$R_w \geq D_{nT,w} + 2 \text{ dB}$
Drywalls	$R_w \geq D_{nT,w} + 7 \text{ dB}$
Doors	$R_w \geq R'_w + 2 \text{ dB}^{[1]}$

^[1] If laboratory tests on single doors are used as the basis for selecting leaf-and-a-half or double doors, an overall tolerance of at least 5 dB shall be used.

Where laboratory sound insulation performances have been specified the on-site performance should be in line with the above tolerances. Interface details between elements shall be constructed to ensure in-situ sound insulation values are not compromised.

It is accepted that where doors are present in partitions, the overall site performance may be reduced.

Where weighted sound absorption coefficients (α_w) are specified, elements shall be installed such that the laboratory measured performance is not degraded.

3 Building envelope

The principal design issues for the fit-out associated with the building envelope are as follows:

- Airborne sound insulation (noise ingress) – to control intrusive noise from external sources including road traffic, helicopters, and building services plant
- Airborne sound insulation (noise egress) – to control breakout from noisy internal areas such as plant rooms to the development itself, public areas around it and nearby sensitive premises in accordance with the requirements of the local planning authority

The following sections set out the key acoustic performance parameters.

3.1 Internal noise criteria

3.1.1 External noise ingress

The base build limit for external noise ingress is L_{Aeq} 40 dB.

Based on the measured external noise levels set out in our Stage 4 review of the base-build in 17389-R03-A *Stage 4 acoustic report*, this would require a minimum sound insulation performance of $R'_w + C_{tr}$ 28 dB.

The facade proposals provided by FKN suggest the curtain wall cladding to the pavilion is capable of achieving at least R_w 35 dB and thus is likely to be suitable. The concrete roof is expected to provide significantly higher performance and therefore would also be suitable.

Based on the relative areas and performance, typical double glazed doors are expected to be suitable to control noise ingress and egress based on the maximum internal noise levels provided below.

3.2 Noise egress

Amplified sound in the retail units in building 3 shall not exceed the maximum permissible noise levels provided in Table 1.

Table 1 Maximum permissible levels from amplified sound (L_{max} dB)

Time period	Octave-band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Daytime 0700 to 2300	80	80	77	79	88	79	75
Night 2300 to 0700	73	74	68	72	79	70	71

These limits would typically be suitable for a bar or restaurant with background music, however, will be too low for events involving higher noise levels (eg DJ sets, live music).

4 Internal sound insulation

The principal design issues associated with internal partitions and doors are:

- Airborne sound insulation – to control airborne sound transfer from one space to another (eg, building services plant)
- Impact sound insulation – to control of impact sound transfer from one space to another (eg, sockets, cupboards, storage trolleys).

The following sections set out the key acoustic performance parameters.

4.1 Partitions

4.1.1 General guidance

The laboratory sound insulation performance, R_w (dB) is the sound insulation provided by a given construction when tested in a laboratory. It is used to select the drywall construction from relevant manufacturer's technical literature. The sound insulation achieved by a single blockwork wall (assuming there are no holes) largely depends on its surface density (mass per unit area), which affects the laboratory sound insulation performance.

The site sound insulation performance, $D_{nT,w}$ (dB), is the sound insulation provided by a given construction when installed on site. The reduction in the sound insulation performance of a blockwork wall between laboratory and site is typically 2 dB and for drywall is typically 7 dB, however this can vary dependent on a number of factors including flanking noise transmission, noise leakage and overall partition size.

4.1.2 Sound insulation

Internal sound insulation criteria are provided below to control noise transfer between various spaces to ensure each is suitable for its use. Lab-to-site tolerances are set out in Section 2.5.

Floors are open to the triple-height space and therefore would not require a sound insulation rating.

Table 2 Partition sound insulation performance requirements

Location	Sound insulation performance, R_w (dB)
Office	50
WCs/Staff room	45
Stores/BoH	40

Example partition constructions capable of achieving the required performances are set out in Table 3.

Table 3 Example partition build-ups

Sound insulation performance, R_w (dB)	Example constructions
50	2 x 15 mm normal weight plasterboard to both sides of 50 mm steel stud with 25 mm mineral fibre insulation in the cavity
45	2 x 12.5 mm normal weight plasterboard to both sides of 50 mm steel stud with 25 mm mineral fibre insulation in the cavity
40	12.5 mm normal weight plasterboard to both sides of 50 mm steel stud with 25 mm mineral fibre insulation in the cavity

4.1.3 Structure-borne sound

Where hand dryers are likely to be located on walls adjacent to sensitive spaces, staggered or twin stud partitions shall be provided to limit the transfer of structure-borne sound.

4.2 Doors

4.2.1 General guidance

The acoustic performance of doors depends on three principal factors, namely:

- The weight of the door leaf and any weaknesses due to vision panels, etc
- The tolerances around the door leaf when hung
- The type and extent of seals including meeting jambs for double doors.

Where acoustically rated doorsets are required, they would need to close onto a frame and have perimeter acoustic seals. Drop threshold seals are required on higher performance doorsets whereas lower ratings typically require a diminishing strip under the threshold in order to close off the gap when the door is shut.

Frameless doors are weak acoustically owing to typically large perimeter gaps. Likewise doors with integral pivot hinges and standard sliding doors are often acoustically weaker owing to the difficulty of accommodating perimeter acoustic seals. Offset pivot or side hung doors tend to perform better as perimeter seals are easier to fit and can be continuous.

Typical constructions are provided in Table 4 for guidance, but the rating shall be confirmed by the manufacturer. All doors shall close onto rebated frames with gaps minimised. Locks shall only be accessible on one side.

A rating of R_w 35 dB should be used for the office door. Markups are presented in Appendix B.

Table 4 Typical door constructions

Sound insulation performance, R_w (dB)	Typical constructions
35	54 mm solid core door closing onto a rebated frame with full acoustic perimeter seals and minimised threshold gap with drop threshold seal. Minimised gap between door leaf and frame when closing.

4.3 Extents and detailing

All interfaces between acoustically rated elements and other adjacent elements shall be made in such a way that the sound insulation performances are not degraded, and that the site sound insulation requirements are met. These adjacent elements include:

- Partitions
- Columns
- Door frames
- Floors
- Suspended ceilings
- Cladding
- Service penetrations.

All connections to adjacent elements shall incorporate flexible airtight sealing using non-hardening sealant or other seal acceptable to the Architect.

Joints in successive layers of plasterboard shall be staggered, and joints in the top layer shall be taped and sealed.

All partitions shall be built full-height from structural floor to structural soffit.

4.3.1 Partition head details

Where partitions have a laboratory sound insulation performance of R_w 45 dB or lower, exposed deflection heads would be suitable.

Where partitions have a laboratory sound insulation performance of greater than R_w 45 dB, the deflection head shall be closed off with metal angles to both sides. An example detail for a generic partition is provided in Figure 3 below.

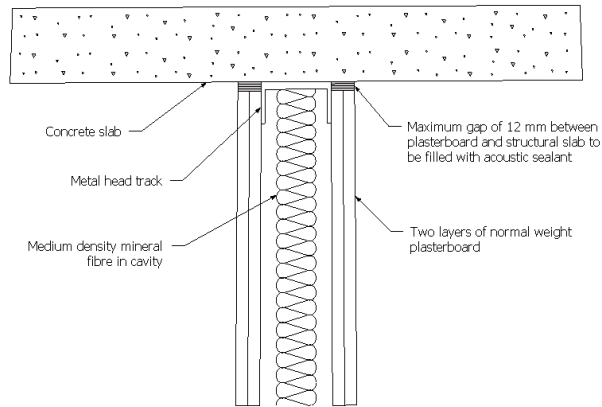


Figure 1 Example drywall head detail for R_w 45 dB

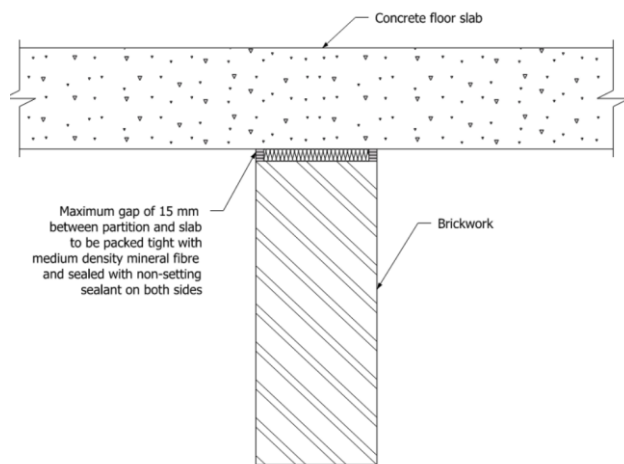


Figure 2 Example masonry head detail for R_w 45 dB

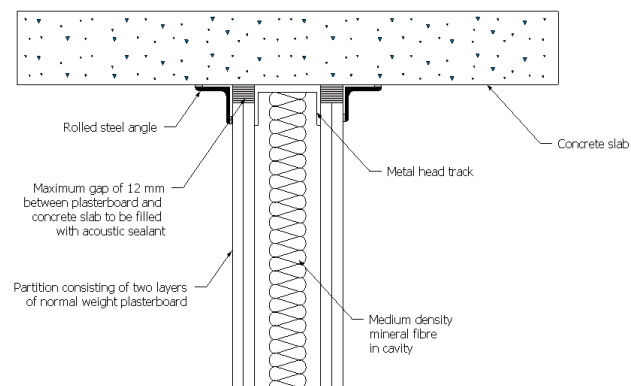


Figure 3 Example drywall head detail showing metal angles closing off the deflection head for $\geq R_w$ 45 dB

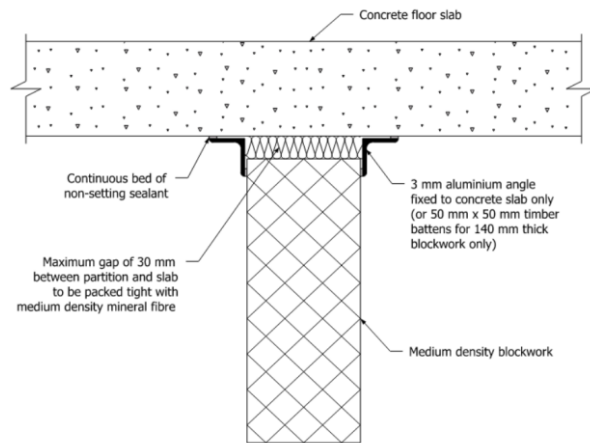


Figure 4 Example masonry head detail showing metal angles closing off the deflection head for $\geq R_w$ 45 dB

4.3.2 Partition junctions

An example sketch detail for instances where a single stud drywall partition abuts another single stud drywall partition is provided in Figure 5.

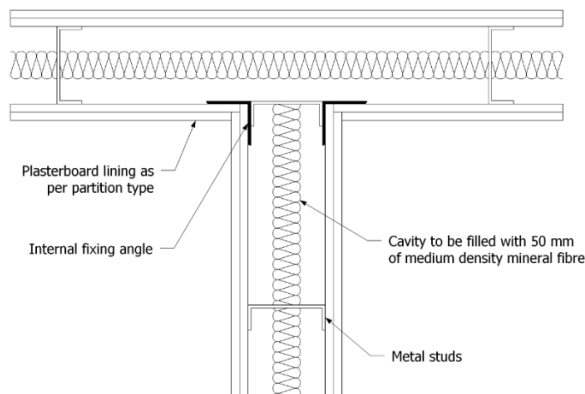


Figure 5 Example sketch detail – Single stud drywall partition T-junction

5 Acoustic finishes

Given the large volume, high rate of occupation and the addition of background music, noise build-up in a highly reverberant space could become an issue.

As such, the reverberation time within the space shall be controlled to be T_{mf} 1.5-2.0s.

The finishes used in the assessment are:

- Vinyl/resin floors,
- Glazed facade,
- Plasterboard/masonry walls where appropriate,
- Glazed balustrades
- Concrete/wood ceiling in baseline condition, 50 mm mineral fibre backing to spray finish behind slatted wood in treated conditions
- Hard furnishings as shown in furniture plans.

A 3D model has been created to assess the required extent of finishes, a screenshot of which is presented in Figure 6.

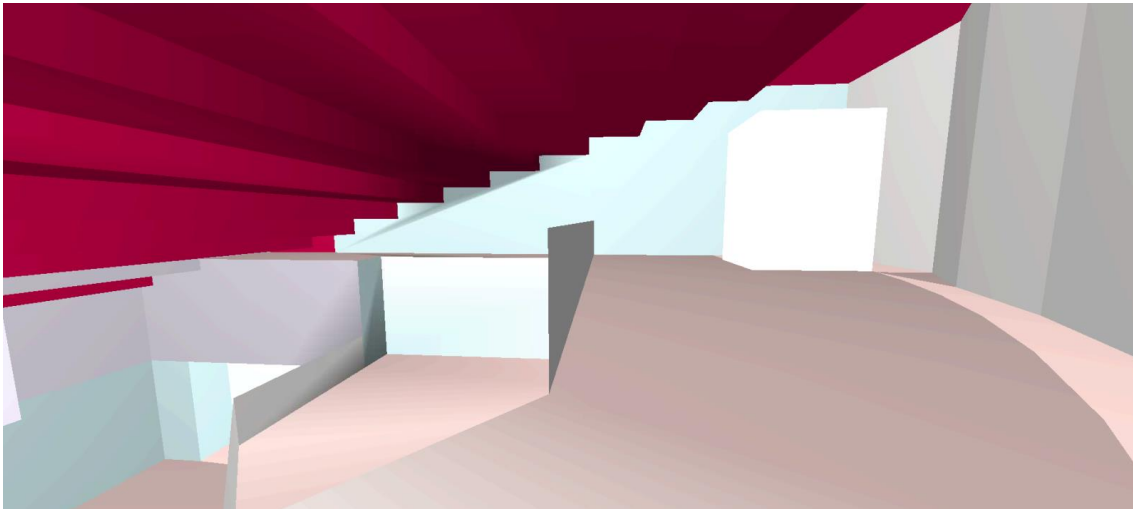


Figure 6 Screenshot of computer acoustic model

The options with acoustic treatment use a spray treatment with a 50 mm mineral fibre backing to achieve Class B sound absorption. Where this is only applied to the feature ceiling, this covers the area shown in Figure 7 below, equivalent to 365 m² treatment area. Where all ceilings are considered, this includes to the underside of the ground and mezzanine slabs

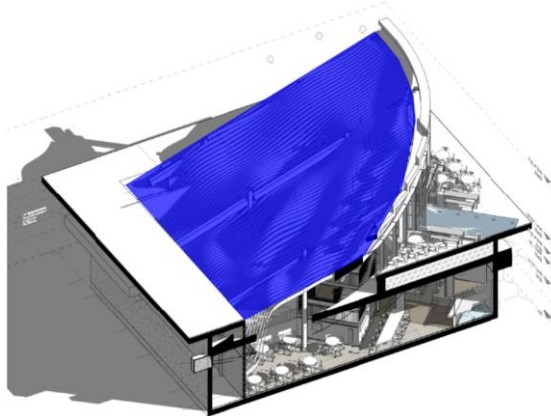


Figure 7 Extent of acoustic spray treatment for the feature ceiling condition

5.1 Reverberation times

The predicted average reverberation times across the occupiable space at seated height are summarised in Table 5.

Table 5 Predicted reverberation times for various treatment and occupation rates

Treatment condition	Octave band reverberation time (s)			Mid-frequency reverberation time, T_{mf} (s)
	500 Hz	1 kHz	2 kHz	
Baseline unoccupied	3.9	3.7	3.1	3.5
Baseline 150 people	1.9	2.0	1.7	1.8
Feature ceiling unoccupied	2.7	2.3	2.2	2.4
Feature ceiling 150 people	1.3	1.2	1.1	1.2
Feature plus mezz underside unoccupied	2.0	1.7	1.6	1.8
Feature plus mezz underside occupied	1.1	1.1	1.0	1.0
All ceilings unoccupied	1.0	1.0	1.0	1.0
All ceilings 150 people	0.9	1.0	0.9	0.9

Treatment of 50 mm mineral fibre insulation behind a spray finish to the feature ceiling and the underside of the mezzanine slab is likely to be acceptable given the rate of occupation.

This is a treatment area of 360 m² Class B sound absorption applied to the soffit behind the slatted timber ceiling in the triple height space and 110 m² Class B sound absorbent treatment to the underside of the mezzanine slab at basement level.

The introduction of soft furnishings would help to further reduce the reverberation time.

These reverberation times will need to be discussed with the PAVA system designer to inform the design.

5.2 Noise build-up

Based on previous work for large reverberant retail spaces, a constant exposure level of L_{Aeq} 70 dB is the level at which employee noise complaints are minimal. Above this level of constant exposure there is an increasing likelihood of complaints due to annoyance, difficulty hearing customers and so on.

Occupation rates have been estimated based on a maximum density of around 3m² per person, equivalent to around 150 people, to allow predictions of the expected noise level due to patron noise at peak times to assess the suitability of the guidance range of reverberation times.

The levels estimated below are Lombard calculations which account for the effect where patrons will talk louder in noisier environment. The calculations are based on 1/4 of people talking at any one time and give the sound pressure level from talking only, but are all significantly louder than the building services noise. Background music may increase the overall level further.

Table 6 Estimated patron noise levels for maximum occupancy of around 150 people

Treatment condition	Predicted reverberant speech noise level, L_{Aeq} (dB)
Baseline 150 people	80
Feature ceiling 150 people	76
Feature plus mezz underside 150 people	75
All ceilings 150 people	74

The above levels are for the above estimated peak occupancy. It is likely that the occupancy and therefore the noise levels will vary, significantly reduced at off-peak times. As such, it is likely that the individual noise exposure to staff over a full working period will be lower provided there are periods of relief and rotation of activities.

As such, the recommended treatment of Class B sound absorption to the feature ceiling and mezzanine slab underside is expected to be suitable.

6 Building services noise and vibration

Noise control measures will require detailed consideration once plant has been selected and noise data is available. However, key acoustic issues are:

- The control of noise and vibration from plant and equipment to acceptable levels within the building
- The control of noise egress to outside in relation to potential noise break-in to the development itself, nearby public spaces and sensitive buildings in line with the requirements of the local planning authority
- The acoustic sealing of penetrations through sound insulating constructions

6.1 Internal noise criteria

6.1.1 Limits

Maximum internal noise criteria, in line with the guidance provided in BS8233 are summarised in Table 7. It should be noted that this is based on the facade noise ingress being sufficiently controlled. The noise criteria shall apply at any point greater than 1 metre from an enclosing surface (floor, wall or ceiling) unless the designed use of the space necessitates occupancy within this zone.

Table 7 provides internal building services noise criteria for the fit-out.

Table 7 Building services noise criteria for the fit-out

Room type	Maximum building services noise, NR
Office (speculative)	38
Bar	40
Corridor/Fire escape	40
Lift lobby	40
Restaurant	40
Toilets	45
Plant room	70 ^[1]

^[1] Includes additional low frequency limit at 63 Hz and 125 Hz of L_{eq} 80 dB.

Building services noise shall have no attention catching characteristics, such as hums, whines, whistles and clicks. Where this is not possible, noise limits for new plant shall be at least 5 dB lower than those identified in Table 7.

6.1.2 Noise levels in plant spaces

The above table includes a requirement to control noise levels in plant spaces to NR 70 with specific low frequency octave band noise limits.

Whilst in principle it may be possible to permit higher noise levels in plant rooms, these limits are recommended as they represent a reasonable level in relation to plant attenuation measures whilst;

- allowing suitable control of noise transfer from the plant room to adjacent occupied spaces. If higher noise limits were used higher levels of sound insulation would need to be provided by the separating elements (floors, partitions, etc).
and
- minimising any implications for hearing protection under The Control of Noise at Work Regulations 2005.

The regulations are aimed at ensuring that workers' hearing is protected from excessive noise at their place of work, which could cause them to lose their hearing and/or to suffer from tinnitus (permanent ringing in the ears).

The level at which employers must provide hearing protection and hearing protection zones is 85 dBA (daily or weekly average exposure) and the level at which employers must assess the risk to workers' health and provide them with information and training is 80 dBA. There is also an exposure limit value of 87 dBA, taking account of any reduction in exposure provided by hearing protection, above which workers must not be exposed.

6.2 External noise criteria

6.2.1 Overall tenant limits

Tenant plant within the pavilion development would need to comply with the overall tenant limits as set out in Table 8 below. The nearest noise sensitive receptors are the surrounding buildings within the square, including Buildings 2 and 4.

These limits include all tenant plant for the 2-4 Circle Square development including the roof plant on building 2 and 4. However, due to increased screening of the rooftop plant, the combined levels at the worst case receptor affected by the pavilion will not be significantly increased by the rooftop plant.

Table 8 Overall tenant plant noise limits at nearest noise sensitive receptor

	Plant noise limits, $L_{eq,15min}$ (dB), octave-band centre frequency (Hz)						
	63	125	250	500	1000	2000	4000
Daytime limit	48	43	40	36	36	29	18
Night-time limit	41	37	31	29	27	20	14

A relaxed noise egress limit of 10 dB above the ambient noise level has been proposed for emergency plant noise egress within the EIA prepared by Fisher Acoustics. On the basis that this has been accepted by Manchester City Council, any additional life safety/emergency plant shall be limited to achieve a cumulative noise egress level of L_{Aeq} 68 dB outside the nearest noise sensitive receptor. It is currently understood that all life safety plant is to be installed by the landlord and so does not fall within the scope of the fit-out.

6.2.2 Specific plant limits

The kitchen extract terminates at ground level of Building 2, adjacent to extract louvres for other retail units. The limit for these areas is driven by the requirement to control plant noise in public areas to L_{Aeq} 55 dB. This is expected to also allow the octave band limits at the nearest noise sensitive premises to be met. As such, based on an equal contribution from the adjacent kitchen extract, the limit for the Hello Oriental kitchen extract alone is L_{Aeq} 52 dB at 1 m from the louvre

Based on the duct layouts set out in CPW-200493-M-110-01 and -03, and on typical fan and attenuator spectra, the limiting sound power levels to meet the above noise egress limits are set out in Table 9. Minor variations between octave bands may still comply with the limits.

Table 9 Limiting sound power levels for kitchen extract fan with attenuation

	Octave-band centre frequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Limiting sound power levels for kitchen extract fan with attenuation, L_w (dB)	90	88	82	74	67	62	59	55

6.2.3 Characteristics

The noise from building services plant and systems shall not contain any distinguishable, discrete, continuous notes (whine, hiss, screech, hum, etc) or distinct impulses (bangs, clicks, clatters or thumps) and shall not be irregular enough to attract attention.

6.3 Design strategy

6.3.1 Noise control measures

Appropriate measures will need to be adopted to ensure that the noise criteria are achieved. Measures to be considered include:

- Plant room connections to atmosphere to be ducted via attenuators
- Low noise equipment
- Double-skin casings to air-handling plant
- In-duct attenuators
- Acoustic lagging and lining to ductwork
- Ductwork/pipework connected to plant supported from resilient brackets
- Select attenuators of appropriate width and height so that maximum pressure drops do not exceed 30 Pa
- Select attenuators so that regenerated noise from the attenuator does not increase the resultant noise level
- Limit airflow across louvres to no more than 2 m/s.

6.3.2 Internal plant room

A large internal plant room is proposed to the mezzanine level. All atmospheric terminations shall be ducted to louvres located in the facade, with in-duct attenuators and acoustically lined plenums.

To control vibration generated by plant items, appropriately selected anti-vibration mounts shall be provided. For the internal plant rooms resilient hangers/supports shall be provided for services supported from the soffit in order to reduce potential vibration transmission to the spaces on the first floor.

6.3.3 Maximum velocities

Mechanical ventilation systems shall be designed to ensure the face velocities at terminals do not exceed the values in Table 10.

Table 10 Maximum velocities for mechanical services terminations

Maximum NR	Maximum terminal face velocity (m/s)
30	2.5
35	3.0
40-45	4.0

Where in-duct velocities exceed the maximum values in Table 11, they shall be acoustically lagged to minimise noise breakout. The acoustic lagging is required to be a minimum 25 mm thick with a mass layer of at least 5 kg/m², such as Rockwool Techwrap. All ductwork is understood to be rectangular.

Table 11 Maximum in-duct velocities

Ductwork type	Ductwork location	Maximum velocity (m/s)
Rectangular	Final run	4.0
	Main branch	6.0

6.3.4 Ventilation strategy and crosstalk

Where common ductwork/ventilation openings are to be formed in sound insulating partitions, these shall be appropriately attenuated such that the partition performance is not significantly degraded. Crosstalk attenuators shall be provided where required to common ventilation ductwork in order to maintain the partition sound insulation performance.

6.3.5 Services penetration details

Penetrations shall be over-boarded and well-sealed to ensure the sound insulation between rooms meets the specified requirements.

Example sketch details showing duct/pipe and cable tray penetrations through partitions are provided in Figure 8 to Figure 9.

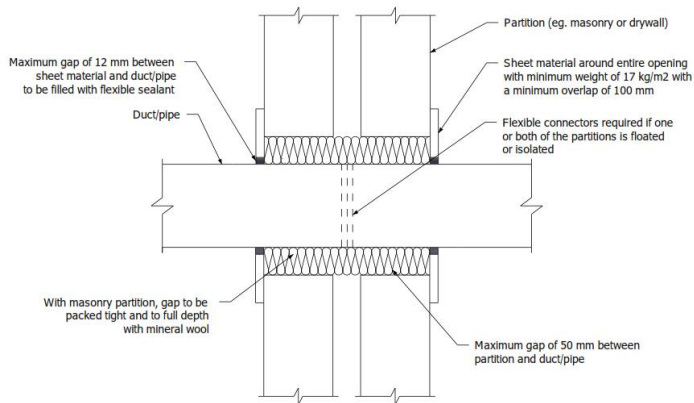


Figure 8 Example sketch detail – Duct/pipe penetration through a double/staggered partition

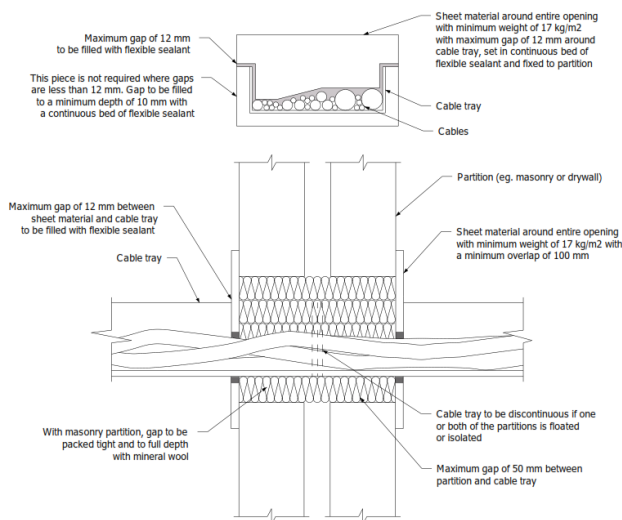


Figure 9 Example sketch detail – Cable tray penetration through a double/staggered partition

6.3.6 Pipework

Any potentially noisy pipework which passes through the ceiling void above sensitive spaces is recommended to be either:

- Acoustically lagged (minimum 5 kg/m² flexible mass layer on 25 mm mineral fibre); or
- Boxed in with 2 x 12.5 mm Wallboard, independent of the pipework and 25 mm Isowool APR 1200 or equivalent insulation in the void.

6.4 Vibration criteria

The maximum permissible vibration amplitudes shall not:

- a) exceed a Vibration Dose Value (VDV) of $0.4 \text{ m/s}^{-1.75}$ as given in BS 6472-1: 2008 *Guide to evaluation of human exposure to vibration in buildings: Part 1 Vibration sources other than blasting* in any occupiable space
- b) be of a magnitude which causes the maximum noise criteria to be exceeded.

In addition, vibration transfer from plant to occupied areas 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.

6.5 Vibration control measures

Fans, motors, and all other vibration producing equipment shall be fitted with suitable anti-vibration equipment (anti-vibration mounts, flexible connections, resilient hangers etc) to reduce the transmission of vibration. The degree of vibration isolation shall be such that the noise and vibration criteria are met.

All anti-vibration equipment shall be specifically selected for the duty it has to perform.

7 Construction (Design and Management) Regulations

The Construction (Design and Management) Regulations 2015 places legal duties on virtually everyone involved in construction work. Those with legal duties are commonly known as 'dutyholders' and include clients, designers, contractors and workers.

Typical risks specifically associated with acoustic design are:

- Access at height to install and to maintain such elements as acoustic absorbers
- Manual handling of heavy building elements such as high density concrete blocks.

Acoustic treatment is proposed which will require installation at height, eg soffit of spaces. However, this would be required in any event for installation of ceiling finishes, lighting, etc and is therefore not a risk specifically related to the acoustic design.

Man-made mineral fibres (MMMF) are used extensively in the construction industry and these are sometimes specified for their acoustic properties. When contractors make use of MMMF they should act on relevant legislation and the latest guidance issued by the Health and Safety Executive.

The above risks are not unusual and would be appropriately managed by a competent contractor.

Appendix A

Glossary of terms

General terms

Absorptive material	Material that absorbs sound energy. Soft or porous finishes such as mineral fibre are effective sound absorbers.
Acoustic absorption	The conversion of sound energy, often by the use of a porous material. It is a term used to describe the amount of sound absorbed by a finish or object within a room.
Airborne sound	Sound propagating through the air.
Airborne sound insulation	The ability of building elements or structures to reduce airborne sound transmission.
Density	Mass per unit volume, expressed in kilograms per cubic metre (kg/m^3).
Direct sound transmission	The process in which sound that is incident on one side of a building element is radiated by the other side.
Flanking element	Any building element that contributes to the sound transmission between rooms in a building that is not the separating element in question. It is typically an element which continues past the separating element
Flanking sound transmission	Sound transmitted between rooms via flanking elements instead of directly through separating elements, or along any path other than the direct path.
Floating/isolated floor	A floating or isolated floor consists of a floating layer that is decoupled from the main structure by a resilient layer or other resilient element (see also 'Resilient layer' and 'Floating/isolated layer'). The type of resilient element depends on the level of isolation required.
Floating/isolated layer	A surface that rests on a resilient layer or other resilient element and is therefore isolated from the main structure (see also 'Floating/isolated floor' and 'Resilient layer').
Frequency	The number of cycles per second. The unit of frequency is the Hertz (Hz). Frequency gives a sound its distinctive tone.
Frequency band	A continuous range of frequencies between stated upper and lower limits (see also 'Octave band' and 'One-third octave band').
Impact sound	Sound resulting from direct impact (such as footsteps) on a building element.
Impact sound insulation	The ability of building elements or structures to reduce impact sound transmission.
Independent ceiling or lining	A ceiling or lining which is mounted independently of (ie with no direct physical connections to) a separating floor or wall.
Isolation	The absence of rigid connections between two or more building elements.
Mass per unit area	The mass per unit area, expressed in terms of kilograms per square metre (kg/m^2). Also known as 'surface density'.
Resilient layer/element	A layer or other resilient element that isolates a floating layer from a base floor and the surrounding walls.
Resiliently mounted ceiling or lining	A ceiling or lining which is mounted resiliently from (ie connected only via specialist resilient hangers or ties) a separating floor or wall.

Reverberation	The persistence of sound in a space after a sound source has stopped.
Reverberation time	The time, in seconds, taken for the sound in a room to decay by 60 dB after a sound source has been stopped.
Separating element	An element (such as a wall, floor, door, window) which separates buildings or parts of buildings.
Sound pressure level	A logarithmic measure of the effective sound pressure of a sound relative to a reference value, measured in decibels, dB. Sound pressure levels are dependent on the conditions under which they are measured.
Sound power level	A logarithmic measure of the sound power in comparison to specified reference level, measured in decibels, dB. Unlike sound pressure, sound power is not room or distance dependent.
Spectrum	The composition of a particular sound in terms of separate frequency bands.
Surface density	The surface density, expressed in terms of kilograms per square metre (kg/m^2). Also known as 'mass per unit area'.
Structure-borne sound	Sound which is transferred by vibration via the structure of a building.

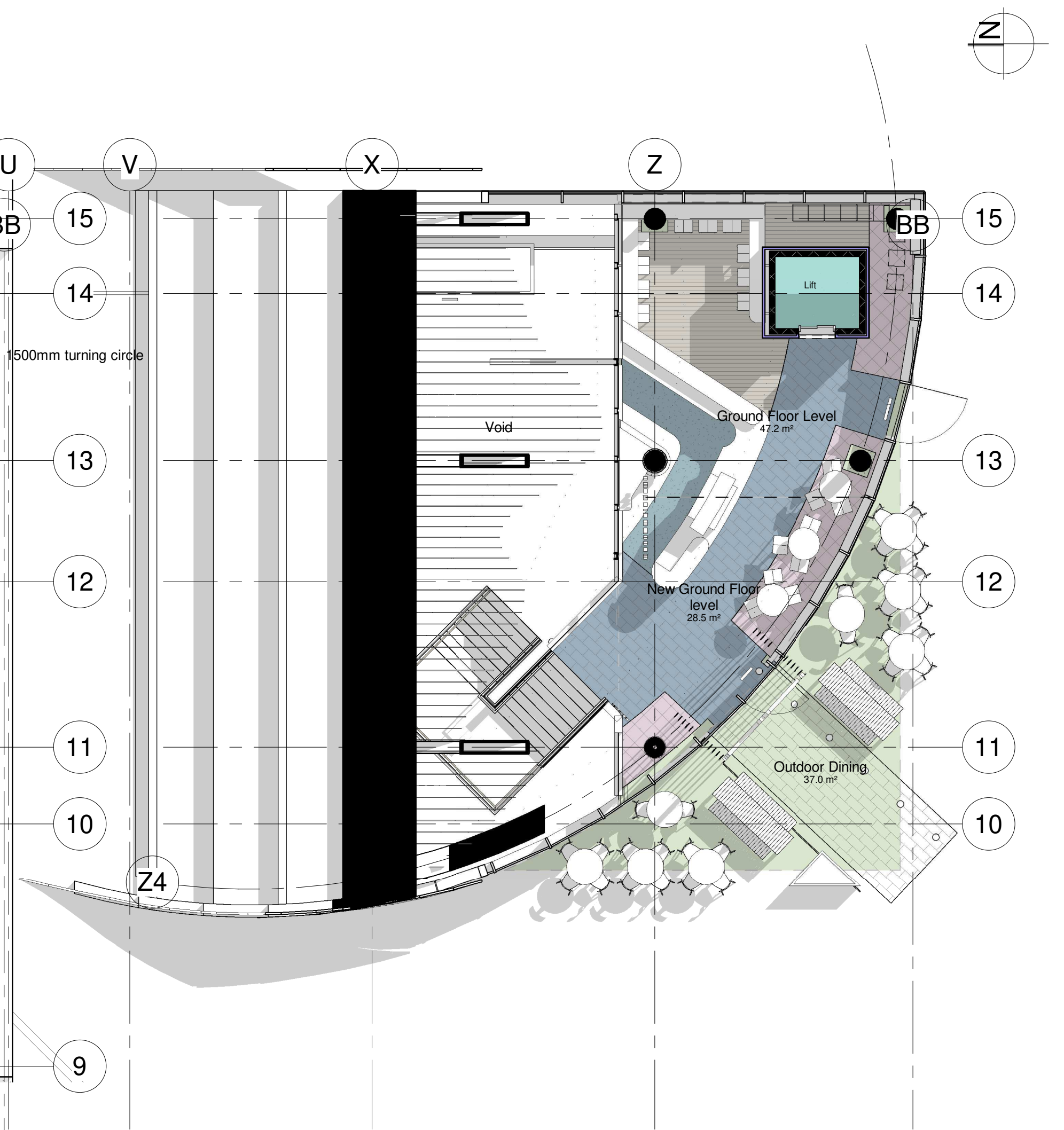
Acoustic parameters

'A' weighting	Frequency weighting based on the frequency response of the human ear which has been found to correlate well with the subjective response to sound.
C_{tr}	The correction to a sound insulation quantity (such as R_w or $D_{nT,w}$) to take account of a specific sound spectrum with low frequency sound energy.
Decibel (dB)	A logarithmic unit used for many acoustic values to indicate the level with respect to a reference level
$D_{n,f,w}$, $D_{n,c,w}$	A single number weighted quantity which characterizes the airborne sound insulation between rooms via a specified flanking path. $D_{n,c,w}$ relates specifically to ceilings but has been superseded by $D_{n,f,w}$ which can relate to any specified path. A higher numerical quantity represents a better performance.
D_{nT}	The difference in sound level between a pair of rooms, in a stated frequency band, normalized for the reverberation time. A higher numerical quantity represents a better performance.
$D_{nT,w}$	A single number weighted quantity which characterizes the airborne sound insulation between rooms, corrected for reverberation time. A higher numerical quantity represents a better performance.
Hz	Hertz (Hz) is the unit of frequency (see also 'Frequency')
$L_{n,f}$	The impact sound pressure level in a stated frequency band, flanking via a floor connecting adjacent rooms. A lower numerical quantity represents a better performance.
$L_{n,f,w}$	A single number weighted quantity used to characterize the flanking impact sound pressure level via a floor connecting adjacent rooms. A lower numerical quantity represents a better performance.

$L_{A90,T}$	The A-weighted sound pressure level exceeded 90% of the measurement period (T) over which a noise is measured (ie, the quietest 10% of the period). When not weighted it is denoted $L_{90,T}$. This parameter is generally considered to be representative of a constant noise source, or background noise level.
$L_{Aeq,T}$	Equivalent A-weighted sound pressure level of a steady noise that has the same acoustic energy as a fluctuating noise over the measurement period (T). When not weighted it is denoted $L_{eq,T}$.
$L_{Amax,T}$	The highest A-weighted sound pressure level measured in the period (T) with either fast (L_{AFmax}) or slow (L_{ASmax}) time weightings. When not weighted it is denoted L_{Fmax} or L_{Smax} .
NR	Noise rating. Single figure term used to reflect the spectral content of noise. This is generally applied within rooms in relation to building services noise.
Octave band	A frequency band in which the upper limit of the band is twice the frequency of the lower limit.
One-third octave band	A frequency band in which the upper limit of the band is the cube root of two times the lower limit of the band or more simply one third of an octave band.
R	Sound reduction index. A quantity, measured in a laboratory, which characterises the airborne sound insulation of a material or building element in a stated frequency band. A higher numerical quantity represents a better performance.
R_w	Weighted sound reduction index. A single number quantity which characterises the airborne sound insulation of a material or building element in the laboratory. A higher numerical quantity represents a better performance.
R'	Apparent sound reduction index. The on-site equivalent of the sound reduction index, R , which is measured in the presence of flanking paths. A higher numerical quantity represents a better performance.
R'_w	Apparent weighted sound reduction index. The on-site equivalent of the weighted sound reduction index, R_w . A higher numerical quantity represents a better performance.
T_{mf}	The arithmetic average of the reverberation time in the 500 Hz, 1 kHz and 2 kHz octave bands (see also 'Reverberation time').
α_w	Weighted absorption coefficient – a quantity characterising the effectiveness of a sound absorbing surface. The proportion of sound energy absorbed is given as a number between zero (for a fully reflective surface) and one (for a fully absorptive surface).
ΔL_w	The measured improvement of weighted impact sound insulation resulting from the installation of a floor covering or floating floor on a test floor in a laboratory. A higher numerical quantity represents a better performance.

Appendix B

Partition and door performances



Mark-up key laboratory ratings

-  R_w 50 dB partition
- R_w 45 dB partition
-  R_w 40 dB partition
-  R_w 35 dB door

REV.	DATE	DRN.	CHKD.
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Preliminary

3 Key Plan Ground Floor

