

10 ACOUSTICS

10.1 INTRODUCTION

This Stage 3 acoustic design chapter provides a summary of the acoustic design development to date and sets out the proposed performance standards including:

- i Sound insulation
- i Room acoustics
- i Building services noise and vibration control, internal and external

This chapter does not cover sound system design or assessment of public address / voice alarm systems.

10.2 BASIS OF THE DESIGN

The RIBA Stage 3 Acoustic Design is based on the following information:

- i EPR Architects WIP General Arrangement drawings (preliminary issue P01)
- i EPR Architects Elevation drawings (received via email 23/04/21)
- i WSP MEP Stage 3 WIP drawings
- i WSP acoustic design development notes
- i WSP Structures design development notes.
- i WSP report 70075436-R01-AC-rev01 THG 16-24 Kennedy Street environmental noise survey report
- i WSP Stage 2 Engineering Report (multi-discipline)

The following standards and documents are also referenced:

- i Manchester City Council's *Planning & Noise Technical Guidance (December 2015)* Technical Advisory
- i Building Regulations Approved Document E, 2003 edition incorporating all amendments
- i BS 8233:2014 Guidance on sound insulation and noise reduction for buildings
- i BS 4142: 2014 Methods for rating and assessing industrial and commercial sound (+A1:2019)
- i BS 6841:2005 Evaluation of Human exposure to Vibration in Buildings- Part 1: Vibration from sources other than blasting.

10.3 KEY ACOUSTIC CONSIDERATIONS

The key acoustic considerations at the stage are listed below.

- i **Level 1 Event Space, 20 Kennedy Street:** A very high level of sound insulation performance is required for the separating floor between the Level 1 Event Space and Level 2 guestrooms. The aspiration is that the two areas could be used independently (i.e. guestrooms would not need to be booked in conjunction with the event space). Four possible options to do this are provided in this report and are expected to permit amplified music levels in the region of L_{Aeq} 95-100 dB and 85-90 dB at low frequencies (63 Hz and 125 Hz). These are considered suitable for events with a DJ for example, though some management of the spaces will be required should there be a band with live drums. The final operational noise levels will be determined through on-site testing when the construction is complete.
- i **Rooftop terrace, 20 Kennedy Street:** A retractable glazed roof is proposed over 20 Kennedy Street event space to provide an outdoor space, enclosed by the perimeter walls supporting the roof. In addition, along the Kennedy Street elevation the current strategy is that the four openings proposed will not be glazed and will be open to provide access to the front balcony. As a result, music levels within the roof terrace will need to be limited. Given the proximity to the nearest noise sensitive receptors, this outdoor space is not suitable for events involving high levels of amplified music. Initial calculations indicate that amplified music on the terrace should be limited to around L_{Aeq} 70 dB, which would permit low level background music. This is the cumulative level and the individual limits from external speakers depends on the number, type, location, directivity and frequency response of any speakers. Given the distance to the nearest receptors and their geometry in relation to 16-24 Kennedy Street there is limited mitigation measures that could be used to permit higher levels.
- i **Noise egress from Immersive Media, 24 Kennedy Street:** Noise break-out through the existing building envelope needs to be considered in relation to the Immersive Media. An independent lining is proposed to help with this. Activities within the Immersive Media are expected to be audible in other areas of 24 Kennedy Street.
- i **Flanking sound transmission, all buildings:** Interface between new internal partitions and floors and existing perimeter walls needs careful detailing so that flanking sound transmission via this route does not undermine the specified sound insulation performances. In a number of locations an independent lining is proposed to the external and perimeter walls to help control this (e.g. 20KS Level 1 Event Space, guestrooms).
- i **External plant:** Noise from external roof mounted plant will need to be adequately controlled so that it meets Manchester City Council's requirements and does not negatively impact the external terraces proposed to 20 and 24 Kennedy Street. Initial guidance is provided in this report and a further study will be undertaken once preliminary selections have been made. An allowance should be made at this stage for 1200 mm long attenuators to extract fans. In addition it may be necessary to consider acoustically rated plant screens or louvres.

10.4 BUILDING ENVELOPE

CRITERIA

External noise ingress criteria

It is recommended that external noise ingress is controlled so that the limits in Table 10-1 are met when windows are closed.

Table 10-1 - Recommended internal ambient noise levels due to external noise ingress

Internal space	Recommended maximum internal level due to external noise ingress
Guestrooms/ bedrooms	L_{Aeq} 35 dB (07:00-23:00) L_{Aeq} 30 dB (23:00-07:00)
Immersive Media	L_{Aeq} 30 dB
Meeting rooms, lounges	L_{Aeq} 35 dB
Office, training studios	L_{Aeq} 40 dB
Restaurant/ Café, kitchen, entrance	L_{Aeq} 40 dB
Event Space	L_{Aeq} 40 dB

OPERATIONAL NOISE EGRESS

Manchester City Council specify the following in relation to entertainment noise:

Entertainment noise (L_{Aeq}) should be controlled to 10 dB below the background noise level (L_{A90}) without the entertainment noise present, in each octave band at the nearest noise sensitive location.

This criterion applies to any operational noise associated with the development, for example amplified music played in the event space and forms the basis of the advice below, based on the measured existing background sound levels.

The nearest noise sensitive receptors are considered to be:

- i King Street Town House
- i The Chambers apartments, 2-6 Booth Street
- i Belvedere Offices, Kennedy Street
- i Existing offices along Bow Street

These receptors are approximately 10-15 m from 16-24 Kennedy Street.

Based on the results of the environmental noise surveys carried out, the following limits apply to amplified music at the nearest noise sensitive location.

Table 10-2 - Maximum operational noise limits 1m from the nearest noise sensitive receptor

	Octave band centre frequencies (Hz)							
Maximum operational noise levels (L_{eq} dB) 1m from façade of nearest noise sensitive receptor	63	125	250	500	1k	2k	4k	8k
Daytime 07:00 to 23:00	47	43	42	40	40	33	24	14
Night-time 23:00 to 07:00	46	43	41	40	39	32	24	14

BUILDING ENVELOPE DESIGN

Where new windows are referred to the performances are for the complete assembly including glazing, framing and all associated hardware.

Existing Windows & Internal noise levels

Where existing windows are retained, when closed the internal level is expected to be $L_{Aeq} \leq 35$ dB. Comfort cooling is to be provided mechanically during which windows will be closed.,.

When windows are open the internal noise level is expected to be in the region of L_{Aeq} 48 dB in rooms along Kennedy Street. This is higher than desirable for bedrooms, though this would be no different than the levels experienced when the property was a single-family dwelling. If windows remain closed for the majority of the time this is unlikely to be an issue.

New Windows to Guest rooms and Bedrooms

Where existing windows are to be replaced with new, they should be selected to have a minimum sound insulation performance of $R_w + C_{tr}$ 28 dB. This performance is achievable with a standard thermal double glazed unit or some slimmer double glazed systems uses in heritage buildings.

Where trickle vents are required in new windows to provide natural ventilation, an allowance should be made for these to be acoustically rated with a minimum performance of $D_{ne,w} + C_{tr}$ 32 dB (assuming 1 vent per room).

Level 1 Event Space, 20 Kennedy Street

To limit noise egress from the Level 1 Event Space it is to be mechanically ventilated so that there is no reliance on opening windows or façade/window vents.

Based on a reverberant sound pressure level within the Level 1 Event Space in the region of L_{Aeq} 100 dB, with limits of around L_{eq} 90 dB at low frequencies (63 Hz and 125 Hz), calculations indicate that new windows should be selected to have a minimum overall sound insulation performance of $R_w + C_{tr}$ 31 dB. In addition, it should also be selected to have a minimum sound reduction performance at low frequencies of R_{63Hz} 24 dB and R_{125Hz} 27 dB.

An example glazing configuration capable of achieving this is 6 mm glass, 12 mm air gap, 6.8 mm acoustic laminate glass.

If these performances cannot be met (e.g. if a slimmer system is required for heritage reasons) then the internal limits may need to reduce.

Level 1 Immersive Media, 24 Kennedy

It is understood that the Immersive Media room is to provide users with a unique experience and that it may be used for a variety of activities including, product launches, screenings, gaming and immersive audio-visual presentations.

The space is to be fully mechanically ventilated and an allowance has been made for an independent lining to the external wall to improve the sound insulation performance and help limit external noise ingress. The independent lining should be formed from 2 x 12.5 mm plasterboard with 25 mm mineral fibre insulation within a 75 mm cavity (overall construction zone 100 mm). There should be no rigid connections between the lining and the perimeter walls.

At the window opening, secondary glazing could be used instead of a plasterboard lining and it is recommended that this is formed from a minimum of 6.8 mm acoustic laminate glass. The framing supporting the secondary glazing should be independent from the primary glazing (external window) and if possible, sound absorbent reveals should be provided between them.

Where the existing window is retained,

Roof Terrace, 20 Kennedy Street

Similarly to the Level 1 Event Space, noise egress from the roof terrace at 20 Kennedy Street needs to be considered.

It is understood that the current intention is that the roof over this space will be glazed and retractable. Along the Kennedy Street elevation EPR drawing 11175-EPR-ZZ-EL-DR-A-04-0201 notes that the four openings proposed will not be glazed and will be open to provide access to the front balcony. As a result, music levels within the roof terrace will be limited.

Initial calculations indicate that, with the openings to the façade and retractable roof open, amplified music on the terrace would be limited to around L_{Aeq} 70 dB, which would permit low level background music. This is the cumulative level and the individual limits from external speakers depends on the number, type, location, directivity and frequency response of any speakers. Given the distance to the nearest receptors and their geometry in relation to 16-24 Kennedy Street there is limited mitigation measures that be used to permit higher levels.

Higher levels of amplified music would be permitted if glazing can be provided to these openings (it could be openable to provide flexibility). On the basis of this being a possible option, it is recommended that the new glazed roof and façade elements provide an overall sound insulation performance of R_w 37 dB and a low frequency performance of R_{63Hz} 17 dB and R_{125Hz} 21 dB. An example configuration capable of achieving this is 6.8 mm acoustic laminate, 16 mm air gap, 6.8 mm acoustic laminate glass.

Non-glazed elements to the façade and roof should provide a minimum an overall sound insulation performance of R_w 47 dB and a low frequency performance of R_{63Hz} 27 dB and R_{125Hz} 31 dB.

These performances assume a maximum reverberant sound pressure level of around L_{Aeq} 85-90 dB with limits at low frequencies (63 Hz and 125 Hz) of around 80 dB. This limit takes account of sound transfer to the Level 3 guestrooms below based on the proposed construction in Table 10-7.

Roof Event Lounge/Space, 24 Kennedy Street

Based on the same limits for amplified music as the 20 Kennedy Street terrace, the sound insulation performances for the new roof and glazed elements would be applicable to 24 Kennedy Street also.

The roof over 24 Kennedy is not glazed and an example construction capable of meeting this performance is :

- i Slate roof tiles
- i 200 dense mineral fibre insulation ($\geq 100 \text{ kg/m}^3$)
- i 2 x 12.5 mm dense plasterboard (SoundBloc or equivalent) internal lining

Skylights, 16 Kennedy Street

Where skylights are proposed over the Level 3 offices at 16 Kennedy Street it is recommended that they have a minimum sound insulation performance of $R_w + C_{tr}$ 28 dB. This is achievable with standard thermal double glazing.

Rooftop Plant Deck

Where roof mounted plant is located over Level 3 Guestrooms at 20 Kennedy Street, it is understood the separating construction is 200 mm concrete on a re-entrant deck ($\geq 2200 \text{ kg/m}^3$). This construction is expected to adequately control sound transfer to below

EXTERNAL DOORS

General

Where new external doors are proposed to external terraces, they should be selected to have equivalent sound insulation performance as the glazed façade system they are located in.

New entrance doors at ground levels should be selected to have a minimum sound insulation performance of R_w 30 dB and be fitted with full perimeter seals.

Plant Rooms

Where louvred doors are proposed to plant rooms, the performance will need to be reviewed in relation to the expected noise levels from the proposed plant items. At this stage it is advised that an allowance is made for these to be acoustically rated.

10.5 INTERNAL PARTITIONS & DOORS

PARTITIONS

Criteria and Mark-ups

Where partitions separate individual guestrooms the target sound insulation performance is to achieve an on-site performance at least 5 dB better than the minimum requirements of Building regulations Approved Document E (2003 edition incorporating all amendments, ADE 2003).

It is understood that 24 Kennedy Street will be a luxury aparthotel, rented as a single dwelling rather than individual guestrooms. As a result the required sound insulation performance for partition forming these rooms is lower under ADE 2003 as they can be considered to be internal partitions within a dwelling.

The minimum criteria under ADE 2003 along with the target criteria (ADE 2003 + 5 dB) are summarised in Table 10-3.

Table 10-3 - Sound insulation requirements between individual guestrooms

Separating element	Minimum airborne sound insulation	
	ADE 2003 (minimum requirement)	ADE 2003 + 5 dB (target performance)
Walls between guestrooms	$D_{nT,w} + C_{tr} \geq 43$ dB	$D_{nT,w} + C_{tr} \geq 48$ dB
Internal walls between rooms at 24 Kennedy (excluding walls containing doors or walls separating bedrooms from en-suites)	R_w 40 dB	R_w 45 dB

Sound insulation mark-ups are provided the appendix showing the recommended minimum sound insulation performances for internal partitions. The performances along with example configurations capable of achieving them are summarised in Table 10-4.

Where drywall constructions are used the following laboratory performance between guestrooms ($R_w + C_{tr}$ dB) shall be selected to be at least 9 dB higher than the specified site performance ($D_{nT,w} + C_{tr}$).

In all other locations the laboratory performance (R_w , dB) shall be at least 7 dB higher than the specified site performance.

Table 10-4 – Partition key and example drywall and blockwork partition constructions

Partition type (see mark-ups)	Minimum lab. performance	Example drywall construction	Example blockwork construction
P1	R_w 40 dB	2 x 12.5 mm plasterboard to both sides of 48 mm 'C' stud no mineral fibre cavity insulation (overall width 100 mm).	100 mm medium density blockwork (≥ 1450 kg/m ³)
P2	R_w 45 dB	2 x 12.5 mm plasterboard to both sides of 48 mm 'C' stud with 25 mm mineral fibre cavity insulation (overall width 100 mm).	100 mm medium density blockwork (≥ 1450 kg/m ³)
P3A	R_w 50 dB	2 x 12.5 mm dense plasterboard (SoundBloc or equivalent) to both sides of 70 mm 'C' stud with 25 mm mineral fibre cavity insulation (overall width 122 mm).	140 mm medium density blockwork (≥ 1450 kg/m ³)
P3B	R_w 50 dB (staggered)	2 x 12.5 mm plasterboard to both sides of 60/70I staggered studs with 25 mm mineral fibre cavity insulation (overall width 122 mm)	100 mm medium density blockwork (≥ 1450 kg/m ³) plus independent lining of 2 x 12.5 mm plasterboard with 25 mm mineral fibre insulation within ≥ 60 mm cavity (overall construction width 160 mm)
P4	R_w 47 dB (riser)	19 mm Gyproc Coreboard, 92 mm I Stud, 25 mm mineral fibre insulation with 2 x 12.5 mm Fireline to non-shaft side (overall width 119 mm).	140 mm medium density blockwork (≥ 1450 kg/m ³)
P5	R_w 53 dB (Lift shaft excl. linings)	n/a	140 mm dense blockwork (≥ 1850 kg/m ³) See note below regarding additional linings
P6	$R_w + C_{tr}$ 57 dB	2 x 15 mm dense plasterboard (SoundBloc or equivalent) to both sides of 2 x 50 mm I studs with 100 mm mineral fibre insulation in cavity (overall width 250 mm)	140 mm medium density blockwork, 100 mm cavity with 50 mm mineral fibre within it, 100 mm medium density blockwork. No rigid connections between blockwork leaves.
P7	$R_w + C_{tr}$ 52 dB	2 x 15 mm dense plasterboard (SoundBloc or equivalent) to both sides of 2 x 70 mm 'C' stud with 50 mm mineral fibre cavity insulation (overall width 200 mm)	2 x 100 mm medium density blockwork separated by 100 mm cavity with 50 mm mineral fibre within it. No rigid connections between blockwork leaves.

LIFT-SHAFT LININGS

Where lifts are located next to noise sensitive areas it is advised that an independent lining is provided to the room side consisting of a minimum of 2 x 12.5 mm dense plasterboard (SoundBloc or equivalent) with 25 mm mineral fibre insulation within 60 mm cavity (minimum overall construction zone 85 mm). There can be no rigid connections between the lining and the blockwork forming the lift-shaft enclosure.

The locations where independent linings are advised are shown on the mark-ups at the end of this note.

In all other areas it is understood that a minimum 63 mm allowance has been made for a plasterboard lining to the non-shaft side. This is acceptable where an independent lining is not required.

STAGGERED CONSTRUCTIONS

In 16 Kennedy Street where the meeting rooms are located next to a WCs and kitchen, it is recommended that a staggered stud construction is used to minimise the risk of structure borne noise and vibration causing disturbance to occupants of the meeting room.

Where this can't be accommodated it is recommended that the mounting of cupboards, hand dryers and other sanitary ware on this partition is avoided where possible.

PARTITION INTERFACE DETAILS

Head and base

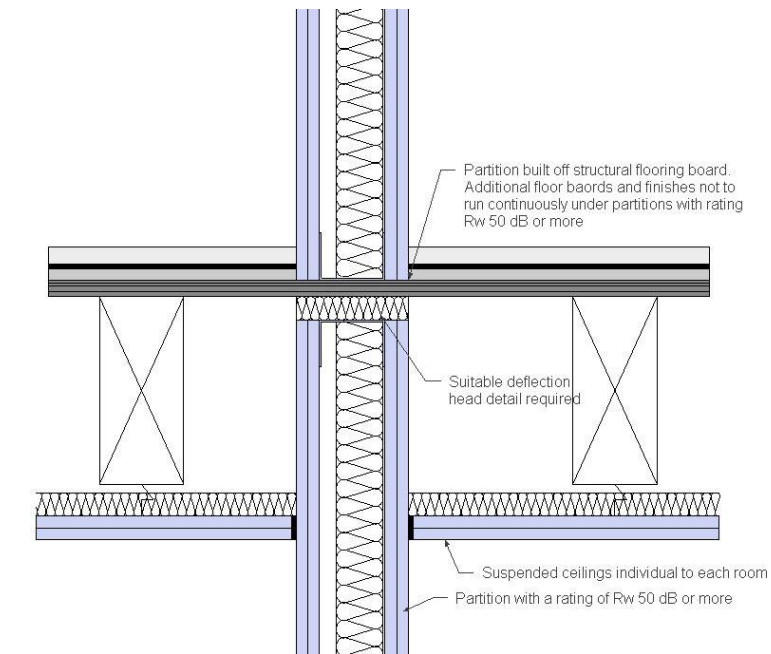
The head and base details of partitions to guestrooms ($R_w + C_{tr}$ 52 dB & $R_w + C_{tr}$ 57 dB) will need to be carefully considered to make sure the room-to-room sound insulation performance is not compromised due to flanking sound transmission via these routes.

Guestroom partitions at 20 Kennedy are to be built off the new concrete floors to the underside of the floor above. Suspended ceilings and all floor finishes are to be individual to each room and should not run continuously between rooms.

In other areas, where partitions have a rating of $R_w < 50$ dB, these can be built to the underside of suspended ceilings. Where partitions have a rating $R_w \geq 50$ dB these should be built to the underside of the floor above with suspended ceilings individual to each room.

Where existing floors being retained are timber, an example interface detail for partitions is provided below. Additional flooring boards and floor finishes are to be individual to each space also.

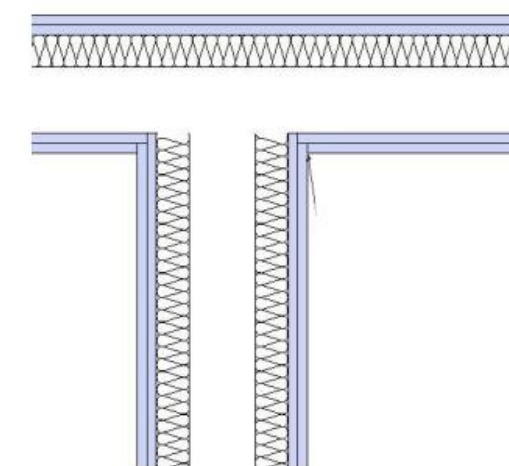
Figure 10-1 - Indicative detail of drywall abutting timber floor



Interface with other drywalls

Where drywall partitions with a rating $R_w \geq 50$ dB and $R_w + C_{tr} \geq 52$ abut other drywalls, they shall break the internal plasterboard lining so that it does not run continuously between rooms.

Figure 10-2 - Indicative detail between drywalls



Interface with External walls

In locations where an internal plasterboard lining is provided to external walls, partitions with a rating $R_w \geq 50$ dB and $R_w + C_{tr} \geq 52$ dB should break this lining so that the internal plasterboard lining does not run continuously between rooms.

In areas where no internal façade lining is provided, partitions abutting the external wall shall be well sealed to minimise flanking sound transmission via this route.

Cross-talk

Where guestrooms or other noise sensitive spaces (e.g. meeting rooms) are served by common ductwork, an allowance should be made for cross-talk attenuators to be provided so that the overall room-to-room sound insulation performance is not compromised.

INTERNAL DOORS

The mark-ups in the appendix show where internal doors are acoustically rated. Table 10-5 provides example constructions capable of meeting the recommended acoustic ratings.

Table 10-5 - Example door constructions

Door type (see mark-ups)	Minimum lab. performance	Example door construction
D1	R_w 29 dB	44 mm solid core timber door with minimum mass per unit area 25 kg/m ² fitted with full perimeter seals, (e.g. Norsound Nor 755 or Lorient LP1504 to head and jambs and Norsound Nor 815 or Lorient IS8010 si to threshold). Door to be side hinged rather than picoted or sliding.
D2	R_w 35 dB	54 mm solid core timber door with minimum mass per unit area 30 kg/m ² fitted with full perimeter seals (e.g. Norsound Nor 710 or Lorient IS 1212 to head and jambs and Norsound Nor 810 or Lorient IS8010 si to threshold). Door to be side hinged rather than picoted or sliding.
D3	n/a	See note below regarding sliding pocket doors and doors to WCs

WC doors

No acoustic rating has been provided on the mark-ups for doors leading into WCs or changing rooms as these are often undercut for ventilation purposes which undermines the acoustic performance. It is recommended that doors leading into shared or accessible WCs/changing have a minimum mass per unit area of 25 kg/m² and be fitted with perimeter seals where possible. In any location where they are undercut for ventilation purposes this shall be as small as possible and ideally less than 20 mm.

Where sliding pocket doors are proposed to WCs, the sound insulation performance will be limited and lower than a hinged door, due to the practicalities of providing perimeter seals to

these types of doors. As a result there will be less privacy provided between these WCs and adjacent spaces.

Immersive media

The WIP layouts issued on 14/04/21 show a sliding pocket door to the Immersive Media space. As noted above, these types of doors have a limited acoustic performance as effective seals cannot be formed. It would be better in terms of limiting sound transfer from this space to other areas of 24 Kennedy if a hinged doorset with full perimeter seals and rebated meeting stile (where double doors are used) is provided to this space. The acoustic rating shown on the mark-ups is on the basis of a hinged doorset.

Riser doors

Doors and access panels to risers shall be selected to have a minimum sound insulation performance of R_w 35 dB. They are to be side hinged rather than pivoted and fitted with full perimeter seals.

10.6 INTERNAL FLOORS & CEILINGS

STATUTORY REQUIREMENTS

A summary of the statutory sound insulation requirements for internal floors in each of the buildings is provided in Table 10-6.

Table 10-6 – Summary of statutory requirements for internal floors

Building	Statutory Requirements	Comment
16 Kennedy Street	None	There are no statutory requirements applicable to 16 Kennedy Street as this building will house ESPA training studios, office space and meeting rooms. Therefore the relevant guidance in British Council for Offices (BCO) Guide to Specification (2019) has been used as the basis of the design.
20 Kennedy Street	ADE 2003 airborne and impact requirements for party floors separating guestrooms from other spaces	A 5 dB improvement over ADE 2003 is being targeted. A higher level of separating is proposed between the Level 1 Event Space and Level 2 guestrooms
24 Kennedy Street	ADE 2003 airborne sound insulation requirement for internal floors within a single dwelling.	A higher performance than ADE 2003 is being targeted to provide greater flexibility.

AIRBORNE SOUND INSULATION

A summary of the minimum airborne sound insulation performances along with the proposed constructions is provided in Table 10-7.

Table 10-7 – Summary of floor airborne sound insulation requirements and proposed constructions

Building	Vertical adjacency	Minimum airborne sound insulation	Proposed construction/ comment
16 Kennedy Street	Basement substation to GF Meeting Room	$D_{nT,w}$ 55 dB	250 mm RC concrete slab ($\geq 2200 \text{ kg/m}^3$) proposed & is capable of meeting the performance. See Section 10.8 about additional requirements for equipment in the substation.
	All other floors	$D_{nT,w}$ 45 dB	130 mm concrete on a re-entrant deck proposed & is capable of meeting the performance.
20 Kennedy Street	GF Café/Lounge to Level 1 Event Space	$D_{nT,w}$ 55 dB	200 mm concrete on a re-entrant deck proposed & is capable of meeting the performance. It is worth noting that although this represents a reasonably high level of sound insulation, low frequency sound (i.e. bass thump) may be audible in the café/lounge particularly during quieter/ low occupancy periods.
	Level 1 Event Space to Level 2 Guestrooms	$D_{nT,w} + C_{tr}$ 57 dB plus Music limits will need to be set so that the resultant level in guestrooms does not exceed NR 15 L_{eq} and L_{eq} 47 dB and 41 dB at 63 Hz & 125 Hz respectively.	Four options are provided in Table 10-8 to maximise the separation between these spaces to provide greater flexibility. It is understood the structural design is currently being progressed on the basis of Option 2.
	Level 2 Guestroom to Level 3 Guestroom	$D_{nT,w} + C_{tr}$ 48 dB	160 mm concrete on a re-entrant deck proposed with suspended ceiling below. This is capable of meeting the performance.

Building	Vertical adjacency	Minimum airborne sound insulation	Proposed construction/ comment
	Level 3 Guestroom to Roof Terrace	$D_{nT,w} + C_{tr}$ 52 dB	200 mm concrete on a re-entrant deck proposed & is capable of meeting the performance without relying on suspended ceilings. To provide greater protection against amplified music it is recommended the ceiling to Level 3 guestrooms is formed from 2 x 12.5 mm plasterboard with 50 mm mineral fibre insulation above. See Section 10.4 regarding music limits within the roof terrace.
24 Kennedy Street	Basement Studio to GF Entry Lounge	$D_{nT,w} + C_{tr}$ 43 dB	As existing, no changes in terms of acoustics required.
	Basement bin Store to GF Dining & Kitchen	$D_{nT,w} + C_{tr} \geq 43 \text{ dB}$	Concrete option: 160 mm concrete on re-entrant deck OR Timber construction: - 18 mm timber flooring board, - 19 mm Gyproc plank - 5 mm resilient layer - 12 mm plywood deck - Timber joists $\geq 195 \text{ mm}$ with 100 mm mineral fibre insulation between - 2 x 12.5 mm SoundBloc (or equivalent) on resilient bars.
	GF Entry Lounge to Level 1 Guest Kitchen	N/A	Spaces open to one another by stairwell limiting sound insulation performance
24 Kennedy Street	GF Dining & Kitchen to Level 1 Immersive Media	$D_{nT,w} + C_{tr} \geq 43 \text{ dB}$	Existing floor build-up plus new sound insulating ceiling provided within the Immersive Media formed from 2 x 12.5 mm SoundBloc (or equivalent) on resilient hangers with 50 mm mineral fibre insulation within a 100 mm ceiling void
	Level 1 Guest Kitchen to Level 2 Bedroom 2	$D_{nT,w} + C_{tr} \geq 43 \text{ dB}$	Assuming floor construction between Level 1 and 2 is the same across the floor, the existing floor should be capable of meeting this performance without any enhancements. Construction between these areas to be confirmed by others.

Building	Vertical adjacency	Minimum airborne sound insulation	Proposed construction/ comment
	Level 1 Immersive Media to Level 2 Bedroom 1	$D_{nT,w} + C_{tr} \geq 48$ dB	Existing floor build-up plus new sound insulating ceiling provided within the Immersive Media formed from 2 x 12.5 mm SoundBloc (or equivalent) on resilient hangers with 50 mm mineral fibre insulation within a 100 mm ceiling void. An independent lining to perimeter walls of immersive media is also advised to control flanking via this route.
	Level 2 Bedroom 2 to Level 3 Master Lounge	As existing (measured performance was $D_{nT,w} + C_{tr}$ 46 dB)	As existing , no changes in terms of acoustics required. Care shall be taken that any works do not reduce the performance of the existing floor.
	Level 2 Bedroom 1 to Level 3 master Bedroom	As existing (measured performance was $D_{nT,w} + C_{tr}$ 49 dB)	As existing , no changes in terms of acoustics required. Care shall be taken that any works do not reduce the performance of the existing floor.
	Level 3 Master Lounge to Level 4 Event Lounge/space	N/A	Spaces open to one another by stairwell limiting sound insulation performance.
	Level 3 Master Bedroom to Level 4 Event lounge/space	$D_{nT,w} + C_{tr} \geq 48$ dB	See Section 10.4 regarding music limits within the Event space. Example construction: 130 mm normal weight concrete on trapezoidal deck with suspended ceiling below formed from 2 x 12.5 mm SoundBloc (or equivalent) on resilient hangers with 50 mm mineral fibre insulation within a 100 mm ceiling void.

20 KENNEDY STREET, LEVEL 1 EVENT SPACE

Floor construction options

Possible options for the separating floor construction between the Level 1 Event Space and Level 2 Guestrooms are provided in Table 10-8.

Options are based on a minimum overall construction zone of 450 mm. Where the material forming the feature ceiling has mass per unit area of at least 10 kg/m², one layer of plasterboard from the example ceiling constructions could be omitted.

Table 10-8 - Possible options for floor between Level 1 Event Space and Level 2 Guestrooms

Option	Floor slab	Ceiling/ Floor	Expected maximum operational noise limits in Event Space*	Comment
1	250 mm concrete (≥ 2200 kg/m ³) on re-entrant deck	2 x 15 mm dense plasterboard (SoundBloc or equivalent) on resilient hangers with 100 mm mineral fibre insulation (30-60 kg/m ³) above. Ceiling void to be at least 150 mm.	L_{Aeq} 95-100 dB L_{eq} 85-90 dB at 63 Hz & 125 Hz	Where thinner slabs are used, the ceiling void increases to minimise the reduction in performance at low frequencies. To maximise the performance at low frequencies and provide greatest flexibility, Option 1 or 4 are the preferred solutions in terms of acoustics. With all options the operational limits are expected to be suitable for events with amplified music (e.g. wedding DJ). However, where events have live bands, the 'bass thump' from live drums and bass guitar may be audible in the rooms above.
2	200 mm concrete (≥ 2200 kg/m ³) on re-entrant deck	2 x 15 mm dense plasterboard (SoundBloc or equivalent) on resilient hangers with 100 mm mineral fibre insulation (30-60 kg/m ³) above. Ceiling void to be at least 200 mm.		
3	160 mm concrete (≥ 2200 kg/m ³) on re-entrant deck	2 x 15 mm dense plasterboard (SoundBloc or equivalent) on resilient hangers with 100 mm mineral fibre insulation (30-60 kg/m ³) above. Ceiling void to be at least 250 mm.		
4	250 mm concrete (≥ 2200 kg/m ³) on re-entrant deck	Lightweight floating floor consisting of 1 x 18 mm timber flooring board plus 1 x 19 mm Gyproc plank (or equivalent) on resilient cradle and batten system to create minimum 100 mm floor void with 50 mm mineral fibre within the void (30-60 kg/m ³).		

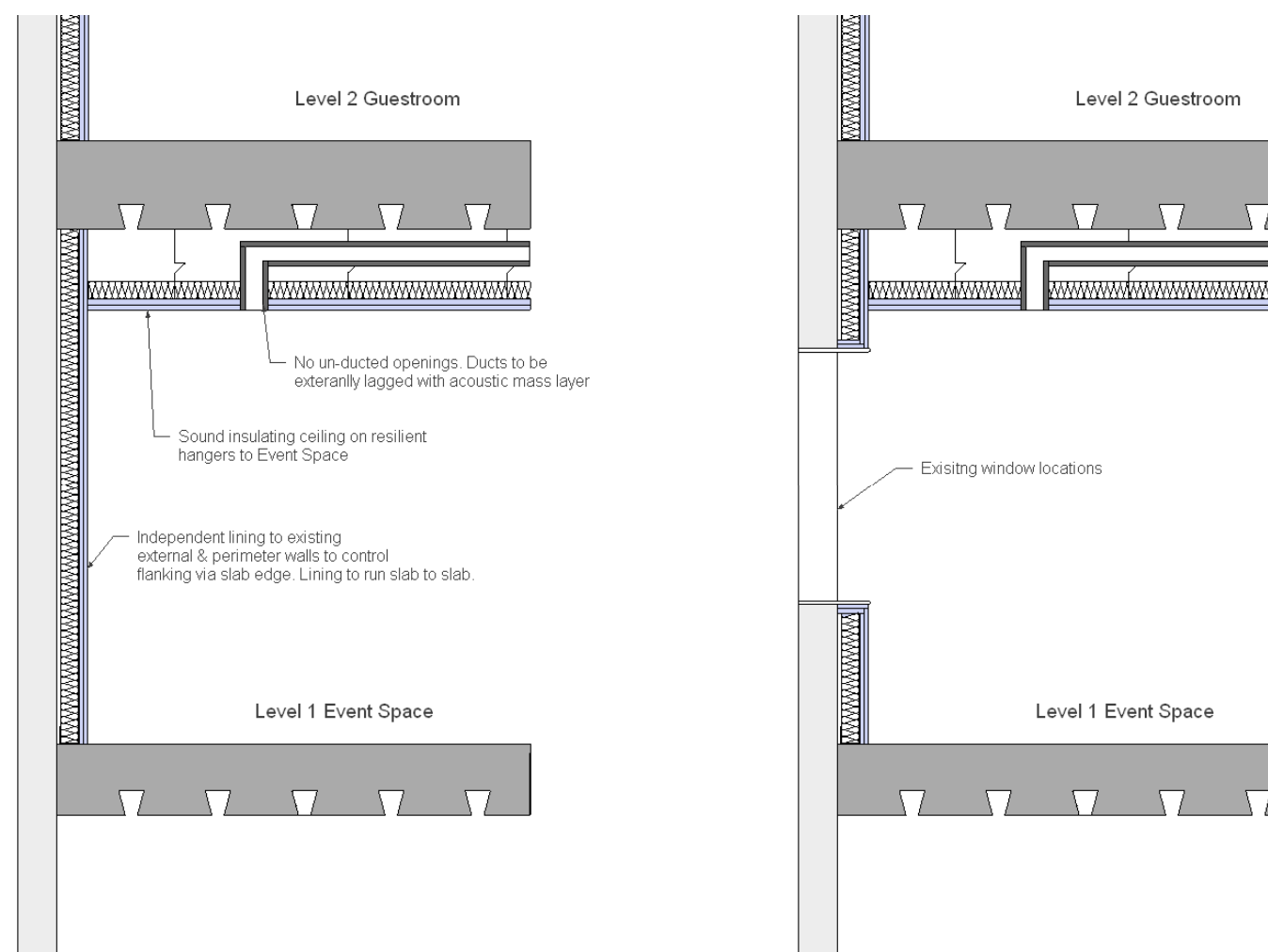
Building services Routing with Event Space Ceiling Void

Ideally, where a ceiling is relied upon for sound insulation reasons, this should be located above any building services, to minimise any penetrations to it. However, it is appreciated that space restrictions mean it is not possible in this instance. As a result, there can be no un-ducted connections within the suspended ceiling (e.g. open return air grilles) and all ductwork will need to be externally lagged with an acoustic lagging containing a mass layer $\geq 10 \text{ kg/m}^2$ (e.g. 25 mm Muftilag). This increase the overall dimensions of the ductwork by 50 mm (i.e. 25 mm on all sides).

Interface with perimeter walls

Where the separating floor abuts the existing external and perimeter walls, an independent lining should be allowed for to control flanking sound transmission via this route. The lining should be built slab to slab and be formed from 2 x 12.5 mm plasterboard on an independent stud (no connections to external wall) with 25 mm mineral fibre insulation in the cavity. A minimum 85 mm zone should be allowed for to accommodate this.

Figure 10-3 - Indicative details of independent lining to Event Space & Guestroom



20 KENNEDY STREET, FLOORS BETWEEN GUESTROOMS

Building services strategy

As the ceiling is not relied upon to maintain the sound insulation performance, it is possible to have un-ducted return air paths within the ceiling.

Interface with perimeter walls

Where the separating floor abuts the existing external and perimeter walls, an independent lining should be allowed for to control flanking sound transmission via this route. The lining should be built slab to slab and be formed from 2 x 12.5 mm plasterboard on an independent stud (no connections to external wall) with 25 mm mineral fibre insulation in the cavity. A minimum 85 mm zone should be allowed for to accommodate this.

24 KENNEDY STREET IMMERSIVE MEDIA

Within the Immersive Media room, building services, including FCUs should ideally be located below the sound insulating ceiling. Where this is not possible due to space restrictions all discharge and return air paths will need to be ducted. In addition, all ductwork will need to be externally lagged with an acoustic lagging containing a mass layer $\geq 10 \text{ kg/m}^2$ (e.g. 25 mm Muftilag). This increase the overall dimensions of the ductwork by 50 mm (i.e. 25 mm on all sides).

IMPACT SOUND INSULATION

16 Kennedy Street

To control impact sound to spaces below (e.g. footfall, furniture movements) it is recommended that one of the following options is provided to floors above meeting rooms, offices, training/theory studios and staff lounge:

- i Carpet floor covering OR;
- i Resilient layer below non-carpet finish (typically 3-5 mm) with a minimum ΔL_w 17 dB when measured in combination with the proposed floor finish.

20 Kennedy Street

Floor finishes, including any resilient layers below should be selected to be capable of controlling impact sound to Guestrooms below to $\leq L'_{nT,w} \leq 59 \text{ dB}$. Based on the floor construction currently proposed, one of the following options should be adopted to be capable of meeting the criterion:

- i Carpet floor covering OR;
- i Resilient layer below non-carpet finish (typically 3-5 mm) with a minimum ΔL_w 17 dB when measured in combination with the proposed floor finish.

The impact sound insulation criterion applies where the roof terrace is located over Level 3 Guestrooms. It is recommended that an allowance is made to incorporate a resilient layer below the final terrace finishes. This should be selected to provide a minimum ΔL_w 17 dB when measured in combination with the proposed finish. Alternatively, where the terrace build-up

incorporates thermal insulation below the finishes, in combination with the concrete slab it is expected to be capable of controlling impact sound to below.

24 Kennedy Street

As 24 Kennedy Street is to be considered as a single occupancy dwelling, there are no statutory impact sound insulation criteria to be met. However, to help control impact sound (e.g. footfall, furniture movements) to bedrooms and the Immersive Media, it is recommended that one of the options given for 16 or 20 Kennedy Street is provided to the floor of the spaces above.

10.7 ACOUSTIC FINISHES

GENERAL GUIDANCE

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 is rated in terms of the Weighted Absorption Coefficient, α_w , in accordance with BS EN ISO 11654:1997 Acoustics-Sound absorbers for use in buildings- Rating of sound absorption or it is given a absorption class (A-E). The Weighted Absorption Coefficient varies from $\alpha_w=0.0$ (for minimal absorption) to $\alpha_w=1.0$ (for very effective absorption). Generally, most proprietary absorbent treatments have α_w values between 0.60 (Class C) and 0.95 (Class A).

Initial guidance is provided below on finishes options, though the exact performance and area of treatment will depend on the final finishes selections.

16 KENNEDY STREET

Training Studios

The current proposal is for the training studios to be used as an ESPA training space, to train beauty technicians in different therapies (facials, massage, etc). As a result, the finishes in these spaces are likely to be hard and reflective.

Provision of sound absorbent treatment within the space has the benefit of helping to reduce reverberant noise build-up and aid speech intelligibility. This could be in the form of a sound absorbent ceiling/ rafts or incorporated behind any artwork on the walls. However, given the size of the spaces and likely occupancy levels, the spaces could still function without any treatment.

Meeting rooms

Within meeting rooms it is recommended that an allowance is made for a carpet floor covering along with a Class C sound absorbent ceiling. In addition, if the space will be used for AV presentations or video-conferencing, it is advised that sound absorbent treatment is allowed for on two adjacent walls also. This treatment should ideally be located from seated head height to standing height. When joining a meeting virtually, if the space is very reverberant it can be difficult for the person listening remotely to hear clearly what is being said. Provision of the sound absorbent wall treatment will help minimise this risk.

Office

Within the office a carpet floor covering is recommended along with sound absorbent treatment to the soffit. This could either be as a suspended ceiling, or suspended sound absorbent rafts. If rafts are used, they should ideally be located over desks/groups of desks.

20 KENNEDY STREET

Guestroom corridors

Requirement E3 requires that where common areas provide direct access rooms for residential purposes they shall be designed and constructed in such a way as to prevent more reverberation around the common areas than is reasonable. There are two ways of complying with Requirement E3, Method A and Method B, both are summarised below.

Method A – this is the simplest way to comply with requirement E3. It states that for corridors or hallways, an area equal to or greater than that of the floor should be covered with an absorber achieving a Class C rating. This method can generally be satisfied by installing proprietary acoustic ceilings.

Method B – this method considers the contribution to absorption in the space from all proposed surface elements. In most cases this method allows greater flexibility in meeting requirement E3 and less additional absorption than for Method A.

Requirement E3 applies to circulation spaces providing direct access to all guestrooms.

Ground floor restaurant/café

The provision of sound absorbent treatment will help control reverberant noise build-up within the ground floor restaurant/café, however, the amount of absorption provided within the space will depend on the interior design and the desired atmosphere.

If the majority of surfaces are hard (e.g. timber floor, plastered soffit, hard furnishings) the space will have a canteen style feel and be quite 'lively' and reverberant.

For a more intimate atmosphere or traditional 'fine dining' absorption should be provided to the space. This could be by the use of sound absorbent treatment to the soffit (ceiling, rafts or baffles), sound absorbent panels on the wall or inclusion of drapes, and the use of soft furnishings.

Level 1 Event Space

Similarly to the ground floor restaurant, providing absorption within the L1 Event Space will help control reverberant noise build-up. If the space may be used for speech (e.g. conferences) then the provision of sound absorbent treatment to the soffit and perimeter walls will help reduce unwanted reflections between parallel reflective surfaces.

As an initial guide a reverberation time of around 1.5 s should be targeted, though this will need to be reviewed in relation to the interior design to see where absorption could be incorporated into the design.

24 KENNEDY STREET

Circulation areas

Provision of sound absorbent finishes will help control reverberant noise build up and where the stairwell is open to floors, will provide some benefit in reducing sound transfer between floors.

For hotels, where circulation spaces provide direct access to guestrooms ADE 2003 requires that a Class C sound absorbent ceiling be provided. This would be beneficial for the proposed bedrooms at Kennedy Street also, though would need to be reviewed with the proposed interior design.

Lounges

There is no requirement under ADE 2003 to provide sound absorbent treatment in communal amenity spaces. Though providing sound absorbent treatment to the soffit and/or walls would be beneficial in terms of controlling reverberant noise build-up within the lounges, if it is not provided (e.g. due to the interior design), it is acceptable in terms of acoustics and would be similar to a typical living-room space.

Event Lounge/space

To help control reverberant noise build-up within the event space it would be beneficial to provide sound absorbent treatment in the space. One option to do this is to provide a sound absorbent ceiling. Alternatively, suspended rafts, baffles and wall panels/ drapes could be considered.

Immersive Media

The fitout of this space is a specialist design. It is understood that projection screens will be located on all available wall area, positioned as close to the perimeter walls as possible.

As the space may have high levels of amplified sound it is recommended that the following finishes are considered:

- i Class A sound absorbent ceiling treatment
- i Fabric upholstered seating
- i Carpet floor covering.

10.8 BUILDING SERVICES

INTERNAL NOISE CRITERIA

Based on the proposed uses, it is recommended that noise from building services does not exceed the levels in Table 10-9.

Table 10-9 - Recommended internal ambient noise levels from building services

Internal space	Recommended maximum internal level due to building services
20 KS Guestrooms, 24 KS Bedrooms	NR 25 (MVHR units) NR 30 (FCUs) see note below regarding mechanical cooling
Immersive Media (excluding noise from projector fan)	NR 25 (MVHR units) NR 30 (FCUs) excludes noise from projector fan
24 KS Level 3 Master Lounge	NR 35
24 KS Level 1 Guest Kitchen	NR 35
Meeting rooms, training studios	NR 35
Office, staff lounge, Restaurant/ Café, Dining & Kitchen	NR 40
Level 4/Roof Event Space/Lounge	NR 40
WCs, changing	NR 45
Kitchen/BOH	NR 45

Ideally internal noise levels within bedrooms should be limited to no more than NR 25 to minimise the risk of disturbance. However, given the large areas of glazing to the façade this limit may be difficult to achieve from the FCUs located in the rooms. Therefore a higher limit of NR 30 is proposed. This is the strategy that has been adopted at Great John Street Hotel.

LIFT NOISE LIMITS GUIDANCE

The following noise limits apply during any part of the lift cycle or operation:

- i L_{AFmax} 55 dB in lift cars
- i L_{AFmax} 65 dB in cars for announcement and arrival gongs
- i L_{AFmax} 55 dB into lift lobbies
- i L_{AFmax} 25 dB into bedrooms
- i L_{AFmax} 35 dB into any other occupied spaces.

GUIDANCE ON SERVICE ROUTES

Where building services pass out of plantrooms or through separating elements (walls, floors, ceilings, etc) care should be taken to avoid the sound insulation performance being compromised.

Holes to accommodate services (ducts, pipes, conduit, etc) should be designed to be as small as possible.

Where services pass through twin or staggered stud constructions a resilient connector should be provided to avoid the cavity between the two leaves being bridged.

Wherever possible, services shall be routed along corridors and enter rooms above doors. No services should pass through party walls between guestrooms.

Where ducts pass through sound insulating elements, cross-talk attenuators may be required to maintain the specified sound insulation performance. This will be reviewed as the design develops.

Where service penetrations need to occur through sound insulating structures, they will need to be acoustically sealed. These will be reviewed as the design develops.

20 Kennedy Street

Refer to Section 10.6 regarding external lagging to ductwork and building services strategy within the Level 1 Event Space ceiling void at 20 Kennedy Street.

24 Kennedy Street

Refer to Section 10.6 regarding external lagging to ductwork and location of building services within the Immersive Media Room at 24 Kennedy Street.

CROSS-TALK ATTENUATORS

Where guestrooms or other noise sensitive spaces (e.g. meeting rooms) are served by common ductwork, an allowance should be made for cross-talk attenuators to be provided so that the overall room-to-room sound insulation performance is not compromised.

Based on the WSP MEP drawings, mark-ups are provided in the appendix of the locations of cross-talk attenuators. As a minimum 600 mm long attenuators should be allowed for. Minimum dynamic insertion loss performances shall be provided once duct sizes and routes are finalised.

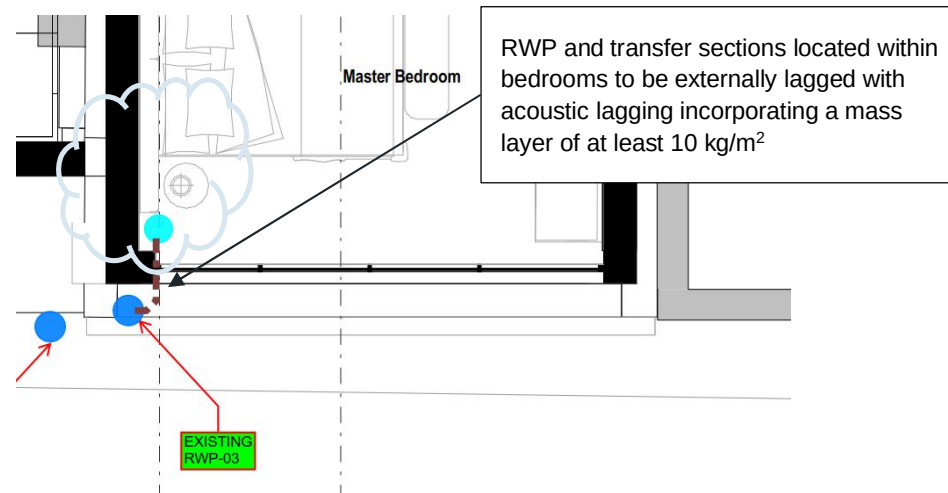
PLUMBING

Rainwater drainage pipework and other drainage routes should be located within self-contained risers where possible. Drainage routes are not to be located within guestroom bedrooms.

From the MEP WIP drainage stacking drawings it appears that there is a RWP dropping into the ceiling void of the Level 3 Master Bedroom with a short transfer section to an existing external RWP. Ideally, drainage routes should not be routed through bedrooms. However, if this is unavoidable it is advised that an allowance is made to externally lag the drainage pipework with a ≥ 25 mm product which incorporates a mass layer of at least 10 kg/m² (e.g. Muftilag). The ceiling it is located above should be formed from 2 layers of board as per Table 10-7.

This guidance applies to any horizontal drainage routes that occur with the bedrooms of 20 Kennedy Street also.

Figure 10-4 - Excerpt from drainage stacking WIP drawing for 24 Kennedy Street



Siphonic systems should be avoided wherever possible. If they are used they will need to be externally lagged and independently boxed in to reduce noise break-out. The precise measures require would depend on a number of factors, including the type of pipework and the location, and would need to be developed at the design progresses.

Horizontal transfers of pipework should be avoided, particularly above guestrooms, as there is a considerable risk that noise will be audible due to the abrupt change in direction of water and waste. Where it is unavoidable, the pipework will need to be lagged and boxed in, and the following measures are also recommended:

- § Acoustically seal pipe penetrations at floor slab using flexible fire-stopping to ensure no direct contact between pipe and floor
- § Fix pipework only to floor slab using resilient fixings
- § Use 2 x 45 degree bends rather than a single 90 degree bend to smooth the transmission and reduce turbulence.

SOCKETS, SWITCHES AND FITTINGS

Where sockets, switches and fittings are recessed, they will need to be fitted with appropriate acoustic backing boxes so that the sound insulation performance is not compromised

In drywalls, recessed sockets and switches should not be back-to-back and should be staggered at least 600 mm.

FAN COIL UNITS

The following guidance regarding fan coil units should be considered:

- ! They should be selected to achieve a noise rating (NR) at least 3 dB lower than the room limit
- ! They should not be in contact with the ceiling or any partitions
- ! They should be hung from the soffit using manufacturer approved anti-vibration mounts
- ! All flexible ducting to be acoustic flex duct.

For rooms where building services noise limits are NR 35 or lower it is unlikely that cassette or wall mounted units will comply with building services noise limit and should be avoided where possible. For these spaces the following acoustic treatments are likely to be required:

- ! Fan coil units should be installed in ceiling voids
- ! An allowance should be made for at least 500 mm acoustic flexible duct to connect the discharge to an acoustically lined sheet metal plenum box.
- ! Attenuation should be allowed for to the intake
- ! Any downlights in the immediate vicinity of the FCU should be fixed head type
- ! Grilles should be low noise grilles (i.e. low velocity not jet type grilles)

If the FCU within the 24KS basement studio bedroom is to be wall mounted rather than in the ceiling, the attenuation measures for the intake and discharge will need to be reviewed.

MVHRS

The WSP MEP WIP drawings show both room-side and atmosphere side attenuators to the MVHRs which works well in terms of acoustics. The minimum performances for the attenuators will be reviewed as details of the MVHR selections become available. However, based on experience on other projects 600 mm long attenuators are expected to be sufficient.

SUBSTATION

The substation, as well as cables and other associated equipment will need to be effectively isolated from the building structure to minimise the risk of structure borne noise. They should incorporate isolation mounts which are effective at frequencies of 50 Hz and above. All equipment and cables directly connected to the substation should be supported from the slab beneath the unit and not from the walls or level 1 slab above.

EXTERNAL BUILDING SERVICES CRITERIA

Normally operating plant

Manchester City Council requires the following in relation to noise from any external plant:

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 5 dB (L_{Aeq}) below the typical background (L_{A90}) level at the nearest noise sensitive location.

An environmental noise surveys have been undertaken at Kennedy Street and King Street Town House to determine the existing background noise level (L_{A90}) to set appropriate plant noise limits for the scheme and support the planning application.

Based on the measured representative background sound levels, the resultant rating level from building services plant associated with the development should not exceed the limits Table 10-10 at the nearest noise sensitive receptors. The nearest noise sensitive receptor is considered to be King Street Town House, opposite the site on Kennedy Street.

To the rear of the site on Bow Lane, are existing offices. Limits for external plant at this receptor based on the results of the survey at 24 Kennedy Street are also provided.

These limits are cumulative and include contribution from all plant associated with 16-24 Kennedy Street.

An initial review of external plant will be undertaken once preliminary selection data and locations are known and guidance on possible attenuation measures will be provided where required.

Table 10-10 - Rating noise level limits for external plant, 1m from noise sensitive receptor

NSR location	Period	Maximum rating noise level from external plant, 1m from façade of nearest noise sensitive receptor $L_{Ar, Tr}$ (dB)
Kennedy Street	Daytime (07:00-23:00)	48
	Night-time (23:00-07:00)	47
Bow Lane	Daytime (07:00-23:00)	49
	Night-time (23:00-07:00)	49

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.

Noise from any rooftop units will also need to be reviewed in relation to any opening rooflights/retractable roofs. From drawing *THG-WSP-KS-RF-DR-M-500101-P01* it is noted that there are currently 7 condensers proposed on the roof of 20 Kennedy Street, along with 2 extract fans. Once preliminary selections for these units are available, a review of the expected resultant noise levels will be carried out and assessed against the criteria to highlight if any attenuation measures are required.

Emergency plant noise limits

For emergency plant items, that will only operate outside an emergency for short periods to be tested, a higher noise limit is typically permitted. It is understood that MCC permit a level 10 dB above the existing background sound level (L_{A90}) at the nearest noise sensitive location.

Therefore, the rating noise level for emergency plant should not be more than 15 dB higher than the limits in Table 10-10.

Building Services Anti-Vibration

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 levels in all locations outside of plant rooms or decks shall not exceed the following criteria:

- i Exceed a Vibration Dose Value (VDV) of $0.1 \text{ m/s}^{1.75}$ as given in BS 6472-1:2008 within guestrooms or bedrooms and $0.4 \text{ m/s}^{1.75}$ in all other areas;
- i Be of a magnitude which causes the maximum noise criteria to be exceeded as set out in Table 10-9.

Some typical vibration isolation measures for building services plant to be considered at this stage are included in Table 10-11.

Table 10-11 - Typical vibration isolation for building services plant

Plant Type	Typical Anti Vibration Mount Requirement	Other Measures
Air Handling Plant / Fans	Spring isolation mounts	Flexible duct connections on supply and extract ducts
Pumps	Concrete inertia bases on spring mounts	Flexible connections to pipework
Chillers / Coolers	Restrained spring mounts on rubber isolator	Flexible connections to unit

AIR HANDLING UNITS

The following guidance regarding AHUs should be considered:

- i Casing breakout should be kept low
- i Fans should be selected to run at low speed and isolated from the AHU casing

- i The air distribution system should be designed to minimise flow resistance and turbulence
- i Acoustic flex duct should be used where flexible ducting is required
- i Attenuators are required to the intake, supply, extract and exhaust ducts. 900 mm should be allowed for at this stage, but this will be reviewed as the design is developed
- i Secondary attenuation should be allowed for where building services noise limits are NR 30 or below.

SUPPLY AND EXTRACT FANS

It is recommended that 1200 mm long splitter type attenuators are allowed for to both sides of any fan.

AIR SPEEDS

To minimise regenerated noise in ductwork, air velocities in ducts should generally be kept as low as possible throughout the system. Table 10-12, includes guidance on airflow velocities through ducts and Table 10-13 includes guidance on airflow velocities at supply and return air openings.

Table 10-12 - Maximum recommended in-duct airflow velocities

Duct location	NR limit	Maximum airflow velocity (m/s)					
		Rectangular duct			Circular duct		
		Main duct	Branch duct	Final runouts	Main duct	Branch duct	Final runouts
In shaft or above dry wall ceiling	45	17.8	14.2	8.9	25.4	20.3	12.7
	40	15.3	12.2	7.6	21.6	17.3	10.8
	35	12.7	10.2	6.4	17.8	14.2	8.9
	30	10.7	8.5	5.3	15.3	12.2	7.6
	25	8.6	6.9	4.3	12.7	10.2	6.4
Above suspended ceiling	45	12.7	10.2	6.4	22.9	18.3	11.5
	40	10.8	8.6	5.4	19.1	15.2	9.5
	35	8.9	7.1	4.5	15.2	12.2	7.6
	30	7.5	6.0	3.8	12.7	10.2	6.4
	25	6.1	4.9	3.1	10.2	8.2	5.1
Duct in occupied space	45	10.2	8.2	5.1	19.8	15.8	9.9
	40	8.8	7.0	4.4	16.5	13.2	8.3
	35	7.4	5.9	3.7	13.2	10.6	6.6

Duct location	NR limit	Maximum airflow velocity (m/s)					
		Rectangular duct			Circular duct		
		Main duct	Branch duct	Final runouts	Main duct	Branch duct	Final runouts
	30	6.1	4.9	3.1	10.9	8.7	5.5
	25	4.8	3.8	2.4	8.6	6.9	4.3

Table 10-13 - Maximum airflow velocities at supply and return air openings

Opening	NR	Maximum airflow velocity (m/s)
Supply air outlet	45	3.2
	40	2.8
	35	2.5
	30	2.2
	25	1.8
Return air opening	45	3.8
	40	3.4
	35	3
	30	2.5
	25	2.2