

Rusupo Ltd

Manchester Airport Plot H3 - Tribe Hotel

Stage 4 Acoustic Technical Design



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Contents

1	Introduction	1
2	Design Criteria	2
2.1	Building Regulations - Approved Document E	2
2.2	Brand Standards – Tribe Hotels: Construction and Renovation Guideline (ver.01)	3
2.3	BREEAM New Construction 2018.....	5
2.4	British Standard 4142:2014 Method for Rating and Assessing Industrial and Commercial Sound	6
3	External Building Fabric Assessment	8
3.1	Overview.....	8
3.2	Ventilation Acoustic Requirements	8
3.3	Building Envelope Sound Reduction Requirements – Hotel Guestrooms.....	9
3.4	Building Envelope Sound Reduction Requirements – Other Areas	10
3.5	Building Envelope Sound Reduction Requirements – External Wall Plant Area Level 8	11
3.6	Building Envelope Sound Reduction – North Façade Upper Floors, Level 06 to Level 08.....	11
3.7	Building Envelope Sound Reduction – Level 9 Roof External Plant.....	12
3.8	Building Envelope Sound Reduction – Level 8 Roof External Plant.....	12
4	Internal Building Fabric Assessment.....	14
4.1	Wall Sound Insulation between Guestrooms.....	14
4.2	Wall Sound Insulation within Guestrooms	15
4.3	Wall Sound Insulation between Other Areas	16
4.4	Floor Sound Insulation between Hotel Rooms	22
4.5	Floor Sound Insulation between Other Areas.....	23
4.6	Guestrooms Door Sound Insulation.....	28
4.7	Control of Flanking Transmission	29
4.8	Penetrations.....	30
4.9	Lift Noise	33
4.10	Control of Reverberation	34
5	Building Services Acoustic Design	38
5.1	External Sound Level Criteria	38
5.2	Noise Sensitive Locations	38
5.3	Building Services Overview	38
5.4	Calculation of Noise Levels at Noise Sensitive Receptors	42
5.5	General Mitigation Guidance	44
5.6	Services Distribution	46
5.7	Cross Talk Attenuation	46
6	Conclusion	47

Appendix A - Glossary of Acoustic Terminology

Appendix B - Standard Penetration Details

1 Introduction

MLM Consulting Engineers Limited has been commissioned by Rusupo Limited, to provide an acoustic technical design for the proposed development at Plot H3 Manchester Airport. An assessment of current construction proposals for the proposed hotel development has been undertaken, in terms of their ability to achieve compliance with Part E of the Building Regulations, the targeted BREEAM credits and the Brand Standards.

The proposed development includes the construction of a nine storey Accor Tribe Hotel with 412 guestrooms, in addition to plant, back-of-house and associated ancillary spaces.

Accordingly, this report presents appropriate acoustic design criteria for the various areas of the development and, based upon the latest Dexter Moren Associates Ltd proposals, provides an assessment of the ability of the scheme to satisfy these requirements. Where the assessment indicates the currently proposed scheme is unlikely to achieve compliance with the required performance levels, alternative solutions are proposed.

This report may also assist in informing external parties, including the Local Planning Authority and Building Control of the approach to address acoustics and noise control.

Whilst every effort has been made to ensure that this report is easily understood, it is technical in nature; a Glossary of Terms is included in Appendix A to assist the reader.

2 Design Criteria

2.1 Building Regulations - Approved Document E

2.1.1 Sound Insulation – Separating Walls and Floors

The requirements under the 2003 Part E of the Building Regulations are as follows:

- E1. Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that they provide reasonable resistance to sound from other parts of the same building and from adjoining buildings.
- E2. Dwelling-houses, flats and rooms for residential purposes shall be designed and constructed in such a way that (a) internal walls between a bedroom or a room containing a water closet and other rooms and (b) internal floors, provide reasonable resistance to sound. This requirement does not apply to internal walls containing doors, to internal walls separating en suite toilets from the associated bedrooms or existing walls and floors in a building subject to a material change of use.
- E3. The common parts of buildings which contain flats and rooms for residential purposes shall be designed and constructed in such a way as to prevent more reverberation around the common parts than is reasonable.

The performance standards defining “reasonable resistance to sound” are quantified in Approved Document E. These numerical standards are listed in Table 1 below. For this project Requirements E1, E2 and E3 apply. The following numerical performance standards apply to the residential element of the proposed development:

Table 1: Numeric Performance Standards			
		Airborne standard $D_{nT,w} + C_{tr}$ dB	Impact standard $L'_{nT,w}$ dB
Purpose built rooms for residential purposes	Walls	≥ 43	-
	Floors and stairs	≥ 45	≤ 62

Please note, in addition to the above performance standards, Approved Document E of the Building Regulations also suggests that these standards are appropriate for separating walls and floors used for normal domestic purposes. It goes on to suggest that a higher standard of sound insulation may be required between spaces used for normal domestic purposes and communal or non-domestic purposes. In these circumstances, the appropriate level of sound insulation will depend upon the noise generated in the communal or non-domestic space.

2.1.2 Internal Floors and Walls

Approved Document E also sets a minimum performance requirement of 40 dB R_w for internal walls surrounding bedrooms and internal partitions surrounding WCs. It should be noted that the 40 dB R_w criterion is a laboratory rating only and cannot be measured on-site. It should also be noted that this criterion specifically does not apply to any walls containing doors or to walls between en-suite bathrooms and the associated bedroom.

2.1.3 Reverberation in Common Parts

This requirement only applies to corridors, stairwells, hallways and entrance halls which give access to the flats or rooms for residential purposes.

2.2 Brand Standards – Tribe Hotels: Construction and Renovation Guideline (ver.01)

The specific acoustic performance requirements for the Accor Hotels are set in the 'Construction and Renovation Guidelines (ver.01)'. The relevant acoustic performance standards for the proposed hotel are summarised below.

2.2.1 Internal Ambient Noise Levels

The required internal ambient noise levels to be achieved are presented in the Table below. The requirements for building envelope sound reduction are determined by assessing the existing external noise levels and calculating the level of mitigation required to achieve the internal ambient noise level requirements.

Table 2: Tribe External Noise Intrusion Limits		
Application	External Noise Intrusion Levels to be Achieved	
Guestrooms (Airborne)	30dB $L_{A10,10mins}$	35dB $L_{A01,10mins}$
Meeting Break Area, Restaurant, Bar, Reception, Indoor Pool	40dB $L_{A10,10mins}$	50dB $L_{A01,10mins}$
Fitness Room	35dB $L_{A10,10mins}$	45dB $L_{A01,10mins}$
Administrative offices, staff rest room and canteens	35dB $L_{A10,10mins}$	40dB $L_{A01,10mins}$

It is assumed that there will not be any events in the Tribe Hotel that will comprise noisy events such as musical entertainment or live matches.

The requirements governing internal plant noise levels are as follows:

Table 3: Tribe Building Services Noise Limits		
Application	Building Services Noise Levels to be Achieved	
Guestrooms	Low Speed: 28 dBA L_{eq} (Approximately NR22)	Medium Speed: 31 dBA L_{eq} (Approximately NR25)
Guestrooms (lift noise)	25 dBA L_{eq}	NR20
Guestrooms (plant noise intrusion)	22 dBA L_{eq}	NR17
Guestrooms (evacuation pipes)	28 dB L_{Amax}	
Breakout Area, Restaurant, Bar, Reception, Staff Rest & Canteen	35 dB L_{eq}	NR30
Restaurant, Bar, Reception (evacuation pipes)	35 dB L_{Amax}	
Kitchen	45 dB L_{eq} - 55 dB L_{eq} with extractor in Operation	NR40 – NR50 with extractor in Operation
Offices	30 dBA L_{eq}	NR30

2.2.2 Internal Sound Insulation

The requirements governing internal airborne sound insulation are as follows:

Table 4: Tribe Internal airborne Sound Insulation Requirements		
Source Room	Receiving Room	Sound Reduction Requirement
Guestroom (including Bathroom)	Guestroom (Including Bathroom)	51dB $D_{nT,w} + C$
Corridor	Guestroom	43dB $D_{nT,w} + C$
Corridor	Bathroom	45dB $D_{nT,w} + C$
Restaurant, Bar, Reception, Kitchen, bin room, staff canteen, cloakrooms, laundry	Guestroom	56dB $D_{nT,w} + C$
Air Cond and Ventilation Area, LV Switch Room	Guestroom	60dB $D_{nT,w} + C$ ($D \geq 41$ dB @ 125-250Hz)
Lift Machinery, Chiller Room, Boiler Room, Heat Pump	Guestroom	60dB $D_{nT,w} + C$ ($D \geq 45$ dB @ 125-250Hz)
Fitness Room	Guestroom	60dB $D_{nT,w} + C$
Public Toilet	Public Toilet	40dB $D_{nT,w} + C$

It is assumed that there will not be HI-FI systems and or TV home cinemas in the guestrooms. Also there will be no potential acoustic weak spots in separating walls between bedrooms (eg sockets incorporated into the separating wall between guestrooms).

Floors shall be constructed so as not to exceed the following maximum standardised impact sound levels in the rooms listed in Table 5 below.

Table 5: Tribe Internal Impact Sound Insulation Requirements		
Source Room	Receiving Room	Sound Reduction Requirement
Guestroom	Guestroom	50dB L'_{nTw}
Corridor	Guestroom	50dB L'_{nTw}
Restaurant, Bar, Reception	Guestroom	35dB L'_{nTw}
Kitchen, bin room, staff canteen	Guestroom	32dB L'_{nTw}

It is noted that the impact sound insulation requirement between guestrooms and restaurant, bar and reception areas; and kitchen, bin room and staff canteen are understood to apply when these areas are above guestrooms, which is not the case in the current proposals.

2.2.3 Reverberation Times

The Tribe Brand Standards for reverberation time are presented in the Table below.

Table 6: Tribe Reverberation Time Requirements

Application	Reverberation Time (seconds)
Corridor Leading to Bedrooms	65% Ceiling coverage $a_w \geq 0.75$
Restaurant, Bar, Reception	$0.6s \leq RT \leq 0.8s$ (T_{mf})
Kitchen, Staff Rest and Canteen	100% Ceiling coverage $a_w \geq 0.8$

2.3 BREEAM New Construction 2018

2.3.1 Hea05 Acoustic Performance

Four credits are available under the Hea05 category for Residential Institutions. These concern sound insulation, internal ambient noise levels and reverberation time.

The requirements state the following regarding how the credits may be achieved:

“Where a suitably qualified Acoustician is appointed to define a bespoke set of performance requirements for all function areas in the building using the three acoustic principles defined in criterion 1, setting out the performance requirements for each and the testing regime required.”

It is understood that 2 credits are targeted under the Hea05 category for this development. It has been agreed to focus on the credits related to internal ambient noise levels and sound insulation, with a maximum of 3 credits available.

Internal Ambient Noise Levels (Guestrooms)

Indoor Ambient Noise levels as given in Section 7 of BS8233:2014 are the requirements applicable to the development; to be achieved to gain the BREEAM one credit available.

The indoor ambient noise levels in residential dwellings or rooms for residential purposes should typically comply with the guidelines given in WHO/BS8233. These guidelines recommend an indoor ambient noise level target in bedrooms of 35 dB L_{Aeq} during the day and 30 dB L_{Aeq} during the night, with maximum noise levels not normally exceeding 45 dB L_{Amax} (typically no more than 10-15 times per night). The Accor Tribe Brand Standards based on L_{A10} and L_{A1} levels during the noisiest 10-minute period are more restrictive, and therefore no further assessment of ambient noise L_{Aeq} or typical maximum noise L_{Amax} is required.

The scheme is to be designed to achieve compliance with the Tribe Brand Standards for internal ambient noise levels as set out in Tables 2 and 3 of this report. As explained above, the Tribe Brand Standards are more onerous, and therefore it is deemed appropriate to use the Brand Standards as the bespoke set of performance requirements in this instance.

Internal Ambient Noise Levels (Areas other than Guestrooms)

The scheme is to be designed to achieve compliance with the Tribe Brand Standards for internal ambient noise levels as set out in Tables 2 and 3 of this report. It is deemed appropriate to use the Brand Standards as the bespoke set of performance requirements in this instance.

Sound Insulation (Guestrooms)

There are sound insulation requirements applicable to the development; to be achieved to gain the BREEAM two credits available.

The requirements for the rooms for residential purposes (guestrooms), and are expressed as an enhancement over the Building Regulation requirements. Two credits are targeted in this instance meaning a 5dB enhancement is sought. The resulting sound insulation requirements are presented in Table 7.

Table 7: BREEAM Sound Insulation Requirements (Hotel Guestrooms)

		Airborne standard $D_{nT,w} + C_{tr}$ dB	Impact standard $L'_{nT,w}$ dB
Purpose built rooms for residential purposes	Walls	≥ 48	-
	Floors and stairs	≥ 50	≤ 57

Sound Insulation (Areas other than Guestrooms)

For sound insulation between 'other rooms', a bespoke set of requirements is required. Generally, as with the internal ambient noise level requirements, it is deemed appropriate to use the Brand Standards as the bespoke set of performance requirements in this instance; these are shown in Table 4. In certain cases, such as for the floors performance, alternative requirements are proposed in Sections 4.3 and 4.5.

2.3.2 Pol05 Reduction of Noise Pollution

One credit is available under the Pol05 requirements which is as follows:

A noise assessment compliant with BS4142:2014 should be undertaken in order to calculate the noise rating level from the assessed building.

The noise level from the proposed building, as measured in the locality of the nearest or most exposed noise-sensitive development, must be at least 5 dB lower than the background noise throughout the day and night.

2.3.3 BREEAM Confirmations

It is confirmed that the author of this report is a member of the Institute of Acoustics (IOA), is a practicing acoustic consultant and has worked on the acoustic design of numerous hotel projects, which fulfils the requirement of a 'suitably qualified acoustician' as defined by the BRE.

2.4 British Standard 4142:2014 Method for Rating and Assessing Industrial and Commercial Sound

BS4142 describes the method for assessing whether noise sources of an industrial, commercial or fixed nature are likely to cause adverse impact for people residing in the area.

New development can often incorporate plant and processes that have the potential to generate noise, especially if operated at night-time when background noise levels are at their lowest.

BS 4142 sets out a method to assess whether noise from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises are likely to cause adverse impact at noise-sensitive receptors in the vicinity.

The procedure contained in BS 4142 for assessing the impact is to compare the measured or predicted noise level from the source in question, the $L_{Aeq,T}$ 'specific noise level', immediately outside the dwelling with the $L_{A90,T}$ background noise level.

Where the noise contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific noise level to obtain the $L_{A,r,T}$ 'rating noise level'. A correction to include the consideration of a level of uncertainty in noise measurements, data and calculations can also be applied when necessary.

BS 4142 states: "The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs". An estimation of the impact of the specific noise can be obtained by the difference of the rating noise level and the background noise level and considering the following:

Typically, the greater this difference, the greater the magnitude of the impact.

A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.

A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

The periods associated with day and night, for the purposes of the Standard, are considered to be 07.00 to 23.00 and 23.00 to 07.00, respectively.

3 External Building Fabric Assessment

3.1 Overview

This section presents the results of the external building fabric assessment, which provides performance specifications for the external building fabric elements, such that appropriate internal ambient noise levels and noise breakout levels can be achieved.

The assessment has been based on detailed environmental noise measurements undertaken across the proposed development site, between Wednesday 11 and Thursday 12 September 2019. Full details and results of the environmental noise survey can be found in report with reference number 102945-MLM-ZZ-XX-RP-YA-0001. The survey consisted of three noise monitoring positions across the site to determine the existing noise climate. It was found that the site is subject to high levels of noise due to the close proximity with the surrounding road network, and Manchester Airport.

Based on the results of the noise impact assessment and the predicted internal noise levels within the proposed rooms, calculations have been undertaken to select suitable glazing and ventilator sound reduction performances to ensure full compliance with the requirements set out in Section 2 above.

Guidance on constructions that are typically commensurate with achieving the required performance standards has also been provided.

For the purposes of the analysis a reverberation time of 0.5 seconds is assumed across the frequency spectrum in hotel bedrooms, which is in accordance with BS EN ISO 140 Part 4.

For the purposes of the analysis we have assumed that bedrooms are to be acoustically 'soft', with a carpet floor finish, curtains and other soft furnishings. For the purposes of our analyses we have assumed the following absorption coefficients:

Table 8: Assumed Bedroom Absorption Coefficients							
Absorption Coefficient (α) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
0.15	0.18	0.25	0.27	0.31	0.32	0.32	0.32

3.2 Ventilation Acoustic Requirements

3.2.1 Guestrooms

To determine the ventilation sound reduction requirements, representative external noise levels have been considered at the façades of the proposed development, based on the results of the noise monitoring exercise.

To achieve appropriate internal ambient noise levels within hotel guestrooms, the required ventilation rates will be achieved with windows closed. This is understood to be the case, as mechanical ventilation is provided for the whole development and openings in the façade are not required.

It is understood that mechanical cooling is provided to the development and therefore it is clear that overheating ventilation will not require open windows.

3.2.2 Bars/Restaurants/Back of House

It is understood that the required ventilation rates for the various back of house and restaurant/bar/reception areas will be provided mechanically. To achieve appropriate internal ambient noise levels within these hotel areas it is understood that windows will be closed.

3.2.3 Internal Plant Noise Limits

Mechanical ventilation systems should be designed to achieve appropriate internal ambient noise levels as defined in Table 9.

Table 9: Internal Plant Noise Limits	
Room Type	Noise Limit (dBA)
Hotel Bedroom	Low speed: 28 L _{eq} , Medium speed: 31 L _{eq}
Staff Areas / Restaurant, Bar, Reception	35 L _{eq} & NR30
Kitchen	45 L _{eq} & NR40 - 55 L _{eq} & NR50 with extractor in Operation

It should be noted that 28 dBA can be difficult to achieve with Fan Coil Units located within bedrooms. Appropriate unit selection must be made in order to meet the noise level requirements. Consideration should be given to oversizing the FCU so it can operate at a lower fan speed. Allowance for a sound attenuating plenum may be required to both the inlet & outlet side of the FCU along with internal lined duct work.

3.3 Building Envelope Sound Reduction Requirements – Hotel Guestrooms

In order to achieve the target internal noise levels, it is necessary to determine the minimum acoustic performance requirements of the ventilation system and the building envelope.

Table 10 sets out the broadband sound reduction requirements for the various facades of the proposed development, in order to achieve the target criteria, which are driven by the L_{A1} noise levels at night.

Table 10: Minimum Guestroom Façade Broadband Sound Reduction Requirements dB			
Facade	Max. Measured External Noise Level, L _{A1} dB	Target Internal Noise Level, L _{A1} dB	Required Broadband Sound Level Difference, dB
North	80	35	45
East, South and West	74	35	39

Considering room dimensions and windows size (4m²), the sound insulation requirements of the building envelope, namely the external glazing and walls and roof, to achieve the required indoor ambient noise levels are presented below.

Table 11: Minimum Performance Requirements for Guestroom Facades									
Facade	External Element	Octave Band Centre Frequency, Hz							R _w + C _{tr}
		63	125	250	500	1000	2000	4000	
		Sound Reduction Performance, R (dB)							(dB)
North Façade	Wall	30	39	51	57	59	61	70	51
	Glazing	30	35	46	46	46	56	65	45
All Other Façades ¹⁾	Wall	21	32	45	55	55	55	55	45
	Glazing	22	27	36	43	52	55	59	39
¹⁾ It is recommended that the external wall of the large guestrooms (room area 37 m ²) in the south-east corner of the building is upgraded to achieve the same performance to that of the northern facade									

The northern facade glazing performance can typically be achieved with double windows on separate frames (eg 10mm glass pane, 200mm void and 6mm glass pane, or standard double glazing in conjunction with secondary glazing). The glazing performance for all other facades can typically be achieved using top of the range acoustic double glazing (eg 10.8 laminated glass, 20mm gap and 8.8mm laminated glass).

The glazing system performance specifications detailed above apply to the glazing package as a whole, inclusive of glazing, framing, spandrel panels, etc. The performance of the glazing systems will depend on many factors, such as the glazing configuration, size of window panels, quality of framing, quality of sealing, etc. Performance specifications are frequency specific. Overall performance values are given for guidance purposes only.

Design information showing the glazing specifications have been provided and comments have been issued where found necessary to reflect the recommendations within this report. The specifications include reference to this report and compliance is expected when the recommendations provided are followed.

It is understood that, as a minimum, the external wall proposals will include:

- Aluminium Cladding;
- Rockwool Rainscreen Duo Slab;
- Breather membrane;
- 12mm cement board;
- 150mm Steel Frame System full filled with Rockwool flexi;
- 2 layers 15mm Fermacell Board.

This construction is predicted to achieve a minimum laboratory sound reduction index (SRI) of 65dB R_w (and 59 dB $R_w + C_{tr}$), when installed in accordance with the manufacturer's installation protocols. This is compliant with the project requirements.

Higher sound reduction performances are required for certain guestrooms which are impacted by high levels of proposed external plant noise. A detail assessment is presented in Section 3.6 for the rooms which are exposed to the highest levels of building services noise from the proposed external plant.

3.4 Building Envelope Sound Reduction Requirements – Other Areas

The sound reduction requirements for the glazing in other sensitive areas of the Hotel are presented in Table 12 below. These ratings are expected to achieve compliance with the Brand Standards and therefore BREEAM Hea05.

Table 12: Minimum Performance Requirements for External Glazing in Other Areas								
Room Type	Octave Band Centre Frequency, Hz							$R_w + C_{tr}$
	63	125	250	500	1000	2000	4000	
	Sound Reduction Performance, R (dB)							(dB)
Admin Office	22	27	36	43	52	55	59	39
Restaurant, bar, Reception	19	24	20	25	34	37	35	27
Crew Lounge	22	27	36	43	52	55	59	39

The Table below sets out the performance requirements for the solid external wall in areas other than hotel bedrooms.

Table 13: Minimum Performance Requirements for the External Solid Walls in Other Areas								
Room Type	Octave Band Centre Frequency, Hz							R_w+C_{tr} (dB)
	63	125	250	500	1000	2000	4000	
	Sound Reduction Performance, R (dB)							
Sensitive Areas other than bedrooms	21	32	45	55	55	55	55	45

It is understood that the external wall requirement in Table 13 can be achieved using the construction proposed for the hotel guestrooms and presented in the section above, although other construction may be also suitable.

3.5 Building Envelope Sound Reduction Requirements – External Wall Plant Area Level 8

The external wall requirement for the bedrooms adjacent to the external Plant area will be 60 dB $D_{nT,w} + C$ ($D \geq 41$ dB @ 125-250 Hz) based on Tribe Brand Standards for sound insulation between air conditioning or ventilation areas and guestrooms.

It is understood that the Wall Type 11a is proposed for the bedrooms adjacent to the external plant area will comprise:

- 215mm blockwork;
- 20mm cavity;
- 48mm Metal I stud;
- 50mm mineral wool in the cavity;
- 2 layers 15mm Wallboard plasterboard.

The above construction is predicted to achieve a laboratory sound reduction of 70 dB $R_w + C$, when installed in accordance with the manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the 62 dB $D_{nTw} + C$, which is compliant with the project requirements.

In relation to the sound absorption at 125 and 250 Hz frequency bands, the proposed construction is considered to have a sound reduction performance above 50 dB at each band, and therefore there is potential to comply with a requirement of 41 dB at these frequency bands.

3.6 Building Envelope Sound Reduction – North Façade Upper Floors, Level 06 to Level 08

Based on the noise model constructed to assess the external building services plant noise at Level 8, high noise levels have been predicted at the façades of some rooms, and a detail assessment has been undertaken to ensure plant noise break-in is sufficiently limited.

As set out in Table 3 above, the plant noise intrusion in guestrooms should not exceed 22 dBA L_{Aeq} and NR17.

The most affected rooms are the following:

- Level 7: Rooms 705, 706, 707, 708 and 709 and to a lesser extent Rooms 704, and 710;
- Level 8: Room 803;
- Level 6: Rooms 605, 606, 607, 608, and 609.

It is understood that the external wall is proposed to include 3 layers of 15 mm Fermacell board where necessary. For the rooms mentioned above, this additional 15 mm Fermacell layer is considered necessary.

The use of a glazing specification with a higher sound reduction index has been considered, however the increase in performance does not provide a significant improvement in the internal levels within the guestrooms.

As full compliance cannot be achieved using practical solutions, a derogation against the Brand Standards is required for the rooms in Level 7 affected by the highest levels of noise.

Using the proposed glazing for the north façade presented in Table 11, and the proposed external wall including 3 layers of 15mm Fermacell, the following levels are expected:

- Internal noise level of 25 dBA and NR19 in Rooms 705, 706, 707, 708 and 709. This is below the levels for internal plant at lower speed as per Table 3, and may be considered acceptable although will not ensure the inaudibility of the building services noise intrusion;
- Internal noise level of 21 dBA and NR13 in Rooms 803, 704, 710, 605, 606, 607, 608, and 609. This is compliant with the Tribe requirements.

All other guestrooms are expected to achieve compliant levels of external plant noise break-in.

3.7 Building Envelope Sound Reduction – Level 9 Roof External Plant

The Brand Standard limit for noise intrusion due to external plant noise in guestrooms is 22 dBA and NR17.

The Level 9 roof build-up is as follows:

- External Roof Insulation;
- 250mm in-situ concrete slab;
- Minimum 100mm cavity;
- 2 layers 12.5mm Wallboard plasterboard suspended ceiling on light steel grid frame.

The calculated level of plant noise break-in to the bedrooms below the roof plant area in Level 9 is below 22 dBA and NR17, and therefore is compliant with the Brand Standard requirement.

3.8 Building Envelope Sound Reduction – Level 8 Roof External Plant

The Brand Standard limit for noise intrusion due to external plant noise in guestrooms is 22 dBA and NR17.

The combined noise emissions for the external plant have been considered, assuming normal operation which would include 80% of VRF units running simultaneously, as confirmed by the M&E consultants. The maximum sound level in the roof plant areas has been calculated as 82 dBA. This has been calculated in the area with most of the plant, including the VRF units, which is above the north facing rooms below the external plant area. Based on the predictions, the other roof plant area to the south, which is above the guestrooms facing the atrium below the external plant area are expected to emit lower noise levels, in order of 78 dBA.

The Level 8 roof build-up is as follows:

- External Roof Insulation;
- 300mm in-situ concrete slab;
- Minimum 100mm cavity;
- 2 layers 12.5mm Wallboard plasterboard suspended ceiling on light steel grid frame.

The calculated level of plant noise break-in to the bedrooms below the roof plant area is 36 dBA and NR33 for the southern roof plant areas (78 dBA), and 40 dBA and NR38 for the loudest external plant area to the north.

This is higher than the Brand Standard requirement, 22 dBA and NR17. It is therefore recommended that the sound reduction performance of the plant area roof to be improved, in order to achieve the required noise break in.

For the southern roof plant areas, the following roof build-up is proposed:

- External Roof Insulation;
- 300mm in-situ concrete slab;
- Minimum 100mm cavity;
- Minimum 50mm mineral wool;
- 2 layers 12.5mm Soundbloc plasterboards suspended ceiling on light steel grid frame.

The calculated level of plant noise break-in to the bedrooms facing the Atrium below the external plant areas is 21 dBA and NR13, which is compliant with the Tribe Standards requirements.

For the north roof plant areas, the following roof build-up is proposed:

- External Roof Insulation;
- 300mm in-situ concrete slab;
- Minimum 100mm cavity;
- Minimum 50mm mineral wool;
- 2 layers 15mm Soundbloc plasterboards suspended ceiling on acoustic sylomer hangers.

The calculated level of plant noise break-in to the bedrooms facing the Atrium below the external plant areas is 21 dBA and NR14, which is compliant with the Tribe Standards requirements.

Design information showing the required acoustic enhancements have not been provided at this stage. Compliance is expected when incorporating the recommendations provided, however full compliance cannot be confirmed based on the information provided.

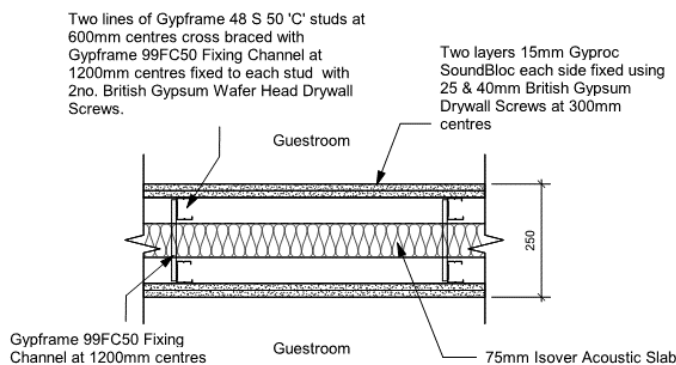
4 Internal Building Fabric Assessment

4.1 Wall Sound Insulation between Guestrooms

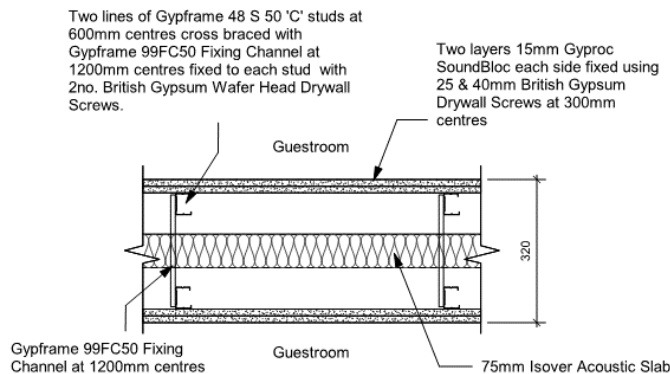
Requirement: 51dB $D_{nTw} + C$ (Tribe Brand Standards) & 48dB $D_{nTw} + C_{tr}$ (Building Regulations + 5dB uplift for BREEAM Hea05). 48 dB $D_{nTw} + C_{tr}$ is typically more onerous for lightweight constructions.

Wall Types 1 and 1a are proposed between the guestrooms and will comprise:

- 2 layers 15mm Soundbloc;
- Two Gypframe 48 S 50 'C' Stud frameworks;
- 75mm Isover Acoustic Slab in the cavity void (cavity 190mm for Type 1 and 260mm for Type1a);
- 2 layers 15mm Soundbloc



1 Wall Type 01



2 Wall Type 01a

The above is in line with a British Gypsum system (A216011), which achieves a laboratory sound reduction of 57dB $R_w + C_{tr}$ when installed in accordance with the manufacturer's installation protocols. Wall Types 1 and 1a are predicted to achieve a performance of 48dB $D_{nTw} + C_{tr}$ assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, which is compliant with the project requirements.

It is understood that a number of the partitions include RC structural walls or columns. Where these occur, Wall Type 4b is proposed, and will comprise:

- 2 layers 15mm Soundbloc;
- 30mm Insulation Mineral Rockwool RW45;
- Gypframe GL2 Channel and GL11 bracket;
- 200mm RC wall;
- Gypframe GL2 Channel and GL11 bracket;
- 30mm Insulation Mineral Rockwool RW45;
- 2 layers 15mm Soundbloc;

Where this detailing is applied to a structural wall (eg between guestroom 143 and 144, etc.), the above is in line with a British Gypsum system (B226008), (using two 15mm Soundbloc in place of one 12.5mm SoundBloc), which achieves a laboratory sound reduction of $56\text{dB } R_w + C_{tr}$ when installed in accordance with the manufacturer's installation protocols. Wall Type 4 is predicted to achieve a performance of $48\text{dB } D_{nTw} + C_{tr}$, which is compliant with the project requirements, assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction.

It must be noted that for the integration of columns in the separating walls between guestrooms, wall Type 4b is also acceptable.

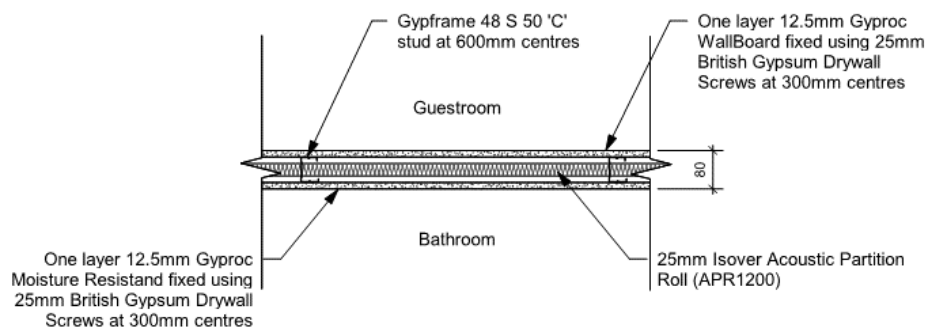
4.2 Wall Sound Insulation within Guestrooms

There is no sound insulation requirement where an internal wall contains a door.

There are currently no instances where walls separate spaces within hotel rooms and do not contain a door and therefore the Building Regulation internal wall requirement ($40\text{dB } R_w$) does not apply in this instance.

It is understood that the Wall Type 6 is proposed within certain guestrooms and will comprise:

- 1 layer 12.5mm Wallboard plasterboard;
- 48mm Gypframe 'C' Stud;
- 25mm Isover APR 1200 in the cavity void;
- 1 layer 12.5mm Wallboard plasterboard.



1 Wall Type 06

The above wall type achieves $40\text{dB } R_w$ and may be used as the internal wall specification however this is not a statutory requirement.

It is understood that the Wall Type 6b is proposed within certain guestrooms and rain water pipes will run in the cavity. Wall type 6b will comprise:

- 1 layer 12.5mm Wallboard plasterboard;
- Two Gypframe 48 S 50 'C' Stud frameworks;
- 25mm Isover APR 1200 in the cavity void;
- 1 layer 12.5mm Wallboard plasterboard.

The above wall type achieves more than 40dB R_w and therefore can be used as the internal wall specification, although this is not a statutory requirement. However, the presence of rain water pipes require additional attention.

Rainwater pipes transmit noise from outside and radiate flow noise in storms. They should be routed outside acoustically sensitive spaces, and should not be attached to the structure of acoustically sensitive spaces. Rainwater pipes passing through noise sensitive areas must be fully enclosed and insulated to prevent noise break out and cross-talk effects.

The pipes should be boxed in using two layers of 12.5mm Soundbloc plasterboard with a 25mm (un-faced) mineral wool quilt within the cavity in addition to a fire-stopping layer at floor level (penetration through this layer should be flexible). It is therefore advised that the proposed Wall Type 6b should include two layers of 12.5mm Soundbloc (or equivalent moisture resistant boards, with comparable density) on both sides.

4.3 Wall Sound Insulation between Other Areas

The required laboratory performance for partitions in other areas of the hotel are presented in Table 14.

Room Type	Adjacency	In-situ Requirement dB $D_{nT,w} + C$	Required / Recommended Laboratory Performance dB $R_w + C$
Bar	Guestroom**	56	64
Staff Break	Guestroom	56	64
BOH	Guestroom	56	64
Corridor	Bathroom (Guestroom)	45	53
Corridor	Guestroom	43	49
Public toilet	Public toilet	40	48
Staff Break	Staff Change / WCs	n/a*	45 (R_w Only)
Staff Canteen	Admin	n/a	48 (R_w Only)
Staff Canteen	Maintenance Office	n/a	48 (R_w Only)
Staff Change	Admin / Maintenance Office	n/a	48 (R_w Only)
Staff Change / WCs	Staff Change / WCs	n/a	45 (R_w Only)
Kitchen	Restaurant	n/a*	45 (R_w Only)

*There are no statutory requirements for these partitions however it should be noted that the sound insulation between these areas will be limited by the presence of the door which should have a minimum rating of 35dB R_w where possible, and the open serving area for the kitchen.

**The bar is deemed to be adjacent to the guestrooms though the void over the courtyard, and therefore the sound insulation requirement will apply to the Atrium Walls, this is assessed in detail below.

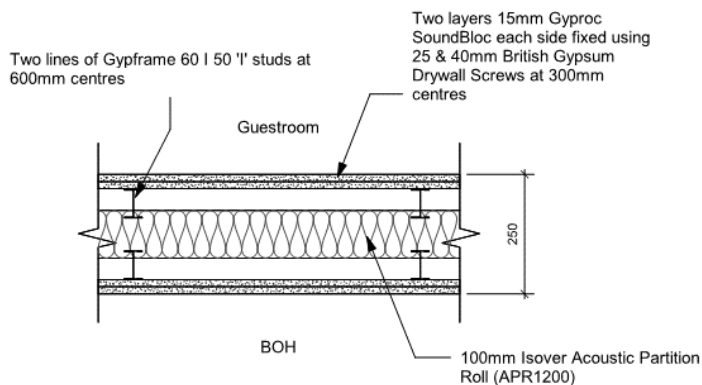
Based on the information provided, the performance of the proposed walls are discussed below.

4.3.1 Staff Break & BOH – Guestroom Partition Wall

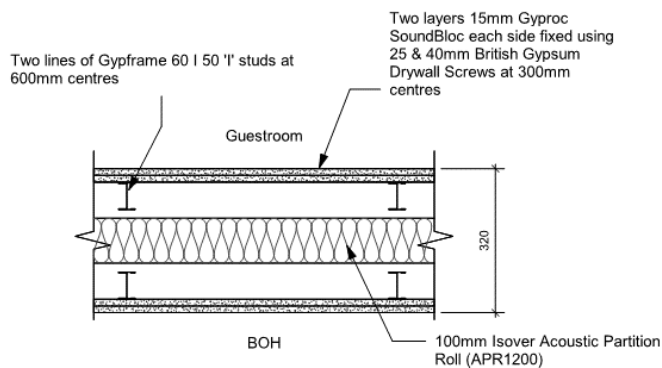
Requirement: 56dB $D_{nTw} + C$; 64dB $R_w + C$ (Tribe Brand Standards).

Wall Types 5 and 5a are proposed between guestrooms and the Staff Break Room, and between Guestrooms and BOH, and will comprise:

- 2 layers 15mm Sound bloc;
- Two 60 Metal 'I' Stud frameworks;
- 100mm Isover APR 1200 in the cavity void;
- Minimum cavity 190mm;
- 2 layers 15mm Sound bloc.



9 Wall Type 05



10 Wall Type 05a

The above is in line with a British Gypsum system (A216013), which achieves a laboratory sound reduction of 70dB R_w when installed in accordance with the manufacturer's installation protocols. The proposed Wall Types 5 and 5a are expected to achieve a performance of 56dB $D_{nTw} + C$ which is compliant with the project requirements, assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction.

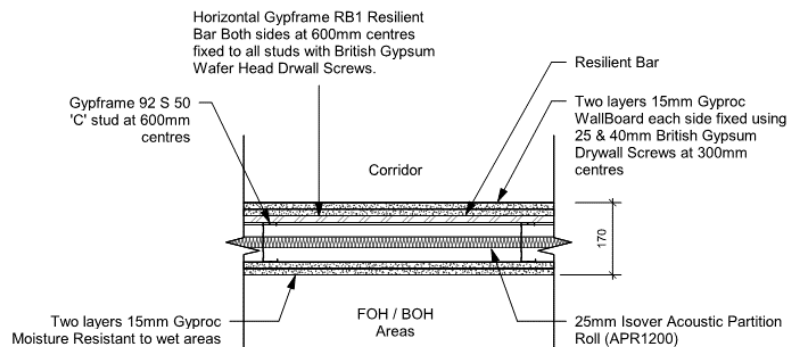
4.3.2 Corridor – Guestroom Wall

Requirement: 45dB $D_{nTw} + C$; 53dB $R_w + C$ (Tribe Brand Standards).

Corridor – Guestroom

Wall Type 3 is proposed between guestrooms and corridors, and will comprise:

- 2 layers 15mm Wallboard;
- 16mm resilient bar;
- 92 Metal 'C' Stud framework;
- 25mm Isover APR 1200 in the cavity void;
- 2 layers 15mm Wallboard (Moisture resistant to wet areas).



4 Wall Type 03

The above is in line with a British Gypsum system (A316014) (using 15mm Wallboard in place of 12.5mm SoundBloc), which achieves a laboratory sound reduction of 61dB R_w when installed in accordance with the manufacturer's installation protocols. Wall Type 3 is expected to achieve a performance in excess of 45dB $D_{nTw} + C$ which is compliant with the project requirements, assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction.

Constructions based on resilient bars require high levels of workmanship and correct installation in accordance with the manufacturer's installation protocols.

Stair Cores – Guestrooms

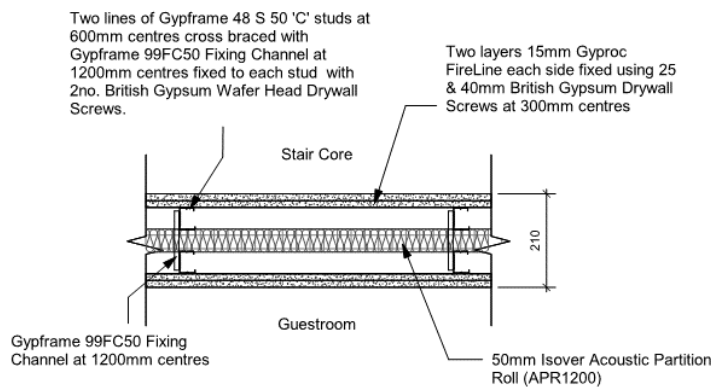
The proposed wall for separating guestrooms and stair cores will comprise:

- 2 layers 15mm Soundbloc;
- 30mm Insulation Mineral Rockwool RW45;
- Gypframe GL2 Channel and GL11 bracket;
- 200mm RC wall;
- Adhesive dabs;
- 1 layer 15mm Wallboard.

The above is in line with a British Gypsum system (B226008), (using two 15mm Soundbloc in place of one 12.5mm SoundBloc), which achieves a laboratory sound reduction of 67dB R_w when installed in accordance with the manufacturer's installation protocols. Wall Type 4b is expected to achieve a performance in excess of 45dB $D_{nTw} + C$ which is compliant with the project requirements, assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction.

In certain areas, Wall Type 9 is proposed for separating guestrooms and stair cores, and will comprise:

- 2 layers 15mm Fireline;
- Two Gyproframe 48 S 50 'C' Stud frameworks;
- 50mm Isover Acoustic Slab in the cavity void (cavity 145mm);
- 2 layers 15mm Fireline.



7 Wall Type 09

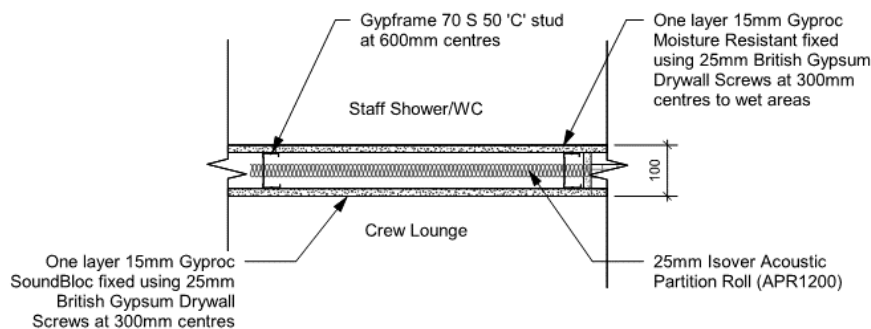
The above is in line with British Gypsum system (A216010), which achieves a laboratory sound reduction of 60dB R_w when installed in accordance with the manufacturer's installation protocols. Wall Type 9 is expected to achieve a performance in excess of 45dB $D_{nTw} + C$ which is compliant with the project requirements, assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction.

4.3.3 Staff Break Lounge – Staff Change / WCs Partition Wall

Requirement: 45dB R_w (Tribe Brand Standards).

Wall Type 8 is proposed between these areas, and will comprise:

- 1 layer 15mm Soundbloc;
- 70 Metal 'C' Stud framework;
- 25mm Isover APR 1200 in the cavity void;
- 1 layer 15mm Wallboard (Moisture resistant to wet areas).



5 Wall Type 08

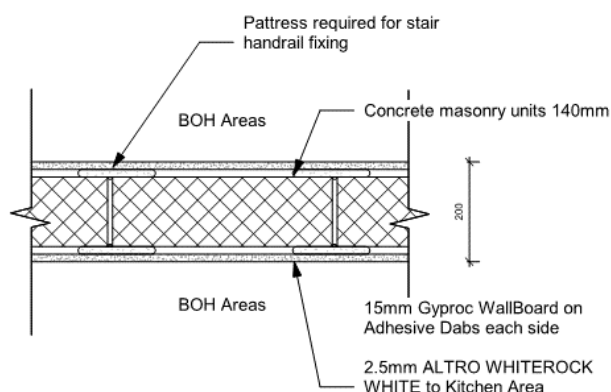
The above is a British Gypsum system (A206197), which achieves a laboratory sound reduction of 48dB R_w when installed in accordance with the manufacturer's installation protocols. Wall Type 8 is expected to achieve a performance of 45dB R_w and therefore is compliant with the project requirements.

4.3.4 Staff Canteen – Admin / Maintenance Office / Staff Change Partition Wall

Requirement: 48dB R_w (Tribe Brand Standards).

Wall Type 12 is proposed between these areas, and will comprise:

- 1 layer of 15mm Gyproc Wallboard on adhesive dabs;
- 140mm concrete masonry units;
- 1 layer of 15mm Gyproc Wallboard on adhesive dabs.



11 Wall Type 12

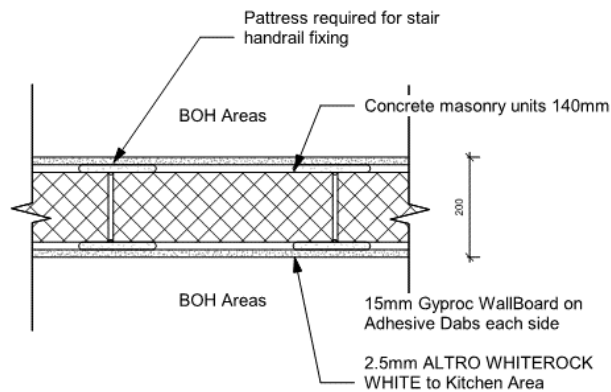
The above construction is expected to achieve a minimum laboratory sound reduction of 48dB R_w , and therefore the proposed Wall Type 12 is expected to meet the required sound reduction performance of 48dB R_w and therefore is compliant with the project requirements.

4.3.5 Kitchen – Restaurant Partition Wall

Requirement: 45dB R_w (Tribe Brand Standards).

Wall Type 12 is proposed between these areas, and will comprise a minimum of:

- 1 layer of 15mm Gyproc Wallboard on adhesive dabs;
- 140mm concrete masonry units;
- 1 layer of 15mm Gyproc Wallboard on adhesive dabs.



11 Wall Type 12

The above construction is expected to achieve a minimum laboratory sound reduction of 48dB R_w . Wall Type 12 is expected to exceed the sound reduction performance requirement of 45dB R_w and therefore is compliant with the project requirements.

4.3.6 Atrium – Guestrooms Partition Wall

Requirement: 56dB $D_{nTw} + C$; 64dB $R_w + C$ (Tribe Brand Standards).

The construction proposed for the Atrium walls will be the same as for the external façade, assuming the highest glazing performance as in Table 11.

As a minimum, the external wall proposals will include:

- Aluminium Cladding;
- Rockwool Rainscreen Duo Slab;
- Breather membrane;
- 12mm cement board;
- 150mm Steel Frame System full filled with Rockwool flexi;
- 2 layers 15mm Fermacell Board.

This construction is predicted to achieve a minimum laboratory sound reduction index (SRI) of 65dB R_w (and 59 dB $R_w + C_{tr}$), when installed in accordance with the manufacturer's installation protocols.

The northern facade glazing performance, assumed as double windows on separate frames (eg 10mm glass pane, 200mm void and 6mm glass pane, or standard double glazing in conjunction with secondary glazing), is expected to be capable of achieving a laboratory sound reduction of 49dB R_w (and 45 dB $R_w + C_{tr}$).

The combined SRI for the façade, based on the glazing and façade dimensions, is calculated as 52dB R_w (and 48 dB $R_w + C_{tr}$). The SRI is a laboratory value. The predicted in-situ performance is expected to be approximately 44 dB $D_{nt,w} + C$ and 42 dB $D_{nt,w} + C_{tr}$ for the bedrooms to Atrium walls. This is significantly lower than the Brand Standard requirement, 56 dB $D_{nt,w} + C$, and is below the minimum Building Regulations ADE requirement, 43 dB $D_{nt,w} + C_{tr}$.

As full compliance cannot be achieved using practical solutions, a derogation against the Brand Standards is required.

It is however, recommended that the sound reduction performance of the atrium walls be improved, in order to achieve a minimum sound reduction that is in line with Building Regulations ADE.

The following is proposed to be included:

- Increase the glazing performance to achieve a minimum laboratory sound reduction of 54dB R_w (and 48 dB $R_w + C_{tr}$) using double windows on separate frames (eg standard double glazing (6-10-6) in conjunction with secondary glazing 10mm glass pane, and 200mm void); and
- The use of the proposed external wall including 3 layers of 15mm Fermacell.

The combined SRI for the enhanced façade above, considering the separating wall dimensions, is calculated to be 57dB R_w (and 51 dB $R_w + C_{tr}$). This is expected to achieve an in-situ performance of 49 dB $D_{nt,w} + C$ and 45 dB $D_{nt,w} + C_{tr}$, which although still significantly lower than the Brand Standard requirements, is acceptable in relation to Building Regulations ADE requirements.

On the basis of the enhanced wall and glazing proposals, the internal sound levels in the bedrooms have been calculated as 24 dBA, as a result of noise break-in from the atrium, assuming a reverberant activity noise level in the Atrium of 74 dBA. The assumed activity noise level is considered representative of the noise levels in the atrium when the restaurant is full; based on conversations occurring at 12 tables simultaneously. Noise break-in from the atrium is therefore expected to be below the noise levels of the ventilation plant in the bedroom. Whilst this does not guarantee that noise from the atrium/restaurant will not be audible in the guestrooms, it should ensure that it is at such a level that does not adversely impact on guests for the majority of the time. The design team have confirmed that significant design and layout changes will not be possible, and therefore any further reduction in noise transfer cannot be achieved.

The above performance can be considered sufficient in relation to BREEAM Hea05 requirements, considering that the internal levels are calculated based on the noise levels in the restaurant, and are capable of ensuring good acoustic conditions within the guestrooms.

Design information showing the required acoustic enhancements has not been provided at this stage. Compliance, assuming the derogation of the Tribe Standards, is expected when incorporating the recommendations provided. Specifications include reference to this report and compliance is expected when the recommendations provided are followed.

4.4 Floor Sound Insulation between Hotel Rooms

4.4.1 Airborne Sound Insulation

Requirement: 51dB $D_{nTw} + C$ (Tribe Brand Standards) & 48dB $D_{nTw} + C_{tr}$ (Building Regulations + 5dB uplift for BREEAM Hea05). 48 dB $D_{nTw} + C_{tr}$ is typically slightly more onerous for masonry constructions.

The proposed floor structure provided at this stage is a 250mm in-situ concrete slab. There will be a suspended plasterboard ceiling beneath the slab and a floor finish zone above. The proposed build-up is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;

- 250mm in-situ concrete slab;
- Minimum 100mm cavity;
- 2 layers 12.5mm Wallboard plasterboard suspended ceiling on metal frame.

The above construction is predicted to achieve a laboratory sound reduction of 59dB $R_w + C_{tr}$ (and 65 dB $R_w + C$), when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the 51dB $D_{nTw} + C_{tr}$, which is compliant with the project requirements.

4.4.2 Impact Sound Insulation

Requirement: 50dB L'_{nTw} (Tribe Brand Standards) & 57dB L'_{nTw} (Building Regulations + 5dB uplift for BREEAM Hea05).

The requirements for impact sound insulation for the development will be driven by the Tribe Standards which require an impact sound insulation of 50 L'_{nTw} for floor constructions between guestrooms and between corridors and guestrooms.

The floor finish zone will require an element of resilience in order to meet the impact sound insulation requirements. The floor covering should meet the following specification:

- Any floor covering with a weighted reduction in impact sound pressure level (ΔL_w) of not less than 20dB when measured in accordance with BS EN ISO 140-8:1998 and calculated in accordance with BS EN ISO 717-2:1997 for bedrooms and corridors above bedrooms.

Design information showing the specification of the proposed floor finish and the required acoustic enhancements have not been provided at this stage. Compliance is expected when incorporating the recommendations provided, however full compliance cannot be confirmed based on the information provided.

4.5 Floor Sound Insulation between Other Areas

4.5.1 Airborne Sound Insulation Requirements

The requirements governing internal airborne sound insulation for separating floors between guestrooms and FOH and BOH areas presented in Table 15.

Table 15: Internal Airborne Sound Insulation Requirements – Floors				
Source Room	Receiving Room	Sound Reduction Requirement Tribe Standard	Sound Reduction Requirement Building Regulation ADE	BREEAM HEA05 Requirement
Restaurant, Bar, Reception	Guestroom	56dB $D_{nT,w} + C$	45dB $D_{nT,w} + C_{tr}$	50dB $D_{nT,w} + C_{tr}$
Fitness Room	Guestroom	60dB $D_{nT,w} + C$	45dB $D_{nT,w} + C_{tr}$	50dB $D_{nT,w} + C_{tr}$
Kitchen, Bin Rooms, Storage & Associate Movement Areas, Laundry, Staff Canteen, Cloakrooms	Guestroom	56dB $D_{nT,w} + C$	45dB $D_{nT,w} + C_{tr}$	50dB $D_{nT,w} + C_{tr}$

Table 15: Internal Airborne Sound Insulation Requirements – Floors

Source Room	Receiving Room	Sound Reduction Requirement Tribe Standard	Sound Reduction Requirement Building Regulation ADE	BREEAM HEA05 Requirement
Plant Rooms (Air Cond and Ventilation Area, LV Switch Room)	Guestroom	60dB $D_{nT,w} + C$ ($D \geq 41\text{dB @ } 125\text{-}150\text{Hz}$)	45dB $D_{nT,w} + C_{tr}$	50dB $D_{nT,w} + C_{tr}$
Plant Rooms (Lift Machinery, Chiller Room, Boiler Room, Heat Pump)	Guestroom	60dB $D_{nT,w} + C$ ($D \geq 45\text{dB @ } 125\text{-}150\text{Hz}$)	45dB $D_{nT,w} + C_{tr}$	50dB $D_{nT,w} + C_{tr}$

4.5.2 Achieving the Requirements

Separating floor between Restaurant, Bar, Reception – Guestrooms

The proposed floor between guestrooms and FOH areas is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab.

The above construction (assuming concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $55\text{dB } R_w + C_{tr}$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $50\text{dB } D_{nT,w} + C_{tr}$, which would be compliant with the ADE and BREEAM requirements, assuming the concrete density above.

The above construction would be expected to achieve a level of airborne sound insulation in the order of the $53\text{dB } D_{nT,w} + C$, which is not compliant with the Tribe Standards. In order to achieve the Tribe Standards a suspended ceiling would be required, however this is understood not to be in line with the Interior Design intent. Therefore a derogation against the Brand Standards is required.

Separating Floor between Gym – Guestrooms

The proposed floor between guestrooms and FOH areas is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab.

As presented above, the above construction (assuming concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $55\text{dB } R_w + C_{tr}$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $50\text{dB } D_{nT,w} + C_{tr}$, which would be compliant with the ADE and BREEAM requirements, assuming the concrete density above.

The above construction would be expected to achieve a level of airborne sound insulation in the order of the $53\text{dB } D_{nT,w} + C$, which is not compliant with the Tribe Standards.

In order to achieve the Tribe Standards a suspended ceiling will be required, comprising:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab;
- Minimum 100mm cavity;
- Minimum 50mm mineral wool;
- 2 layers 15mm Soundbloc plasterboard suspended ceiling on metal frame.

The above construction is expected to achieve a laboratory sound reduction of $70\text{ dB } R_w + C$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $62\text{dB } D_{nTw} + C$, which is compliant with the Tribe Standards project requirements for the separation between guestrooms and Gym.

Design information showing the required acoustic enhancements have not been provided at this stage. Compliance is expected when incorporating the recommendations provided, however full compliance cannot be confirmed based on the information provided.

Separating floor between Kitchen/Staff – Guestrooms

The proposed floor between Guestrooms and Kitchen / Staff areas is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab;
- 100mm cavity minimum;
- Ecophon Hygiene Advance A, 40mm thickness in C4 grid system.

The above construction (assuming a concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $58\text{dB } R_w + C$ and $55\text{dB } R_w + C_{tr}$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $50\text{dB } D_{nTw} + C_{tr}$ and $53\text{dB } D_{nTw} + C$ which would be compliant with the ADE and BREEAM requirements, however this is not compliant with the Tribe Standards.

In order to achieve the Tribe Standards a minimum performance increase of 3 dB would be required. The use of 50mm mineral wool in the cavity is expected to improve the sound insulation and achieve compliance of the Tribe Standards.

Design information and specifications showing the required acoustic enhancements have been confirmed. Specifications include reference to this report and compliance is expected when the recommendations provided are followed.

Separating floor between Staff WC/Cloakroom – Guestrooms

The proposed floor between Guestrooms and Staff FOH areas is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab;
- Minimum 100mm cavity;
- Minimum 50mm mineral wool;
- 2 layers 15mm Soundbloc plasterboard suspended ceiling on metal frame.

The above construction (assuming a concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $70 \text{ dB } R_w + C$ and $66 \text{ dB } R_w + C_{tr}$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $58 \text{ dB } D_{nTw} + C_{tr}$ and $62 \text{ dB } D_{nTw} + C$ which would be compliant with the ADE and BREEAM requirements, and the Tribe Standards.

Separating floor between Bin Room – Guestrooms

The proposed floor between Guestrooms and the Bin Room is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab.
- Minimum 100mm cavity;
- 2 x 15mm SoundBloc plasterboard suspended ceiling on metal frame.

The above construction (assuming a concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $65 \text{ dB } R_w + C$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $57 \text{ dB } D_{nTw} + C$, which is compliant with the ADE, BREEAM the Tribe Standards project requirements.

Separating floor between LV Switch room – Guestrooms

The proposed floor between Guestrooms and the LV Switch room is understood to be as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab.
- Minimum 100mm cavity;
- Minimum 50mm mineral wool;
- 2 layers 15mm Soundbloc plasterboard suspended ceiling on metal frame.

The above construction (assuming concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $70 \text{ dB } R_w + C$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $62 \text{ dB } D_{nTw} + C$, which is compliant with the ADE, BREEAM, and the Tribe Standards project requirements for the separation between guestrooms and FOH areas.

In relation to the sound reduction in the 125 and 250 Hz frequency bands, the proposed construction is considered to have a sound reduction performance above around 50 dB at each band, and therefore is expected to comply with the requirements of 41 dB for both bands.

Separating floor between Linen – Guestrooms

The proposed floor between Guestrooms and the Linen Room is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab;
- 100mm cavity;
- 50mm mineral wool in the cavity;
- Hygienic tiles on grid system.

The above construction (assuming a concrete density of 2340 kg/m^3) when installed in accordance with manufacturer's installation protocol and assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, is expected to achieve a level of airborne sound insulation in excess of $50 \text{ dB } D_{nTw} + C_{tr}$ and a minimum of $56 \text{ dB } D_{nTw} + C$ which would be compliant with the ADE and BREEAM requirements, and the Tribe Standards.

Separating floor between BOH Corridors – Guestrooms

The proposed floor between Guestrooms and the BOH Corridors is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;
- 250mm in-situ concrete slab;
- 100mm cavity;
- 50mm mineral wool in the cavity;
- Tiles on grid system.

The above construction (assuming a concrete density of 2340 kg/m^3) when installed in accordance with manufacturer's installation protocol and assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, is expected to achieve a level of airborne sound insulation in excess of $50 \text{ dB } D_{nTw} + C_{tr}$ and a minimum of $56 \text{ dB } D_{nTw} + C$ which would be compliant with the ADE and BREEAM requirements, and the Tribe Standards,.

Separating floor between Plantroom – Guestrooms

The proposed floor between Guestrooms and the plant room is as follows:

- Floor finish;
- Plywood board;
- 5mm Acoustic layer;

- 250mm in-situ concrete slab;
- 100mm cavity;
- 50mm mineral wool in the cavity;
- Tiles on grid system on acoustic hangers.

The above construction (assuming concrete density of 2340 kg/m^3) is expected to achieve the sound insulation required to be compliant with ADE and BREEAM requirements when installed in accordance with manufacturer's installation protocols and assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction.

The above construction (assuming concrete density of 2340 kg/m^3) is expected to achieve a laboratory sound reduction of $68 \text{ dB } R_w + C$, when installed in accordance with manufacturer's installation protocols. Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during construction, the above construction would be expected to achieve a level of airborne sound insulation in the order of the $60 \text{ dB } D_{nT,w} + C$ which is compliant with ADE, BREEAM and the Tribe Standards requirements.

In relation to the sound reduction in the 125 and 250 Hz frequency bands, the proposed construction is considered to have a sound reduction performance above around 50 dB at each band, and therefore is expected to comply with the requirements of 45 dB for both bands.

4.5.3 Impact Sound Insulation

There are generally no impact sound insulation requirements for areas of the hotel other than guestrooms. Guestrooms at first floor level, above the restaurant, bar or reception areas and kitchen, bin room or staff canteen areas have specific requirements based on Tribe standards, however these requirements are understood to apply when these areas are above guestrooms.

In reference to the Gym, the floor finishes and gym equipment should be specified so that impact noise from use of the gym does not adversely impact on guests within guestrooms.

Design information showing the required acoustic enhancements has not been provided at this stage.

4.5.4 Columns in BOH / FOH Areas Sound Insulation

Any columns in rooms likely to experience high noise levels such as plant rooms, substations, switch room, linen room, kitchen and gym will need to be acoustically lined. The proposed lining is a per Wall type 4b, comprising the below:

- 2 layers 15mm Soundbloc;
- 30mm Insulation Mineral Rockwool RW45;
- Gyframe GL2 Channel and GL11 bracket;

The above is considered acoustically acceptable.

4.6 Guestrooms Door Sound Insulation

The Tribe Brand standards provide a requirement for the sound insulation between corridors and guestrooms, it is assumed that this includes the performance of the door. The requirement is set at $43 \text{ dB } D_{nT,w} + C$. To achieve compliance with this requirement considering the proposed Wall Type 3, the minimum acoustic performance of the door is $41 \text{ dB } R_w + C$. This is very high for a typical hotel door, and may be considered too heavy.

The only alternative proposal that would achieve compliance with standard doorsets would be to include a lobby at the entrance to every guestroom, however this is not in keeping with the current design.

If the installation of a second doorset is not feasible, full compliance cannot be achieved, and therefore a derogation against the Brand Standards is required. The following door specification would represent an enhancement over the Building Regulation requirements but is still relatively simple to achieve.

Solid timber core of minimum thickness 54mm, with a minimum mass per unit area of 29 kg/m², and a minimum sound reduction index of 37 dB R_w (measured according to BS EN ISO 140-3:1995 and rated according to BS EN ISO 717- 1:1997). Where possible, doors should be fitted within rebated frames with compressible neoprene/rubber seals fitted at head and jambs. The installation of drop-threshold seals is required.

If the 37dB doors are chosen as the derogation, the resulting sound reduction index for the separating wall is expected to be about 35dB D_{nT,w} + C which is about 8dB below the Brand Standard requirement.

The design information provided shows the specification of the proposed guestrooms entrance doors to achieve 41dB R_w + C. Compliance, assuming the derogation of the Tribe Standards, is expected when incorporating the recommended doorset minimum sound reduction performance of R_w 37dB.

The design information provided shows the specification of the proposed doors interconnecting two rooms to achieve 33dB R_w. In order to achieve the sound insulation requirements for walls separating guestrooms, each interconnecting door should achieve a sound reduction index of R_w 37dB.

The design information showing the required acoustic enhancements has not been provided at this stage. Compliance is expected when incorporating the recommendations provided above, however full compliance cannot be confirmed based on the information currently available.

4.7 Control of Flanking Transmission

Junction detailing for the proposed walls and floors is not available for review at Stage 4, however the architects have confirmed that, generally, all detailing will be in line with the manufacturer's advice.

Attention should be made to the following guidance to ensure good flanking transmission control. It is essential that junctions are detailed correctly and therefore the proposed detailing should be provided to MLM for review as soon as drawings become available at next stage.

4.7.1 Junction of a Separating Wall with a Separating Floor

The proposed separating walls and any independent wall liners must be constructed from slab to slab. Junctions should be well sealed using flexible or acoustic sealant. There should be a minimum of 20mm overlap at the head of the wall between the plasterboard wall linings and the Core board deflection detail.

4.7.2 Junction of an External Wall with a Separating Floor or Wall

There are likely to be a number of junction details with the external walls. The important principles to be followed in these areas are as follows:

- The inner layers of the external walls should not be continuous across the separating walls and separating floors;
- The void within the external wall system at the line of the separating wall or separating floor should be closed with a flexible mineral wool closer.

4.7.3 Junction of a Separating Wall with a Corridor Wall

Where separating walls form a "T"-connection at the corridors, the inner leaf of the plasterboard lining, which forms the head of the "T", should not cross the line of the leg of the "T". Plasterboard linings of the flanking wall should be double boarded.

4.7.4 Junction of an Internal Wall with a Separating Wall

Where an internal partition meets a separating wall, the partition should be fixed to the face of the separating wall.

4.7.5 Control of Flanking Transmission – General Guidance

The following general principles should be considered:

- It is important that the plasterboard sound insulating ceilings are not penetrated for services such as light fittings etc., and that any items such as drop rods etc. are acoustically sealed as they pass through the ceiling;
- Puncturing the ceiling for light fittings may compromise its insulation performance. Where this occurs in the ground floor ceiling, it is recommended that those light fittings be encased (boxed in) to maintain the acoustical integrity of the ceiling;
- Stagger joints in wall linings to avoid air paths.

4.7.6 Integration of structural elements - Cladding around columns in separating walls.

The integration of columns into infill separating walls is the most common situation where structural elements need to be considered.

Any columns that are on the line of the separating wall must be integrated so they do not act as a bridge through the wall for sound transmission. It is important to ensure that the gypsum lining is not fixed directly to the columns, and to provide some resilience between the column and the separating wall structure. This is usually achieved by providing 30mm of dense mineral wool board around the column.

An indicative detail is provided below:

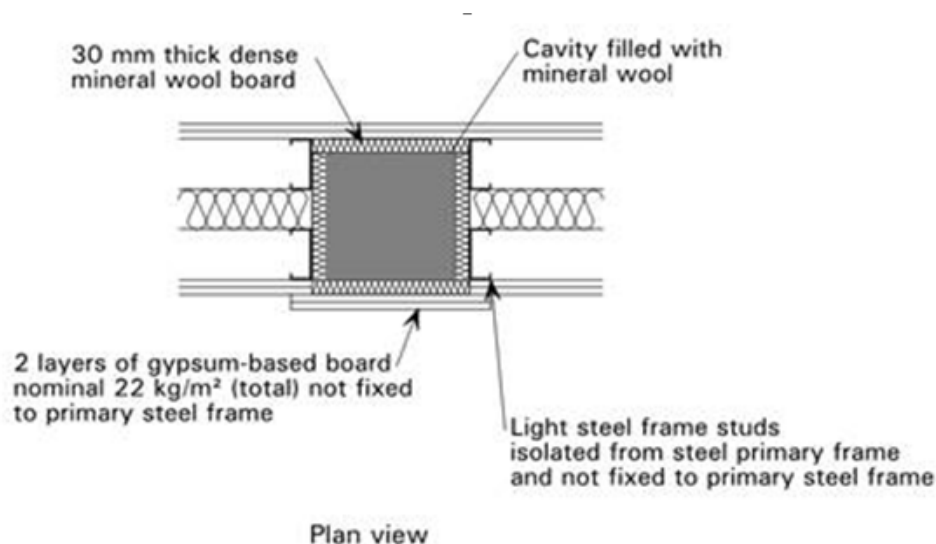


Figure 1: Indicative Structural Column Integration Detailing

4.8 Penetrations

4.8.1 Socket Penetrations

Based on the Tribe Brand Standards there must be no acoustic weak spots in separating walls between bedrooms (eg sockets incorporated into the separating wall between guestrooms).

As a general rule, socket penetrations within separating walls should be avoided wherever possible. Acoustic tests on projects where clients have had a policy of avoiding socket penetrations on separating walls have led to superior results when compared to those obtained from projects where no effort has been made in relation to socket positioning.

If socket penetrations are unavoidable on separating walls, and the Tribe requirement is accepted to be derogated, back-to-back sockets should be avoided, with sockets staggered by at least one stud dimension.

All socket penetrations should be treated by either of the following methods:

- Option 1 – Plasterboard boxing.

Socket boxes should be boxed-in with 2 layers of 15mm dense plasterboard (min 12.6 kg/m²). All interfaces should be well sealed with mastic.

- Option 2 – Hilti Putty Pads.

Socket boxes should be backed with Hilti putty pads. On the second fix, the putty pad can, if required, be introduced within the socket box.

4.8.2 Service Penetrations

Good practice dictates that where services are required to enter hotel rooms, the services should be routed to enter above the guestroom entrance doors. Where other penetrations of separating walls cannot be avoided, suitably robust detailing must be employed. All service penetrations through separating partitions must be fully sealed in order to ensure the acoustic performance requirements are achieved. In practice, improper sealing is one of the most common and significant causes of failure to achieve the sound insulation performance requirements.

4.8.3 Pipework Runs

Vertical Stacks

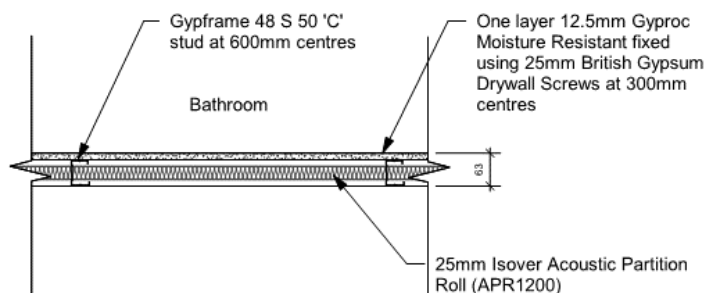
Where Soil Vent Pipework and/or Rain Water Pipework penetrates separating floors within the hotel rooms or other sensitive areas, these pipes should be boxed in using two layers of 12.5mm Soundbloc plasterboard with a 25mm (un-faced) mineral wool quilt within the cavity in addition to a fire-stopping layer at floor level (penetration through this layer should be flexible).

Rainwater pipes transmit noise from outside and radiate flow noise in storms. Ideally, they should be routed outside acoustically sensitive spaces, and should not be attached to the structure of acoustically sensitive spaces. Similar care must be taken in routing of drainage pipes from showers, washbasins and toilets. Rainwater pipes passing through noise sensitive areas must be fully enclosed and insulated to prevent noise break out and cross-talk effects.

Based on the proposals, Wall Type 6b is proposed to contain rainwater pipes between the bathrooms and the guestroom. Advice on this matter has been provided in Section 4.2.

Based on the proposals, Wall Type 6a is proposed between drainage pipes from the bathrooms and the bathroom, and will comprise:

- 1 layer 12.5mm Moisture Resistant Board;
- 48mm Gypframe 'C' Stud;
- 25mm Isover APR 1200 in the cavity.



2 Wall Type 06a

As stated above, the pipes should be boxed in using two layers of 12.5mm Soundbloc plasterboard with a 25mm (un-faced) mineral wool quilt within the cavity in addition to a fire-stopping layer at floor level (penetration through this layer should be flexible). It is therefore advised that if the proposed Wall Type 6a is going to surround pipes, two layers of 12.5mm Soundbloc (or equivalent moisture resistant boards, with comparable density) should be used on both sides.

Design information showing the required acoustic enhancements has not been provided at this stage. Compliance is expected when incorporating the recommendations provided above, however full compliance cannot be confirmed based on the information provided.

Horizontal Pipe Runs

Horizontal pipe runs can often result in noise problems, especially at the vertical – horizontal transition, and warrant particular consideration.

- In the first instance, noise problems can often be avoided by zoning bends and horizontal runs away from sensitive areas (hotel bedrooms in particular);
- There is very little, if any, accurate research on the acoustic performance of pipes. However, the limited information available suggests cast iron pipes or composite type pipes (eg Friaphon) have a better acoustic performance than standard PVC pipes. It is therefore advisable that the pipework for horizontal runs be of the cast iron or a composite (sound attenuated) type. Plumbing consideration permitting, any change in pipe type should occur at least one floor level above the vertical – horizontal transition;
- The pipework should be wrapped with 50mm thickness mineral wool (10kg/m³ minimum);
- The pipework should then be independently boxed with two layers of 12.5mm SoundBloc, with the standard ceiling introduced below.

In order to prevent structure-borne noise problems, it is important all pipework penetrations of floor slabs are flexible with the pipes supported via brackets containing neoprene inserts.

4.8.4 Service Risers

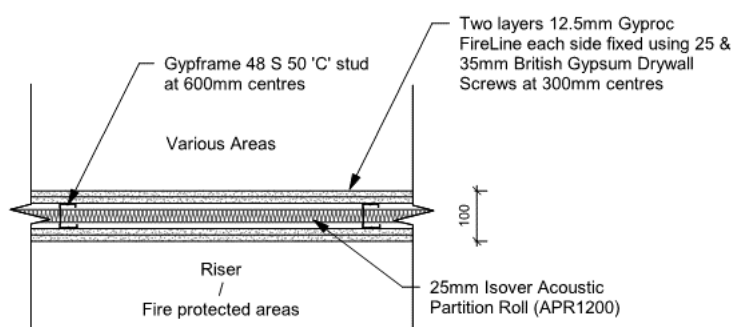
In order to prevent noise transfer across the separating floors via the risers, mineral wool cavity closers/fire-stops should be installed at the line of the separating floors.

Any items within service risers that are likely to cause high levels of noise breakout must be brought to the attention of MLM Consulting Engineers at next stage so that this can be assessed.

It is usually recommended that the guestroom separating wall continues around to form the riser walls.

Wall Type 2 is proposed between bathrooms and service risers and will comprise:

- 2 layers 12.5mm Fireline plasterboard;
- 48mm Gypframe 'C' Stud;
- 25mm Isover APR 1200 in the cavity void;
- 2 layers 12.5mm Fireline plasterboard.



3 Wall Type 02

The above is a British Gypsum system (A206099), which achieves a laboratory sound reduction of 49dB R_w when installed in accordance with the manufacturer's installation protocols. There is no specific requirement for separating walls between service risers and bathrooms, however the combination of riser walls on either side must achieve sufficient sound reduction to achieve compliance with the requirements between guestrooms. It is essential that this area is detailed correctly and therefore the proposed detailing should be provided to MLM for review as soon as drawings become available.

It is noted that in a few rooms per floor (in the north corners and south west corners of the building) the risers have openings to the guestrooms, this is not acoustically advisable if the risers contains noisy elements. It is essential that this area is detailed correctly and therefore the proposed detailing should be provided to MLM for review as soon as drawings become available at next stage.

4.9 Lift Noise

It is noted that a number hotel rooms proposed are to be sited adjacent to the proposed passenger lifts.

The Brand Standards require that noise levels in rooms resulting from the operation of lifts should not exceed the following maximum noise levels.

Table 16: Maximum Noise Levels Resulting from Lift Operations

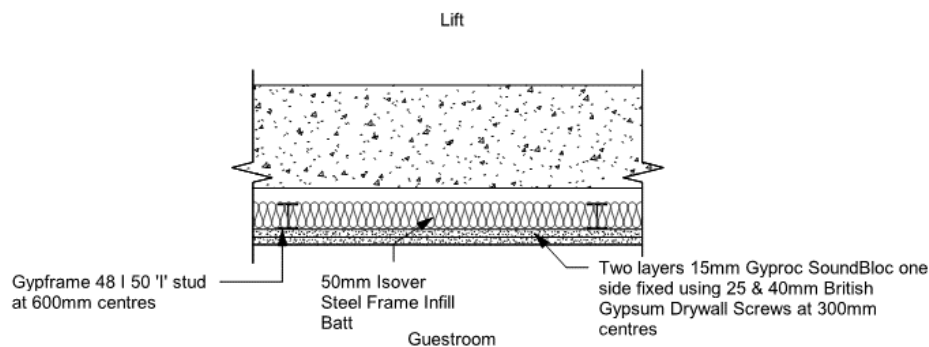
Room Type	Maximum Noise Level dB L_{max}
Bedrooms	25 dBA and NR20

The lift motor and associated equipment should be installed on suitable anti-vibration mountings to prevent the transmission of excessive vibration and/or structure-borne noise to any parts of the hotel.

Lift doors should also operate quietly and acoustic signals indicating the arrival of lifts should not be audible within hotel rooms.

Wall Type 4c is proposed between guestrooms and passenger lifts and is sufficient acoustically, it will comprise:

- 200mm RC wall;
- 10mm gap;
- Minimum 50mm Independent 'I' Stud;
- 50mm mineral wool insulation within the studwork;
- 2 x 15mm SoundBloc plasterboard linings.



8 Wall Type 04c

4.10 Control of Reverberation

4.10.1 Residential Common Areas (Corridors outside Hotel Guestrooms)

Under the current revision of Approved Document E, measures must be taken to control the reverberation in the common internal parts of buildings containing flats or rooms for residential purposes. These will comprise the use of absorbent finishes such as carpets and acoustic ceiling tiles in common areas.

It has been clarified by the Communities and Local Government (CLG) that only areas giving direct access to the residential accommodation (hotel guestrooms) need to be considered.

Based on the current layouts, treatment could therefore be limited to the following areas:

- Communal corridors on all floors giving direct access to guestrooms.

The amount of absorption required depends on whether the particular common area is an entrance hall, defined as a space for which the ratio of the longest to the shortest floor dimension is three or less, or a corridor and hallway defined as a space for which the ratio of the longest to the shortest floor dimension is greater than three. To demonstrate that this has been complied with, two methods are given as described below.

Method A

Cover a specified area with an absorber of an appropriate class that has been rated according to BS EN ISO 11654:1997 Acoustics – Sound absorbers for use in buildings – Rating of sound absorption.

- Entrance Halls, Corridors or Hallways - Cover an area equal to or greater than the floor area with a Class C absorber or better.

Method B

Determine the minimum amount of absorptive material using a calculation procedure in octave bands. In comparison to Method A, this method takes into account the existing absorption provided by all surfaces. This method is intended only for corridors, hallways and entrance halls.

- Entrance Halls - A minimum of 0.2 m² total absorption area per cubic metre of the volume should be provided;
- Corridors and Hallways - A minimum of 0.25 m² total absorption area per cubic metre of the volume should be provided.

Brand Standards

The Brand Standards also prescribe a requirement for absorption on corridors leading to bedrooms. It is a requirement to cover 65% of the ceiling using a material with an absorption coefficient $a_w \geq 0.75$; this is equivalent to a Class B absorber.

It is understood, based on the Interior Design Proposals that it will not be possible to include for absorbent common corridors ceilings, and therefore a derogation against the Brand Standards is required.

Method B above has been used in order to provide the minimum sound absorption performance for the carpet required to meet Building Regulations ADE, assuming the finishes below for the corridors leading to guestroom, based on the information provided by the Interior Design Team:

- Plasterboard suspended ceiling finish;
- Plasterboard walls;
- Timber/Wooden Doors;
- Carpet Floor.

In order to achieve a minimum of 0.25 m² total absorption area per cubic metre of the volume of the corridors, the minimum sound absorption in Table 17 should be provided by the carpet.

Table 17: Minimum Carpet sound Absorption Required α					
Finish	Octave Band Data Provided (α)				
	250	500	1k	2k	4k
Carpet	0.09	0.25	0.35	0.35	0.32

Design information showing the required acoustic enhancements has not been provided at this stage. Compliance is expected when incorporating the recommendations provided, however full compliance cannot be confirmed based on the information provided.

4.10.2 Other Hotel Areas

Kitchen and Staff

The reverberation time requirement which applies to the Kitchen is shown in Table 18 along with the recommended finishes.

Table 18: Tribe Reverberation Time Requirements		
Application	Requirement	Recommended Finishes
Kitchen, Staff Rest and Canteen	100% Ceiling coverage $a_w \geq 0.8$	Class A finish to entire ceiling

Ecophon Hygiene Advance A 40 mm tiles are proposed for the ceiling in these areas. Based on the data from the manufacturer this is a Class A finish and therefore is compliant with the Tribe Brand Standards.

Restaurant, Bar and Reception

The Tribe Brand Standards for reverberation time in the Restaurant, Bar and Reception areas are presented in the Table 19 below, along with the minimum requirement set out to achieve the relevant BREEAM Hea05 credit, and the minimum reverberation time expected to result in reasonable acoustic conditions if BREEAM credit is not sought, and the Tribe Standards are derogated.

Table 19: Reverberation Time Requirements – FOH				
Application	Reverberation Time Requirement Tribe Standard	Reverberation Time Requirement ADE	BREEAM HEA05 Requirement	Minimum Requirement to Achieve Reasonable Conditions
Restaurant, Bar, Reception	$0.6s \leq RT \leq 0.8s$ (T_{mf})	-	$RT \leq 1.0s$ (T_{mf})	$RT \leq 1.5s$ (T_{mf})

The BREEAM requirement is based on the requirement for a dining hall in a school. The minimum requirement is representative of that for an atrium or circulation spaces in a school.

It is understood, based on the Interior Design Proposals that it will not be possible to include the absorptive materials required to achieve the Tribe reverberation time requirement in the FOH main area, and therefore a derogation will be required.

It is also understood that BREEAM credit for Reverberation Time is not sought, and therefore a maximum reverberation time of 1.5 seconds, which is representative of the requirement for a school atrium is targeted. This would be considered as reasonable for such a space. Options for sound absorptive materials and the necessary associated areas have been provided to achieve this target.

To control the reverberation time and noise build-up in the restaurant, bar and reception area, absorptive finishes will be required.

In order to calculate the necessary amount of absorptive finishes, the following finishes and dimensions have been used:

- Hard floor finishes (concrete);
- Blockwork and Plasterboard lining walls;
- Double glazing façade;

- Concrete soffit;
- Ceiling 4.2 metres high.

The following table includes the recommended amount of additional sound absorptive materials to be applied in order to meet the varying targets.

Table 20: Reverberation Time Requirements – Areas required for each criteria and Absorptive Material Class			
Area	Tribe Standard Requirement	BREEAM Hea05 Requirement	Minimum Advised Requirement
Restaurant, Bar, Reception	506 m ² class A absorption to walls and/or ceiling; or	391 m ² class A absorption to walls and/or ceiling; or	239 m ² class A absorption to walls and/or ceiling; or
	569 m ² class B absorption to walls and/or ceiling; or	440 m ² class B absorption to walls and/or ceiling; or	268 m ² class B absorption to walls and/or ceiling; or
	759 m ² class C absorption to walls and/or ceiling.	587 m ² class C absorption to walls and/or ceiling.	358 m ² class C absorption to walls and/or ceiling.

There are a variety of approaches that can be adopted to control reverberation in FOH areas such as reception, restaurants and bars. The following outlines three common approaches for the treatment of reverberation which could be applied:

Approach 1: Use of Acoustically Absorbing Ceilings

- Direct fix soffit treatment.

Approach 2: Use of Solid Ceilings with Sound Absorptive Panels Below

- Suspended acoustic baffles;
- Free hanging acoustic rafts;
- Acoustic wall panels.

Approach 3: Use of Solid Ceilings with Acoustic Integrated Services

- Lighting trays with acoustic elements;
- Combination of acoustic lighting trays and acoustic wall panels.

Design information showing the required acoustic enhancements has not been provided at this stage. Compliance is expected when incorporating the recommendations provided, however full compliance cannot be confirmed based on the information provided.

5 Building Services Acoustic Design

Noise emissions from building services plant associated with the proposed development will need to be controlled in order to achieve acceptable levels of environmental noise when the development is complete and is in operation.

5.1 External Sound Level Criteria

- BS 4142:2014+A1 “Method for Rating and Assessing Industrial and Commercial Sound”;
- Local Authority Acoustic Requirements. Condition 9 in Planning Application Decision 125848/FO/2020 set out a rating level for the external plant 5 dB below the typical background level at the nearest noise sensitive receptor.

In order to comply with the requirements of Manchester City Council, the noise criteria set out below are proposed. These limits apply to the operating hours of the installation, which may be during the day and night time periods.

Table 21: Proposed Plant sound Emission Limits		
Operating Period	Typical Measured Background Noise Level at MP3, $L_{A90,T}$ dB	Proposed Rating Plant Noise Limit at the NNSR, $L_{Ar,Tr}$ (dB)
Daytime (07:00-23:00)	58	53
Night-time (23:00-07:00)	53	48

Compliance with the above limiting noise levels would result in a low impact at noise sensitive receptors, it would also achieve the BREEAM Pol05 credit for noise pollution.

5.2 Noise Sensitive Locations

The Nearest Noise-Sensitive Receptor (NNSR) is the Radisson Blu Hotel at approximately 200m to the south of the Site. However, there is potential for new hotels or other noise-sensitive developments just a few metres from the Site. It is proposed to limit external plant noise emissions to achieve the BS4142 rating limits at plots H2, H5, H6 to the south and west of the site, Plot G1 to the east of the site and Plot E2 to the north of the site. This should ensure adverse impact is also avoided at locations further from the site.

5.3 Building Services Overview

It is understood that the majority of proposed plant installations will be at eighth floor level with some plant at roof level. Additionally, a louvre at ground floor level will serve the building services plant for the FOH and BOH areas. Based on the information provided by the M&E consultants, the plant serving the hotel at Level 8 will include:

- 33 No External condenser units CU-08-01 to CU-08-33;
- 4 No Hot water EVO Units HWS-B-1 to HWS-B-4;
- 2 No AHUs AHU-08-01 and AHU-08-02;
- Emergency Generator Set LSG-08-01.

It is understood that normal operating conditions will not include the Emergency Generator set, and will include the simultaneous operation of 80% of the external condenser units during the daytime (26 units) and 70% of the external condenser units during the night-time (23 units).

Based on the information provided by the M&E consultants, the plant serving the hotel at Level 9 will include:

- 2 No AHUs serving the kitchen AHU-RF-01 and AHU-RF-02.

Areas such as the restaurant, bar, gym and back of house rooms will have local air handling units installed within the ceiling voids, with inlets and outlets connected to external louvres at ground floor level at the west, north and east facades. There is also a proposed LV switch room, Substation, and Plant Room at ground floor level. Based on the information provided by the M&E consultants, the plant serving the hotel at Ground Floor will include:

- 4 No AHUs serving the Bar AHU-GF-01A, AHU-GF-01B, AHU-GF-02A and AHU-GF-02B;
- 1 No AHUs serving the Gym HRU-GF-03;
- 1 No AHUs serving the Toilets HRU-GF-04;
- 1 No AHUs serving the Admin Room HRU-GF-02;
- 1 No AHUs serving the Linen Room HRU-GF-07;
- 1 No AHUs serving the Services Areas AHU-GF-05;
- 1 Extract Fan serving the Comms Room EF-GF-01;
- 1 Extract Fan serving the Plant Room EF-GF-03;
- 1 Extract Fan serving the Bins Room EF-GF-0.

The plant selections and acoustic data provided by the M&E consultants, and base on manufacturer data is presented in the table below.

Where spectrum data is not available (as per the Hot Water Units) frequency levels have been assumed based on MLM's database.

Table 22: Plant Noise Emission Data From Manufacturer and MLM's Databases

Plant Item	Model		Octave Band Data Provided (dB) - PWL								LWA
			63	125	250	500	1k	2k	4k	8k	dBA
External Condenser units - Level 8	Toshiba MMY-MAP1606FT8P-UK (1 unit)		83	87	88	86	82	74	63	60	87
	Toshiba MMY-MAP1806FT8P-UK (4 units)		83.5	87.5	88.5	86.5	82.5	73.5	63.5	60.5	87.5
	Toshiba MMY-MAP1406FT8P-UK (14 units)		82.5	87.5	86.5	84.5	79.5	72.5	61.5	58.5	85.5
	Toshiba MMY-MAP1206FT8P-UK (14 units)		83	88	87	86	81	74	65	59	86
Hot water Units – Level 8	SUPAflo EVO SF61		54	54	61	67	63	65	61	58	70
AHUs – Level 8	Daikin AHUs AHU-08-01 and AHU-08-02	Supply Inlet	72	90	83	74	71	70	74	61	81
		Breakout	63	82	70	67	74	64	66	42	76
		Return Outlet	75	93	86	84	90	82	84	74	93

Table 22: Plant Noise Emission Data From Manufacturer and MLM's Databases

Plant Item	Model		Octave Band Data Provided (dB) - PWL								L _{WA}
			63	125	250	500	1k	2k	4k	8k	dBA
		Breakout	61	81	70	66	72	62	65	40	75
AHUs – Level 9	AHU-RF-01	Exhaust	77	89	86	86	83	78	76	71	88
		Breakout	64	75	63	57	49	42	33	25	62
	AHU-RF-02	Intake	72	75	82	77	70	64	59	58	78
		Breakout	69	72	70	62	54	46	39	33	65
AHUs Bar – GF	Daikin AHUs AHU-GF-01A, AHU-GF-01B, AHU-GF-02A and AHU-GF-02B	Supply Inlet	71	71	65	53	54	53	41	32	61
		Return Outlet	76	80	80	74	69	72	66	60	78
AHU Gym – GF	Daikin HRU-GF-03	Supply Inlet	65	66	60	48	49	47	35	21	56
		Return Outlet	70	74	74	69	63	65	59	52	72
AHU Toilets – GF	Daikin HRU-GF-04	Supply Inlet	72	71	65	52	49	45	38	27	60
		Return Outlet	68	74	78	70	62	66	60	54	73
AHU Admin Room – GF	Daikin HRU-GF-02	Supply Inlet	72	71	65	52	49	45	38	27	60
		Return Outlet	68	74	78	70	62	66	60	54	73
AHU Linen Room – GF	Daikin HRU-GF-07	Supply Inlet	64	66	64	54	55	54	44	36	61
		Return Outlet	73	76	77	71	66	70	65	59	75
AHU Services Areas – GF	Daikin AHU-GF-05	Supply Inlet	61	63	59	49	48	44	30	18	55
		Return Outlet	68	72	74	70	63	64	56	48	71

Table 22: Plant Noise Emission Data From Manufacturer and MLM's Databases

Plant Item	Model		Octave Band Data Provided (dB) - PWL								L _{WA}
			63	125	250	500	1k	2k	4k	8k	dBA
Extract Fan Comms Room – GF	EF-GF-01	Outlet	71	78	69	67	65	62	54	45	80
Extract Fan Bins Room and Plant Room– GF	EF-GF-02 and EF-GF-03	Outlet	61	77	65	63	61	58	52	42	78

In relation to the Emergency Generator it has been assumed a maximum sound pressure level of 75 dBA at 1 metre, and the sound power level have been calculated as 97 dBA based on the container dimensions.

Attenuators have been included for the majority of the AHUs and extract fans above. The attenuation data provided by the M&E consultant are presented in Table below.

Table 23: Attenuators Insertion Loss From Manufacturer data

Plant Item	Reference	Octave Band Data Provided (dB)							
		63	125	250	500	1k	2k	4k	8k
AHUs AHU-08-01 and AHU-08-02	Supply inlet ATT-RF-02, ATT-RF-10	8	13	23	33	31	24	20	18
	Return Outlet ATT-RF-01, ATT-RF-09	8	13	23	33	31	24	20	18
AHU-RF-01	Exhaust ATT-RF-11	9	17	30	43	43	32	27	24
AHU-RF-01	Intake ATT-RF-13	9	17	30	43	43	32	27	24
AHUs Bar	Supply Inlet ATT-GF-25, ATT-GF-30	5	10	18	24	26	22	17	12
	Return Outlet ATT-GF-24, ATT-GF-31	5	11	17	25	29	27	18	14
AHU Gym HRU-GF-03	Supply Inlet & Return Outlet ATT-GF-18, ATT-GF-19	1	2	5	12	27	17	13	13
AHU Toilets HRU-GF-04	Supply Inlet & Return Outlet ATT-GF-15, ATT-GF-14	1	2	5	11	23	14	12	11
AHU Admin HRU-GF-02	Supply Inlet ATT-GF-05	4	8	12	19	25	23	22	14
	Return Outlet ATT-GF-06	4	7	12	18	20	20	15	12

Table 23: Attenuators Insertion Loss From Manufacturer data

Plant Item	Reference	Octave Band Data Provided (dB)							
		63	125	250	500	1k	2k	4k	8k
AHU Linen HRU-GF-07	Supply Inlet ATT-GF-02	1	2	4	11	22	13	11	10
	Return Outlet ATT-GF-01	1	2	5	11	23	14	12	11
AHU Services Areas AHU-GF-05	Supply Inlet & Return Outlet ATT-GF-11, ATT-GF-10	1	3	7	14	29	21	16	15
EF Comms Room – EF- GF-01	Outlet ATT-GF-22	4	7	9	16	30	32	30	26
EF Bins Room – EF- GF-02	Outlet ATT-GF-09	1	2	5	12	27	17	13	13
EF Plant Room – EF- GF-03	Outlet ATT-GF-23	1	3	9	18	33	30	20	18

In addition to the above, the external plant area at Level 8 is proposed to have 11 ventilation louvres as shown in the elevations drawings. The minimum sound insulation proposed for these louvres is presented in Table below.

Table 24: Sound Reduction Index for Level 8 Louvres (dB)

Item	Frequency (Hz)								R _w
	63	125	250	500	1k	2k	4k	8k	
Acoustic Louvres	7	9	12	24	31	33	29	30	26

The above have been included in the noise assessment for the calculation of the noise impact at the noise sensitive receptors in the Area.

5.4 Calculation of Noise Levels at Noise Sensitive Receptors

The calculated specific sound level at the location of the nearest noise sensitive receptors resulting from the operation of proposed plant items has been assessed in accordance with the requirements of BS4142:2014.

All atmospheric propagation predictions have been carried out with the use of the noise modelling computer packages Sound Design and Cadna/A, in accordance with the ISO 9613 prediction methodology.

In addition to the input source noise data, the Cadna/A model considers the effects of topography, ground absorption, acoustic screening, atmospheric absorption and acoustic reflections, as well as applying a light downwind correction to consider a typical worst case situation.

BS4142:2014 advises that when the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the perceptibility of the aforementioned characteristics of the sound at the receptor location is added to the specific noise level to obtain the $L_{Ar,Tr}$ 'rating level'. A correction to include the consideration of a level of uncertainty in noise measurements, data and calculations can also be applied when necessary. It also advises that the assessment of the significance of sound needs to take into account the context in which the sound will occur.

Based on the operating profile of the proposed plant and data provided by the manufacturers, no penalties are considered necessary for tonality or impulsivity of the sound arising from the development in this instance.

Taking into account the context; the sound from the proposed plant would not be expected to materially alter the character of the prevailing acoustic environment at the location of the nearest noise sensitive receptors, which will be designs according to the current ambient noise levels in the area, which are affected by road traffic noise and airport noise.

The results of the assessment can be seen in Table 25 below, which shows the predicted rating sound levels at the worst affected façades of the existing and future buildings in the surrounding area and provides a comparison against the typical prevailing L_{A90} background sound levels, and the limits for the development.

Assessment Location	Period	Predicted Rating Level $L_{Ar,Tr}$ (dB)	Background $L_{A90,T}$ Sound Level (dB)	Rating Level Limit $L_{Ar,Tr}$ (dB)	Excess of $L_{Ar,Tr}$ above Limit (dB)
NNSR1 - Radisson Blu Hotel	Daytime	38	58	53	-15
	Night-time	37	53	48	-11
Plot H2 - West	Daytime	48	58	53	-5
	Night-time	47	53	48	-1
Plot H5- South West	Daytime	44	58	53	-9
	Night-time	44	53	48	-4
Plot H6- South	Daytime	46	58	53	-7
	Night-time	45	53	48	-3
Plot G2 - East	Daytime	55	58	53	+2
	Night-time	55	53	48	+7
Plot E2 - North	Daytime	48	58	53	-5
	Night-time	48	53	48	+0

As may be seen with reference to the table above, the proposed scheme is predicted to comfortably comply with the proposed noise emissions criteria in the majority of locations and, as such, noise emissions would be expected to result in a low impact for all the existing and future receptors in the area, except for the proposed G2 Plot.

It must be noted that the impact for Plot G2 will generally be compliant with the criteria for the development except for a very small area corresponding to the upper floors (above 22 metres) on the North West corner of the Plot.

The above is compliant with Condition 9 for the development and it would also achieve the BREEAM Pol05 credit for noise pollution. This is clear for the existing receptors in the area and therefore compliance with Condition 9 limits and Pol 05 Credit is possible considering the mitigation measured included above.

In relation to the exceedance found above 22 metres in the North West corner of Plot G2, there is no information at this Stage of the proposals for this Plot, and therefore this should not prevent the development from being compliant with Planning Condition 9 or the Pol05 BREEAM Credit.

In relation to the operation of the Emergency Generation Set, this plant is not included in the normal operation of the site, and therefore the above limits will not apply. However, the impact of the operation of the Emergency Generator Set along with the rest of the plant, has been assessed in order to evaluate any nuisance this may cause. The noise impact will be generally below the background sound levels in the area and therefore, the noise impact of the operation of Emergency Generation Set will be low.

5.5 General Mitigation Guidance

5.5.1 System Regenerated Noise

Noise in ventilation systems is generated by the flow of air past diffusers, grilles, dampers, sound attenuators, turning vanes and duct fittings, as well as by the fan. The noise level generated at each location in the system depends on the air velocity and the local geometry and fittings. The ventilation systems need to be effectively designed to minimise airflow regenerated noise as far as possible.

Systems should be designed to avoid airflow generated noise from excessive air velocities, fittings, duct mounted components and terminal devices. As a general rule, the duct velocities stated below should not be exceeded. These duct velocities are based on a system with good geometry and reasonable spacing of fittings (three to four duct dimensions). For systems in which these factors are compromised, lower velocities should be employed.

Table 26: Recommended Duct Velocities

Noise Level L_{Aeq}	Air Velocity m/s		
	Main Ducts	Branch Ducts	Final Connections
25	4.5	3.5	2.0
30	5.0	4.5	2.5
35	6.5	5.5	3.25
40	7.5	6.0	4.0
45	9.0	7.0	5.0

5.5.2 Building Services Noise Limits

The requirements governing internal plant noise levels in relation to the building services noise emissions are as follows:

Table 27: Tribe Building Services Noise Limits

Application	Building Services Noise Levels to be Achieved	
Guestrooms	Low Speed: 28 dBA L_{eq} (Approximately NR22)	Medium Speed: 31 dBA L_{eq} (Approximately NR25)
Guestrooms (plant noise intrusion)	22 dBA L_{eq}	NR17
Guestrooms (evacuation pipes)	28 dB L_{Amax}	

Table 27: Tribe Building Services Noise Limits

Application	Building Services Noise Levels to be Achieved	
Breakout Area, Restaurant, Bar, Reception, Staff Rest & Canteen	35 dB L_{eq}	NR30
Restaurant, Bar, Reception (evacuation pipes)	35 dB L_{Amax}	
Kitchen	45 dB L_{eq} - 55 dB L_{eq} with extractor in Operation	NR40 – NR50 with extractor in Operation
Offices	30 dBA L_{eq}	NR30

The final design and the contractor will need to ensure that the above limits are met in the different spaces.

5.5.3 Control of Vibration from Building Services

In order to prevent detectable vibration from reaching the occupied areas of the building, and to control noise transmission resulting from vibrating plant, it is necessary to ensure that all such plant is effectively isolated. This is achieved by mounting the machine on vibration isolators, normally comprising springs or rubber, neoprene or glass fibre blocks which are semi - compressed under the load of the plant and its associated base. The lower the forcing frequency of the plant, the greater the static deflection needed to ensure good isolation at the forcing frequency. Increased static deflections are required when plant is located on the upper floors of a building, where the floor itself deflects and acts like a spring.

Vibration can also be transmitted into the building via pipework and ductwork connections. In order to avoid this, flexible connections should be specified between plant and the connected ductwork and/or pipework. Resilient pipe and duct hangers should be specified within the plant rooms and for any ductwork or pipework which is immediately adjacent to any noise sensitive area. Electrical connections to vibrating plant should be looped to control vibration transmission into the building structure. Where pipes and ducts penetrate walls, the perimeter seal (also required to control airborne sound transmission) should be flexible to prevent vibration transmission from the pipe or duct into the adjacent wall.

Any rotating and reciprocating plant should be fitted with efficient anti-vibration mountings. Plant mounted on anti-vibration mountings should be isolated by flexible connections from ducts, pipes and conduits.

Ductwork and pipework in the plant areas, and ductwork and pipework in contact with structures bounding noise sensitive areas will need to be supported on anti-vibration hangers.

5.5.4 Routing Services Through or Near Acoustically Sensitive Spaces

The routing of building services should be considered carefully by the contractor during the construction design stage.

Services serving acoustically sensitive spaces must not be routed through noisy spaces or through other acoustically sensitive spaces. Services serving other areas must not be routed through acoustically sensitive spaces. Noise can enter a duct or pipe in one space and be transmitted down the duct or pipe to another.

Rainwater pipes transmit noise from outside and radiate flow noise in storms. They should be routed outside acoustically sensitive spaces, and should not be attached to the structure of acoustically sensitive spaces. Similar care must be taken in routing of drainage pipes from showers, washbasins and toilets. Rainwater pipes passing through noise sensitive areas must be fully enclosed and insulated to prevent noise break out and cross-talk effects. Double skin enclosures would be required for this purpose. The same treatment would be required at bases of stacks and change of direction.

5.6 Services Distribution

It is strongly recommended that where possible penetrations through acoustically rated partitions between acoustically sensitive areas should be avoided. Where this cannot be avoided, specialist treatment to the penetration is likely to be required. Penetrations which occur where ducts and pipes pass through walls, floors and partitioning are to have flexible, airtight seals to prevent the transmission of vibration into the structure and to maintain the sound insulation performance of the sound insulating element. This is achieved by forming a penetration which leaves a gap of approximately 15mm around the duct or pipe, packing the gap tightly with mineral fibre and caulking the perimeter from both sides, using non-hardening sealant.

The recommendations and requirements for acoustic sealing should be coordinated with the requirements for fire protection of penetrations and for the sealing of plenum voids.

Where services penetrate separating elements, and are common through different areas, particularly those requiring privacy, there will be a need to treat crosstalk with appropriate attenuators. For guidance, these should provide at least the same degree of cross talk attenuation via common ductwork between two rooms as the sound insulation offered by the building fabric separating those rooms. Where ductwork passes through an acoustically rated wall, an airtight seal is also essential and lagging is likely to be required.

Services passing into independent structures (eg independent plasterboard ceilings) must not bridge the independent structure to the building structure, and so will require flexible connections and other vibration isolation measures.

5.7 Cross Talk Attenuation

Control of 'crosstalk' (noise from one room entering a duct and being transmitted through the duct to another room), will be needed between spaces that require acoustic separation but are served by a common air system, and also where ductwork passes through high performance structures. In many cases attenuators and areas of external acoustic lagging will be required. Ducts serving adjacent acoustically sensitive rooms should be routed via the circulation spaces and not directly room-to-room, to reduce the requirements for crosstalk attenuation.

Where the above requirements cannot be met, allowances should be made for the provision of crosstalk attenuators at the line of the separating wall between the two affected spaces. The common ductwork between these spaces will be required to provide at least the same level of performance as the sound insulation offered by the building fabric separating the various rooms

6 Conclusion

MLM Consulting Engineers Limited has been commissioned by Rusupo Limited to provide acoustic technical design for the proposed development at Plot H3 Manchester Airport and to undertake an assessment of current construction proposals for the proposed hotel development, in terms of their ability to achieve compliance with Ibis Brand Standards, Part E of the Building Regulations and BREEAM Hea05 & Pol05.

Accordingly, this report presents appropriate acoustic design criteria for the various areas of the development and, based upon the latest Dexter Moren Associates Ltd proposals, provides an assessment of the ability of the scheme to satisfy these requirements.

Where the analysis indicates that the currently proposed scheme is unlikely to achieve compliance with the required performance levels, or where details have yet to be provided, appropriate solutions are proposed such that the numeric performance standards can be achieved.

The RIBA Stage 4 design proposals are generally compliant with the project acoustic requirements. Certain design enhancements are still currently required to achieve full compliance, and these have been identified in this report.

Appendix A - Glossary of Acoustic Terminology

Wording	Description
Sound Pressure	Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
Sound Pressure Level (Sound Level)	The sound level is the sound pressure relative to a standard reference pressure of $20\mu\text{Pa}$ (20×10^{-6} Pascal's) on a decibel scale.
Decibel (dB)	A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s_1 and s_2 is given by $20 \log_{10} (s_1 / s_2)$. The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is $20\mu\text{Pa}$.
A-weighting, dB(A)	The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
Noise Level Indices	Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
$L_{eq,T}$	A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
$L_{max,T}$	A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
$L_{90,T}$	A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
$L_{10,T}$	A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
Free-Field	Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m
Facade	At a distance of 1m in front of a large sound reflecting object such as a building façade.
Fast Time Weighting	An averaging time used in sound level meters. Defined in BS 5969.
Insertion Loss	The sound level reduction at a given location due to the insertion of a noise control device, expressed in decibels. The difference, in decibels, between the sound pressure level before and after the effect of a sound-attenuating device.

Wording	Description
R_w	Sound Reduction Index: laboratory measurement that characterises the sound insulating properties of a material or building element in a stated frequency band. It is calculated through the following formula: $R = L_1 - L_2 + 10 \log (S/A)$, where L_1 is the average sound pressure level in the source room, L_2 is the average sound pressure level in the receiving room, S is the area of the test specimen in m^2 and A is the equivalent sound absorption area of the receiving room). The w weighting is used to provide a single-number quantity for the sound reduction performance of a material or building element, and it is calculated in line with BS EN ISO 717-1.
D_{nTw}	Standardized Level Difference: in-situ sound insulation measurement between two rooms, which includes the effects of flanking transmission, different room sizes and other on-site considerations (differing from a laboratory measurement). This index corrects the measured level difference between rooms to a standardized reverberation time of 0.5 seconds. This RT value is often cited as approximately average for a medium sized, carpeted and furnished living room. The level difference per each frequency band is calculated using the following formula: $D_{nT} = D + 10 \log (T/T_0)$, where D is the level difference (L_1-L_2), T is the reverberation time in the receiving room and T_0 is the reference reverberation time (0.5 seconds for habitable rooms). The w weighting is used to provide a single-number quantity for the sound reduction performance of a material or building element, and it is calculated in line with BS EN ISO 717-1.
C_{tr}	Spectrum adaption term for an urban traffic noise spectrum, which is usually added to R_w or D_{nTw} values in order to characterise their sound insulation performance taking into account low frequency noise. This C_{tr} adaption term is calculated using the BS EN ISO 717-1.
L_i	Impact Sound Pressure Level: average sound pressure level in a one-third octave band in the receiving room when the floor under test is excited by the standardized impact sound source; it is expressed in decibels.
L'_{nTw}	Weighted Standardized Impact Sound Pressure Level: in-situ impact sound pressure level in a stated frequency band, corrected for the standardized reverberation time of 0.5 seconds for a medium sized, carpeted and furnished living room. It is calculated using the following formula: $L_{nT} = L_i - 10 \log (T/T_0)$, where L_i is the impact sound pressure level, T is the reverberation time in the receiving room and T_0 is the reference reverberation time (0.5 seconds for habitable rooms). The w weighting is used to provide a single-number quantity for the impact sound pressure level of a floor, calculated in line with BS EN ISO 717-2. The L_{nTw} is the equivalent index for laboratory measurements.

In order to assist the understanding of acoustic terminology and the relative change in noise, the following background information is provided.

The human ear can detect a very wide range of pressure fluctuations, which are perceived as sound. In order to express these fluctuations in a manageable way, a logarithmic scale called the decibel, or dB scale is used. The decibel scale typically ranges from 0 dB (the threshold of hearing) to over 120 dB.

The ear is less sensitive to some frequencies than to others. The A-weighting scale is used to approximate the frequency response of the ear. Levels weighted using this scale are commonly identified by the notation dB(A).

In accordance with logarithmic addition, combining two sources with equal noise levels would result in an increase of 3 dB(A) in the noise level from a single source.

A change of 3 dB(A) is generally regarded as the smallest change in broadband continuous noise which the human ear can detect (although in certain controlled circumstances a change of 1 dB(A) is just perceptible). Therefore, a 2 dB(A) increase would not normally be perceptible. A 10 dB(A) increase in noise represents a subjective doubling of loudness.

A noise impact on a community is deemed to occur when a new noise is introduced that is out of character with the area, or when a significant increase above the pre-existing ambient noise level occurs.

For levels of noise that vary with time, it is necessary to employ a statistical index that allows for this variation. These statistical indices are expressed as the sound level that is exceeded for a percentage of the time period of interest. In the UK, traffic noise is measured as the L_{A10} , the noise level exceeded for 10% of the measurement period. The L_{A90} is the level exceeded for 90% of the time and has been adopted to represent the background noise level in the absence of discrete events. An alternative way of assessing the time varying noise levels is to use the equivalent continuous sound level, L_{Aeq} .

This is a notional steady level that would, over a given period of time, deliver the same sound energy as the actual fluctuating sound.

To put these quantities into context, where a receiver is predominantly affected by continuous flows of road traffic, a doubling or halving of the flows would result in a just perceptible change of 3 dB, while an increase of more than 25%, or a decrease of more than 20%, in traffic flows represent changes of 1 dB in traffic noise levels (assuming no alteration in the mix of traffic or flow speeds).

Note that the time constant and the period of the noise measurement should be specified. For example, BS 4142 specifies background noise measurement periods of 1 hour during the day and 15 minutes during the night. The noise levels are commonly symbolised as $L_{A90,1\text{hour}}$ dB and $L_{A90,15\text{mins}}$ dB. The noise measurement should be recorded using a 'FAST' time response equivalent to 0.125 ms.

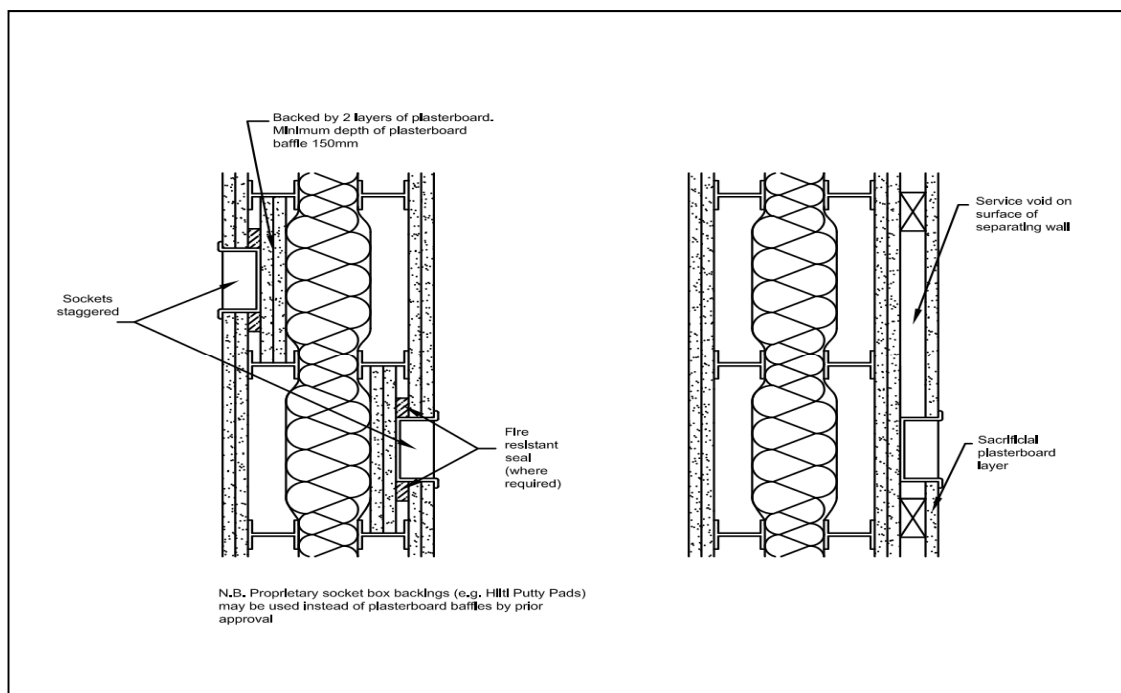
Appendix B - Standard Penetration Details

This document presents standard details that have been prepared by MLM Acoustics to show the general principles that should be adopted when detailing service penetrations in order to minimise the risk of such penetrations downgrading the acoustic performance of the separating construction through which the penetration passes. The sketches in this document should be treated as indicative.

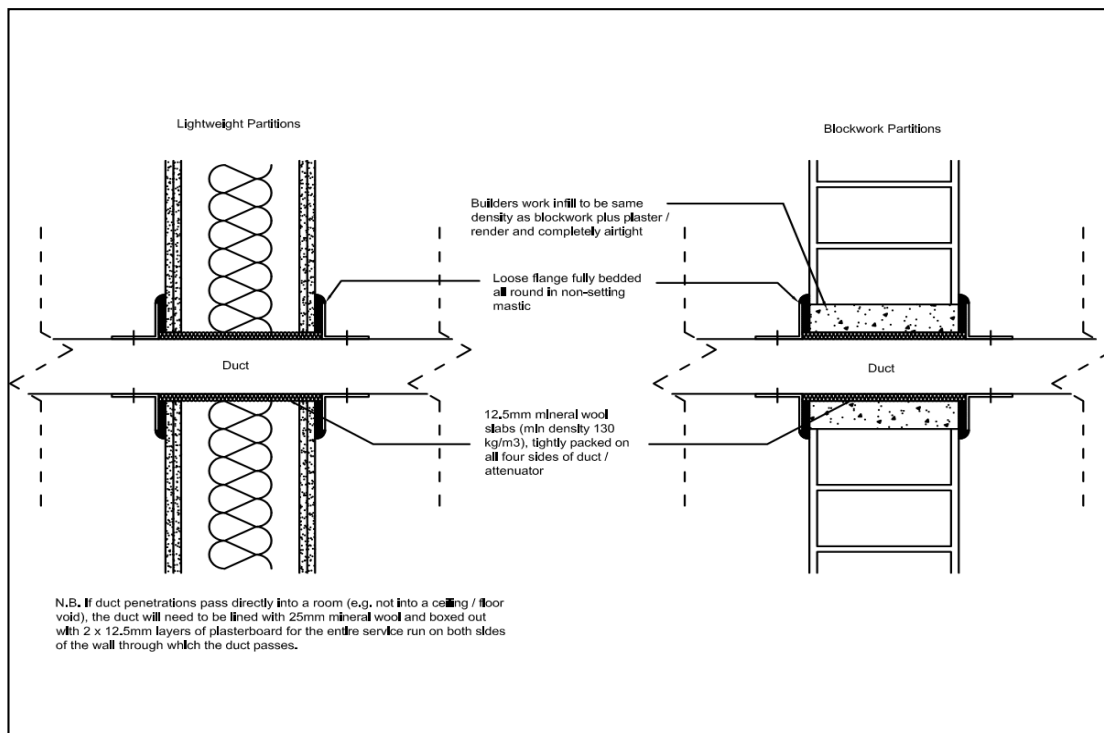
The enclosed sketches present general design principles that should be adopted in order to maintain the acoustic performance of separating constructions. As such, these sketches relate only to acoustic considerations and in no way imply that other statutory or regulatory requirements (eg fire regulations, structural integrity etc) will be achieved with the details shown.

The sketches in this document may not be directly applicable to every situation; however changes to the enclosed details that may appear small can have a disproportionately large impact on the acoustic performance. As such, if similar (but not identical) details to those presented are to be used for a given project, any changes should be checked by MLM Acoustics prior to construction commencing.

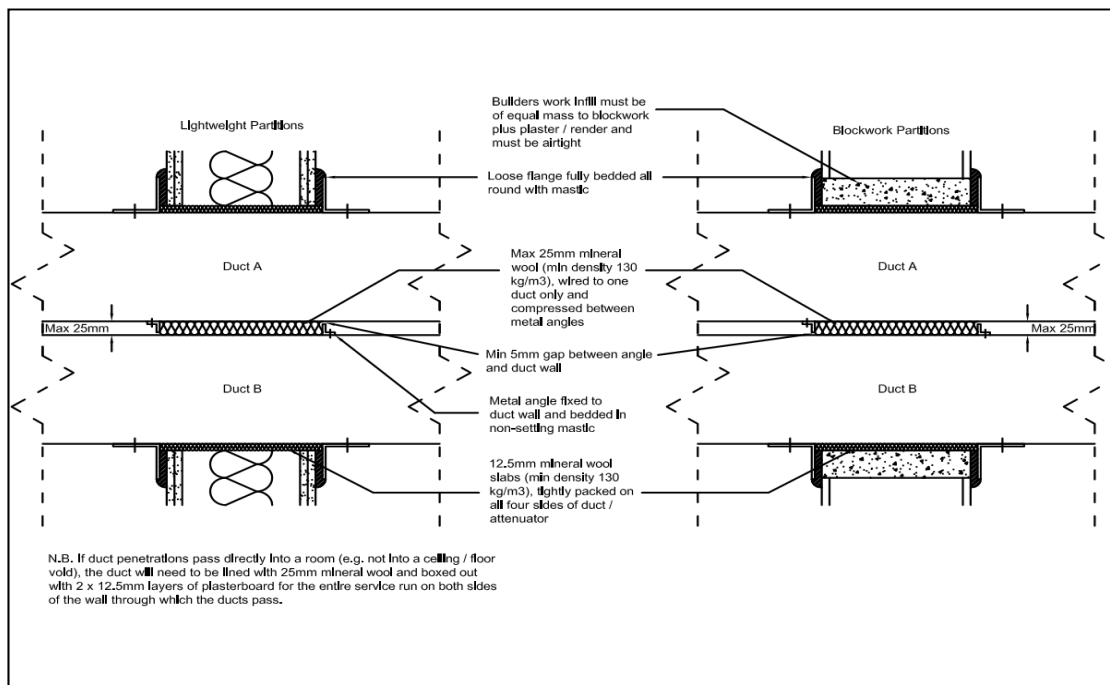
The enclosed details are sketches only and are not intended to be used for construction purposes. Please refer to the Architect's construction issue drawings for construction details.



Detail 1: Sockets in Acoustically Rated Partitions

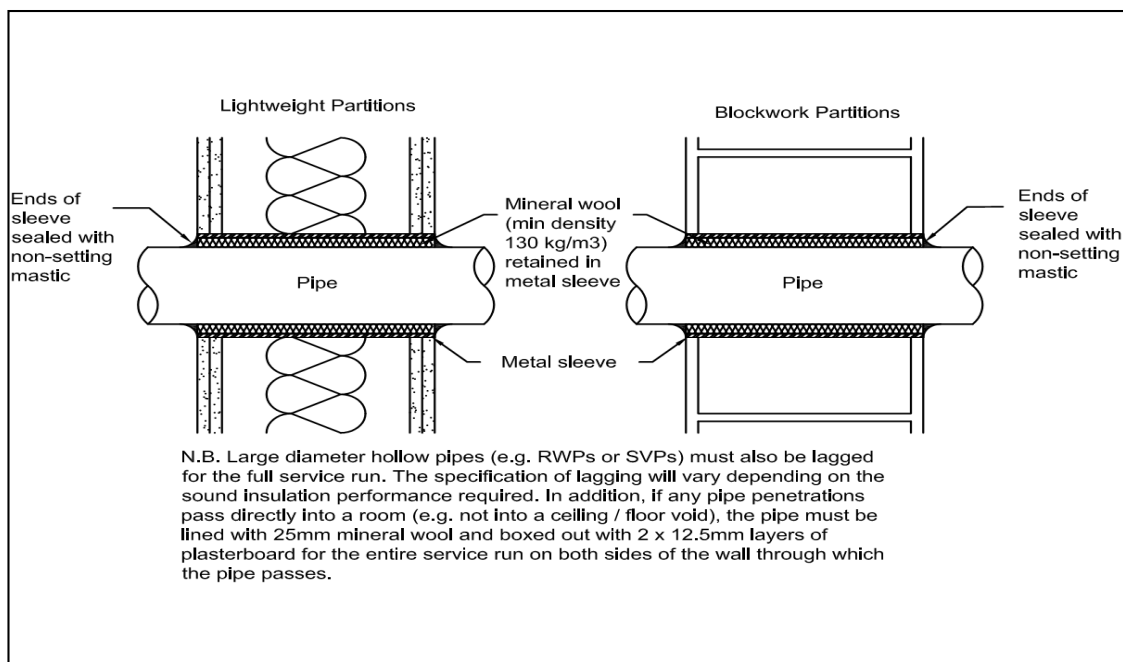


Detail 2: Duct Penetration in Acoustically Rated Partitions – Single Duct

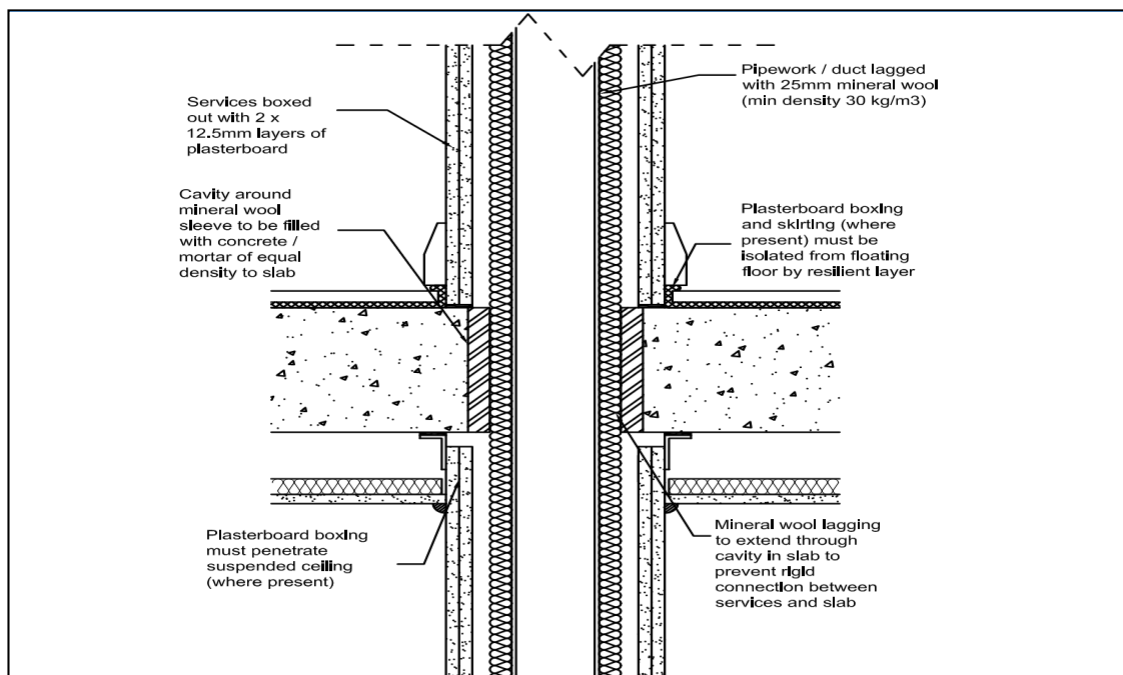


Detail 3: Duct Penetration in Acoustically Rated Partitions – Multiple Ducts

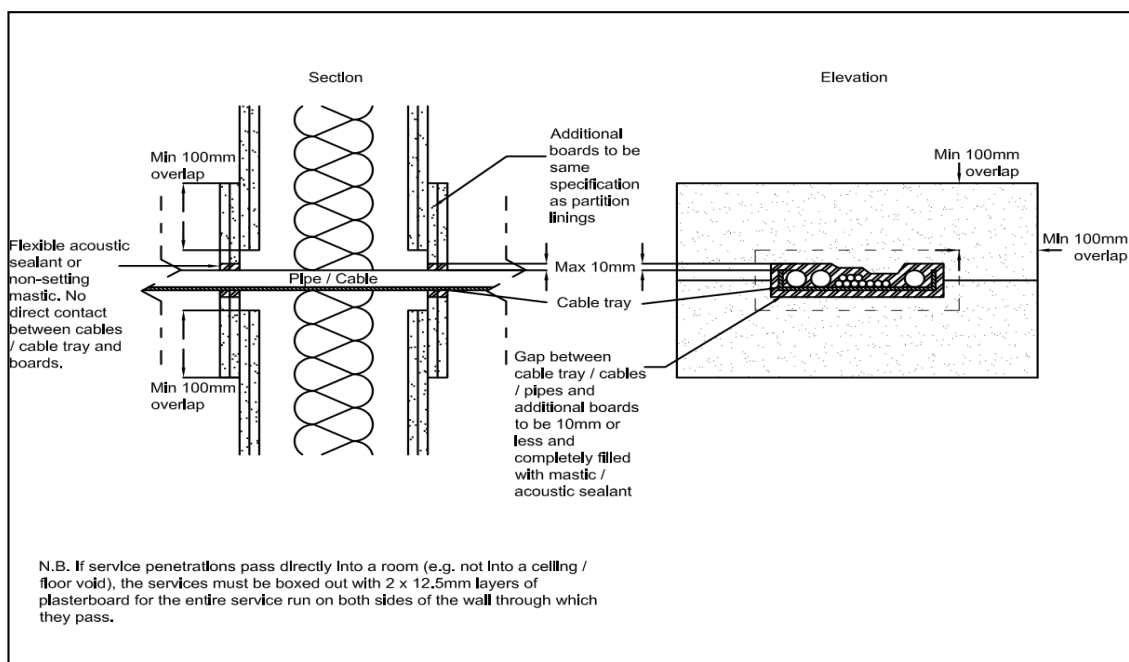
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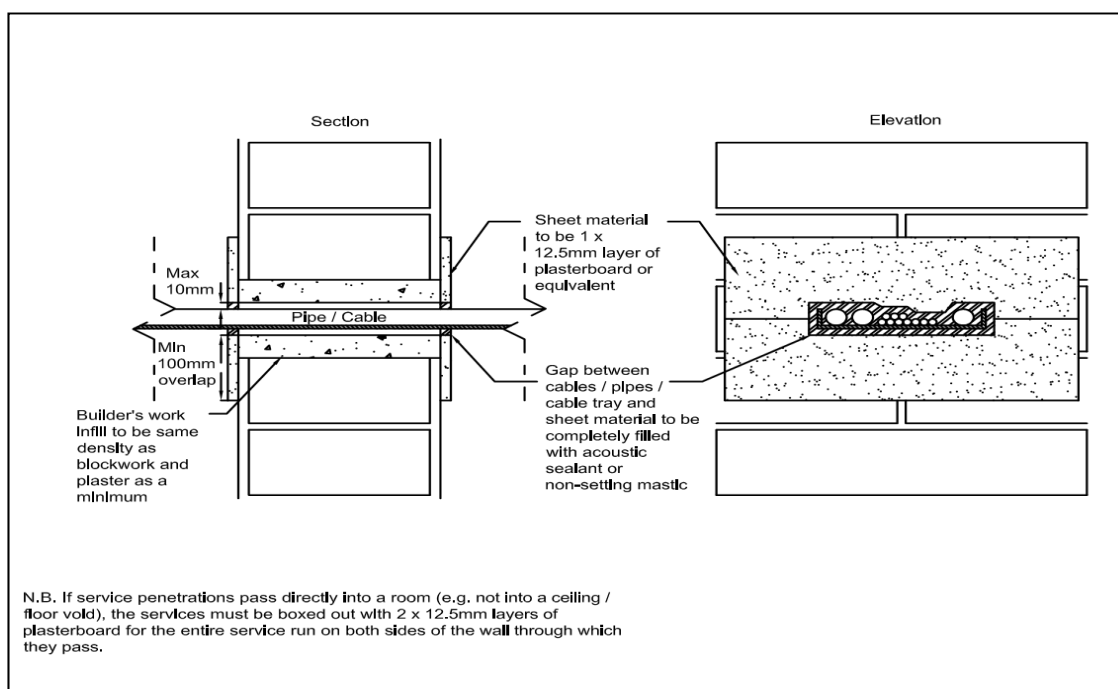
Detail 4: Pipe Penetration in Acoustically Rated Partitions – Single Pipe



Detail 5: Service Penetrations through Floors



Detail 6: Cable Tray Penetrations in Acoustically Rated Lightweight Partitions



Detail 7: Cable Tray Penetrations in Acoustically Rated Masonry Partitions



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