CARNIVAL APARTMENTS

Acoustic Design Report

P1040-MCH-XX-XX-RP-AO-9001

Mid Group

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CARNIVAL APARTMENTS

Acoustic Design Report

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P07	Reference update	William Shen	Josh Childs	Josh Childs	09/03/2022
P08	Junction detail update	William Shen	Josh Childs	Josh Childs	05/04/2022

Contents

Executive Summary

MACH Group have carried out an acoustic review of the current design of the Carnival Residential Apartments in Wokingham. The following provides a summary of the review;

Sound Insulation

The proposed wall constructions are compliant with building regulations; however MACH would recommend the following changes;

- Increase wall lining Type E to 2 layers of 15mm plasterboard where it separates a dwelling from a plant room or bike store (see section 3.3)
- Increase riser linings (Type F) to 2 layers of 12.5mm plasterboard with 50mm insulation (see section 10.0)

Construction Detailing

The following construction details will require review with the design team;

- Section detail between dwellings (see section 11.0)
- Building services penetration detailing to corridor walls

Reverberation

The proposed ceiling finishes within the corridors are compliant with building regulations, however it is recommended that a minimum reverberation time is also achieved in the atrium to maintain a good level of acoustic comfort.

The current finishes achieve a reverberation time of 2.0s. It is considered that a reverberation time of <1.5s is suitable, and as such it is recommended that the atrium includes an additional 18m^2 of Class treatment to bring the reverberation time suitably.

Building Services

Design advice has been provided to reduce risk of noise disturbances from building services design within dwellings, such as from MVHR cupboards. As part of the advice, it is advised that partition ratings to MVHR cupboards are increased where possible, however it is important to note that this goes beyond the minimum requirements of Part E of building regulations.

1.0 INTRODUCTION

This report provides the acoustic strategy for compliance with Approved Document E of the Building Regulations, for the Carnival Apartments residential development in Wokingham. Recommendations have also been provided in relation to sound insulation in residential amenity and other ancillary areas.

The development is summarised in Section 1.1 below. Section 1.2 provides an overview of the performance standards and regulations on which the acoustic design of the development has been based. Section 1.3 outlines the supplementary documents to this report.

1.1 Project Summary

Development Type	New Build
Construction Type	Pre Cast Concrete
No. Storeys	3
ADE Classification	Dwelling Houses / Flats
Performance Requirements	Approved Document E

Table 1.1: Project Summary

1.2 Performance Standards

The table below outlines the various performance standards and guidance documents which have formed the basis of the acoustic design of this development. Note that this report relates solely to the internal acoustic design of this development. Other elements such as planning compliance are addressed in other reports. Please refer to the supplementary reports in Section 1.3.

Document	Building Regulations	Guidance Documents
Approved Document E (ADE) – resistance to passage of sound	√	-
BS 8233:2014 Guidance on sound insulation and noise reduction for buildings	-	√

Table 1.2: Performance Standards

1.3 Supplementary Reports

This report should be read in conjunction with the following reports.

Document Reference	Author	Document Title	Description
P1040-MCH-XX-XX-RP-AO-9000	MACH	Acoustic Façade Review	Provides the environmental noise levels on site, specifications for building envelope sound insulation and plant noise limits.

Table 1.3: Supplementary Acoustic Reports

2.0 PERFORMANCE REQUIREMENTS – INTERNAL NOISE

To protect amenity within residential dwellings ensuring adequate sleeping and living conditions which benefit indoor environmental conditions and wellbeing, the internal noise requirements within this section must be complied with. These noise limits also form the basis of determining the level of sound insulation and subsequent noise limits within high noise areas discussed in the later sections of this report.

2.1 Indoor Ambient Noise Levels

Noise levels within dwellings due to contributions from environmental noise sources must comply with Planning Condition 21 as specified by Wokingham Borough Council. Further information is provided in regard to this in the separate MACH report '*P1040-MCH-XX-XX-RP-AO-9000*'.

2.2 Noise from Non-Domestic Areas

Noise from non-domestic areas, such as communal areas, must not exceed the noise limits presented in Table 2.1 within residential dwellings.

Type	Noise limit $L_{01,T}$ (dB)
Daytime (0700 - 2300)	NR 20
Night time (2300 - 0700)	NR 15

Table 2.1: Noise limits for non-domestic spaces adjacent to residential units

2.3 Noise from Plant Rooms and Services Controlled by Others

Noise from mechanical services controlled by others must not exceed the noise limits presented within Table 2.3 within residential dwellings.

Type	Noise limit $L_{eq,T}$ (dB)
Bedroom	NR 15
Living Room	NR 15
Corridors and Communal Spaces (not within dwellings)	NR 45

Table 2.2: Internal Noise Criteria – Plant Noise

2.4 Noise from Plant Controlled by Residents

Noise from plant and services within dwellings must not exceed the noise limits presented within Table 2.3 within residential dwellings. It will be the responsibility of the M&E engineers for this scheme to design to these limits. These ambient noise criteria will be applicable for background and boost ventilation rates. For higher ventilation rates these internal noise criteria may be relaxed by up to +5 dBA.

Type	Noise limit L_{eq} (dB)
Bedrooms	NR 25
Living Rooms	NR 30
Commercial Units	NR 35

Table 2.3: Internal Noise Criteria – Noise from Services Controlled by Residents

2.5 Noise from Lifts

Noise from lifts must not exceed the noise limits presented within Table 2.4 within residential dwellings and other areas of the building.

Type	Room	Maximum L_{Amax}, dB
Lifts, within dwellings	Bedrooms	30
	Living Rooms	30
	Other Areas	35

Table 2.4: Internal Noise Criteria – Lift Noise

The lift shall provide smooth and reasonably noise-free operation. A high level of importance is placed on the minimisation of noise/vibration during operation of the lift. Noise levels within bedrooms should not exceed 30 dB L_{AFmax}, during any part of the lift operation.

The hoisting machine shall not be car/counterweight guide rail mounted; it shall be mounted on an independent steel frame/raft isolated from the building structure and independent of the lift car/counterweight guide rails. The isolation method should ensure that noise and vibration is not transferred to the structure.

The lift specialist shall also make due consideration in respect of other system components which emit noise and vibration during normal operation, including but not necessarily limited to the following:

- Control panel relays/contactors (including any sited in lift well)
- Variable frequency inverter (including where sited in lift well)
- Machine brake
- Normal floor position system
- Terminal floor limits
- Over-speed governor
- Car/landing door equipment

Maximum vibration levels measured within residential areas should not exceed the values stated in Table 1 of BS 6472-1. The maximum vibration levels shall be less than 0.15 m/s^2 peak to peak.

2.5.1 The Lift Car

At any time during its normal powered travel, with minimal background noise and with all car and landing doors closed and the car ventilation fan switched on, the noise measured at a point 1 m above floor level in the centre of the car shall not exceed 55 dB L_{AFmax}.

2.5.2 Machinery Spaces

The noise level within the lift motor room during normal operation of the lift, irrespective of load or direction with any other heating or ventilation equipment in the plant room operating normally, at any position in the plant room shall not exceed 70 dB L_{AFmax}.

Machinery and equipment noise shall be limited to a level of 55 dB L_{AFmax} in the lift car and 50 dB L_{AFmax} in the lift lobby or landing. Where necessary noise baffles shall be provided at rope apertures to prevent the transmission of noise into the lift well from the machinery space where provided.

Where the machinery/equipment is contained within the lift well then this equipment shall not transmit a level of noise greater than 55 dB L_{AFmax} into the lift car or 50 dB L_{AFmax} into the lift lobby or landing.

Noise shall be measured in accordance with BS EN ISO 16283-1 and rated in accordance with BS EN ISO 717-1.

2.5.3 Entrances

With the stationary car at floor level, the noise of the doors opening or closing measured at a point at least 1.0m above floor level and at any point 1.0m from the face of the doors shall not exceed 55 dB L_{AFmax} in the lift lobby or landing.

When the lift car (or cars) are passing a floor in either direction the noise measured at a point at least 1.0m above floor level and at any point 1.0m from the face of the closed doors shall not exceed 55 dB L_{AFmax} in the lift lobby or landing.

Noise shall be measured in accordance with BS EN ISO 16283-1 and rated in accordance with BS EN ISO 717-1.

3.0 PERFORMANCE REQUIREMENTS – SOUND INSULATION

This section outlines the sound insulation requirements for residential areas. Sound insulation mark-ups that illustrate the necessary performance of separating and internal elements are presented in Section 4.0 of this report. The following tables summarise the on-site and laboratory rated sound insulation requirements for residential areas of the development.

3.1 Regulation E1 - Separating Walls

The table below details the acoustic performance requirements for separating walls. This performance requirement is applicable for walls between dwellings and other areas of the building, including other dwellings.

Type		On-site Requirement, ADE (dB $D_{nT,w} + C_{tr}$)	Calculated Laboratory Rating (dB $R_w + C_{tr}$)
Dwelling Houses and Flats	New Build	≥ 45	≥ 52

Table 3.1: Sound Insulation Requirements for Separating Walls

3.2 Regulation E1 - Corridor Walls and Doors

Corridor walls, i.e. those to circulation spaces are not tested under building regulations; however, they are normally required to have the same performance as those between dwellings. Corridor walls for this development are seen to be formed from pre-cast concrete.

Corridor walls must not breach the performance of separating walls as a result of flanking. Additionally, detailing of junctions must be such that the integrity of separating walls is not breached by rigid connections across cavities and other factors. Additionally, where there is a door in a separating partition between noise sensitive and shared circulation space, the requirements in Table 3.2 are applicable.

Type	Doorset (dB R_w)
Separating walls adjacent to communal corridors	≥ 29 [1]
[1] Only applicable to entrance doors, i.e. between dwellings and circulation spaces.	

Table 3.2: Sound Insulation Requirements to Circulation Spaces

Where corridor walls contain doors, the sound insulation will be reduced by the presence of the door. All doors to flats should have a good perimeter sealing (including the threshold where practical) and a minimum mass per unit area of 25kg/m^2 or a minimum sound reduction index of 29 dB R_w (measured according to BS EN ISO 140-3:1995 and rated according to BS EN ISO 717-1:1997).

3.3 Regulation E1 - Separating Floors

Table 3.3 details the required on-site and laboratory rated performances of the separating floor constructions within the development.

Type		Minimum On-site Requirements		Calculated Laboratory Ratings	
		(dB $D_{nT,w}+C_{tr}$)	(dB L'_{nTw})	(dB R_w+C_{tr})	(dB L_{nw})
Dwelling Houses and Flats	New Build	≥ 45	≤ 62	≥ 52	≤ 55

Table 3.3: Sound Insulation Requirements for Separating Floors

3.4 Regulation E2 - Internal Walls

Table 3.4 details the required airborne sound insulation of the internal walls within this development.

Type		Airborne Sound Insulation (dB R_w)
Dwelling Houses and Flats	New Build	≥ 40

Table 3.4: Sound Insulation Requirements for Internal Walls

3.5 Regulation E2 - Internal Floors

There are no internal floors within dwellings and as such Regulation E2 will not apply to this development.

4.0 ACOUSTIC PERFORMANCE MARK-UPS

Ground Floor

MACH GROUP

Separating Walls

- 45 dB $D_{nT,w}+C_{tr}$ / 52 dB $R_w + C_{tr}$
- 45 dB $D_{nT,w}+C_{tr}$ / 52 dB $R_w + C_{tr}$
- Additional Specifications to be provided

Internal Walls

- 40 dB R_w
- 40 dB R_w (Part E Required) / 50 dB R_w Recommended

Doors

- 29 dB R_w

Separating Floors

- 45 l Dnt,w+Ctr / 52 dB Rw + Ctr 62 dB Lnt,w

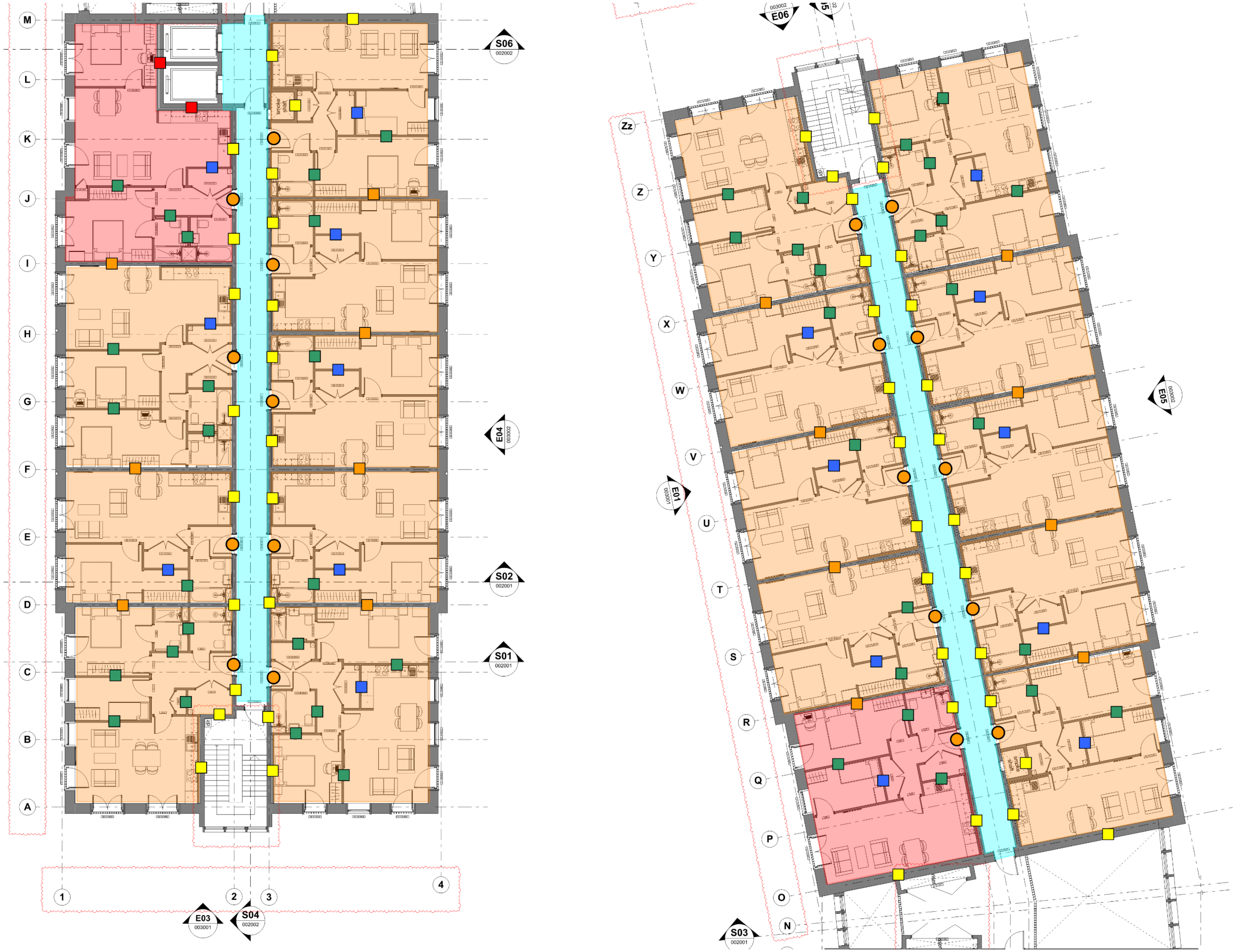
Reverberation Control

- Regulation E3 Applicable

Comments

- Comments see Annotation
- Floor Adjacent to Plant Room

1st Floor



MACH GROUP

Separating Walls

- 45 dB $D_{nT,w}+C_{tr}$ / 52 dB $R_w + C_{tr}$ (orange)
- 45 dB $D_{nT,w}+C_{tr}$ / 52 dB $R_w + C_{tr}$ (yellow)
- Additional Specifications to be provided

Internal Walls

- 40 dB R_w
- 40 dB R_w (Part E Required) / 50 dB R_w Recommended

Doors

- 29 dB R_w

Separating Floors

- 45 l Dnt,w+Ctr / 52 dB Rw + Ctr 62 dB Lnt,w

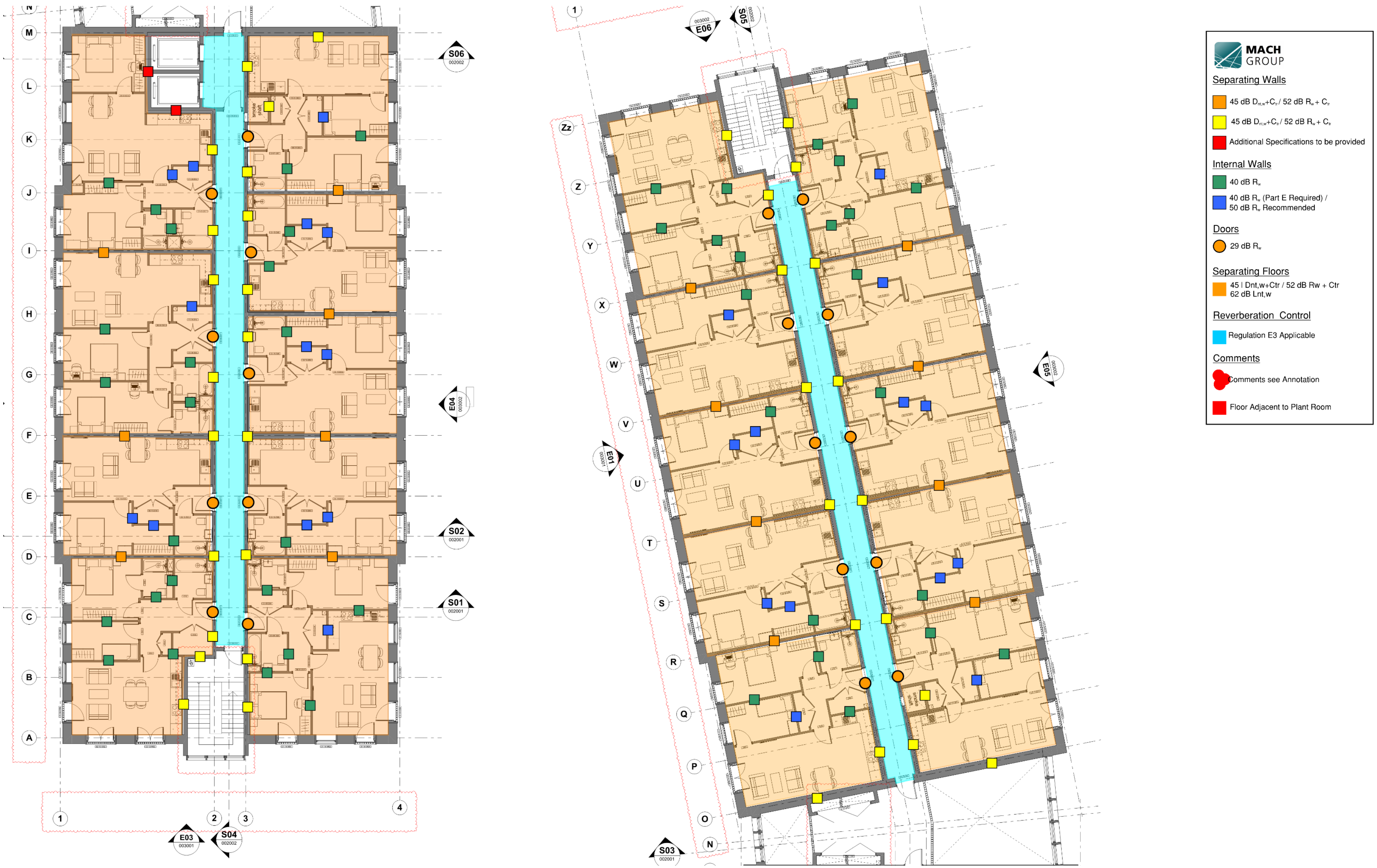
Reverberation Control

- Regulation E3 Applicable

Comments

- Comments see Annotation
- Floor Adjacent to Plant Room

2nd Floor


MACH GROUP
Separating Walls
45 dB $D_{nt,w}+C_{tr}$ / 52 dB $R_w + C_{tr}$
45 dB $D_{nt,w}+C_{tr}$ / 52 dB $R_w + C_{tr}$
Additional Specifications to be provided
Internal Walls
40 dB R_w
40 dB R_w (Part E Required) / 50 dB R_w Recommended
Doors
29 dB R_w
Separating Floors
45 l Dnt,w+Ctr / 52 dB Rw + Ctr
62 dB Lnt,w
Reverberation Control
Regulation E3 Applicable
Comments
Comments see Annotation
Floor Adjacent to Plant Room

5.0 SOUND INSULATION - WALL TYPES - RESIDENTIAL

5.1 Regulation E1 – Wall Type A

Separating walls between dwellings and other areas are to be formed from 200mm Pre-cast concrete. Table 5.1 below provides an overview of the sound insulation across this wall type. The level of sound insulation is seen to be fully compliant with Regulation E1.

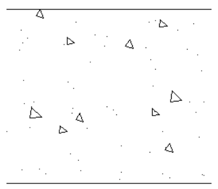
	Illustration of Construction	Description	Thickness (mm)	Predicted Performance dB (Rw + Ctr)
Type A		• 200mm Pre-Cast Concrete	200	54*
*Calculated in INSUL noise prediction software.				

Table 5.1: Separating Walls – Regulation E1

5.2 Regulation E2 – Wall Type D

MACH understands Internal walls within dwellings are to be formed from precast concrete or single stud plasterboard partitions. Pre-cast structural concrete will comfortably meet the requirements of Regulation E2.

For stud walls, Table 5.2 below details example internal wall types that are compliant with the requirements of Regulation E2 of Approved Document E. Note that Regulation E2 does not apply to internal partitions which contain a door, or that separate an en-suite bathroom from its associated bedroom.

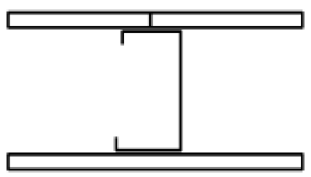
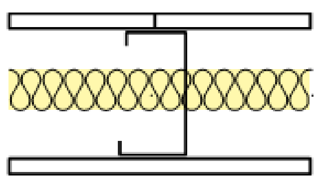
Illustration of Construction	Description	Thickness (mm)	Predicted Performance dB (Rw)
	• 12.5mm Acoustic Plasterboard • 70mm 'C' Stud • 12.5mm Acoustic Plasterboard	97	40
	• 12.5mm Standard Plasterboard • 70mm 'C' Stud • 25mm Insulation (10 - 40 Kg/m3) • 12.5mm Standard Plasterboard	97	42

Table 5.2: Example Internal Walls – Regulation E2

6.0 SOUND INSULATION - FLOOR AND CEILING TYPES - RESIDENTIAL

6.1 Regulation E1 - Separating Floors

MACH understands separating floors are to be formed from 200mm pre-cast concrete planks with 75mm screeds. The table below provides the predicted acoustic performance of the separating floor.

Ref	Description	Predicted Performance dB ($R_w + C_{tr}$)
Floor between Dwellings	• 75mm Screed • Resilient Layer • 200mm Precast Concrete Slab (surface mass: 300 kg/m^2) • MF Grid to form minimum 290mm Void • 1 x 15mm Plasterboard	61*
*Calculated in INSUL noise prediction software.		

Table 6.1 Proposed Separating Floor

6.1.1 Resilient Layer to Separating Floors

In addition to this floor construction, such to ensure that impact sound insulation requirements are met the floor should include a resilient layer that provides a weighted sound reduction of no less than 15 dB ΔL_w.

Note, the resilient layer must be included within the floor build-up, or fully bonded to the floor, <u>not</u> part of the floor finishes. This could be a resilient layer beneath the screed (i.e. Regupol 7210C, InstaCoustic InstaLay 65, YELOfon HD10+). <u>Floor finishes are not counted as resilient layers, as these may be changed throughout the building's life, and must not be laid prior to pre-completion testing.</u>

6.1.2 Separating Floors to Refuse Store & Plant Rooms

It is recommended that a plasterboard ceiling is included to the ground floor Plant Rooms and Refuse Store to mitigate disturbances to the dwellings above. The following separating floor construction will be suitable;

- 75mm Screed
- Resilient Layer
- 200mm Precast Concrete Slab (surface mass: 300 kg/m^2)
- MF Grid to form minimum 100mm void, (50mm insulation within the 100mm void)
- 1 x 12.5mm Plasterboard

6.2 Regulation E2 - Internal Floors

It is understood that dwellings in the development do not have internal floors. Therefore, the development is not subject to Regulation E2 of Approved document E.

7.0 NOISE GENERATING AREAS

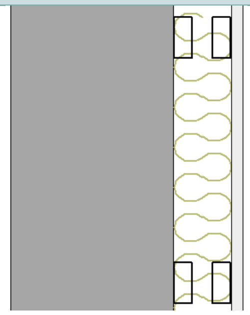
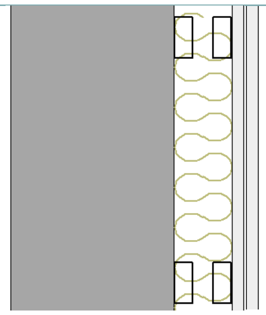
The marked drawings in Section 4.0 indicate locations where noise generating areas are adjacent to residential dwellings. The specifications for sound insulation in these areas are provided in the following sub-sections.

7.1 Separating Wall – Residential to Lifts/Plant/Stores

To protect residents from noise generated by lifts, the noise criteria presented within Table 2.5 must be complied with. MACH has reviewed sound insulation in these areas and provided recommendations for the level of acoustic performance between lifts and residential areas.

A high level of sound insulation will be necessary in order to achieve the requirements. Therefore, wherever lift shafts are adjacent to habitable areas, a wall lining will be required which should be fully independent from the lift shaft (no connections).

For separating walls between dwellings and plant rooms or bike stores, it is proposed that an additional layer of board is included (i.e. 2 x 15mm plasterboard) to further mitigate risk of disturbance from activities within these spaces. This is highlighted in the figures opposite.

Ref	Illustration of Construction	Description	Predicted Performance dB (Rw + Ctr)
Type C + Type E		• 200mm Precast Concrete • Independent wall liner to form; • Minimum 70mm void • 25mm Insulation (10 - 40 Kg/m3) • 15mm Acoustic Plasterboard	65*
Type C + Type E (Improved)		• 200mm Precast Concrete • Independent wall liner to form; • Minimum 70mm void • 25mm Insulation (10 - 40 Kg/m3) • 2 x 15mm Acoustic Plasterboard	70*

*Calculated in INSUL noise prediction software.

Table 8.1: Lift Shaft Walls

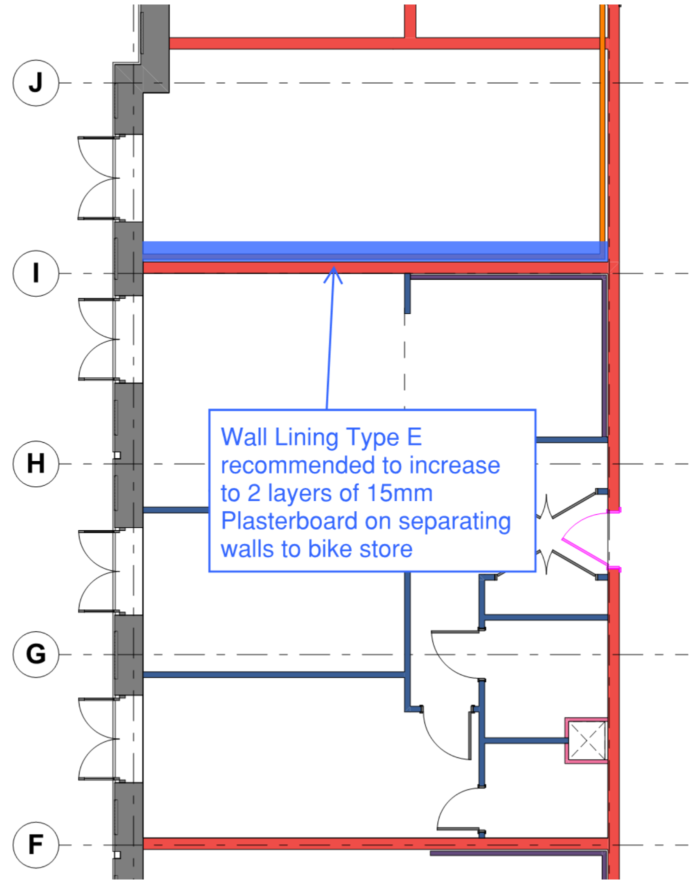


Figure 7.1: Lining to Bike Store (Ground floor)

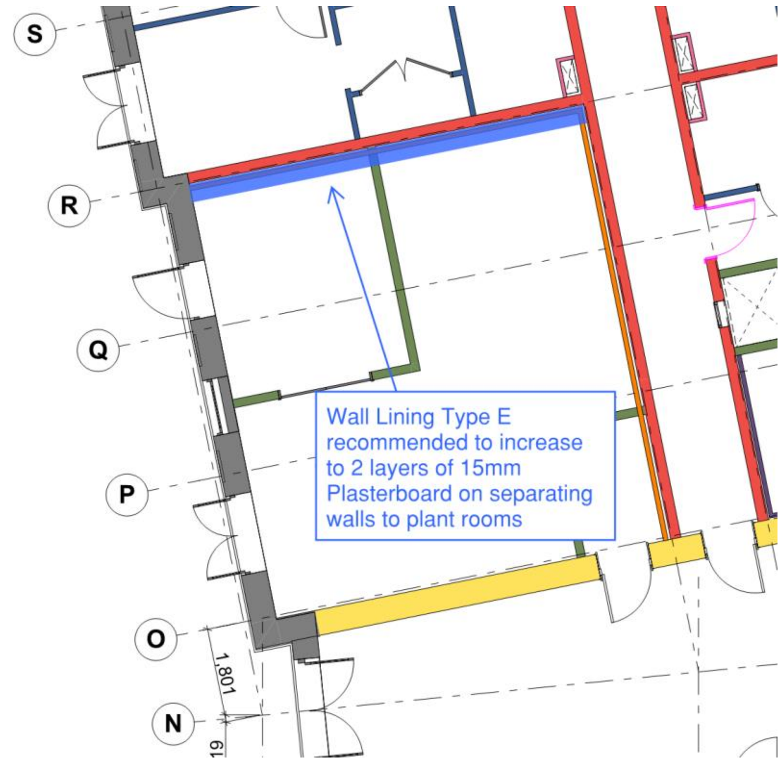


Figure 7.2: Lining to Plant Room (Ground floor)

7.2 Separating Wall – Atrium to Residential

The table below outlines the predicted performance of the proposed external wall construction, which is the party wall between dwellings and the adjacent atrium. The performance is seen to be comfortably above the minimum requirements for building regulations.

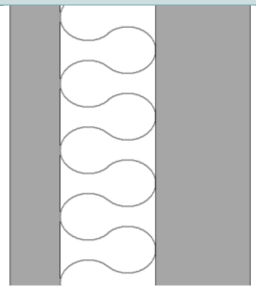
Ref	Illustration of Construction	Description	Predicted Performance dB (Rw + Ctr)
Insulated Precast Concrete Sandwich Panel		• 80mm Precast Concrete • 250mm Cavity with mineral wool insulation • 150mm Precast concrete	66*
*Calculated in INSUL noise prediction software.			

Table 8.2: Lift Shaft Walls

7.3 Separating Floor / Ceiling – Plant/Stores to Residential

MACH understands the separating floors between plant rooms and residential dwellings on the first floor are to be formed from 200 pre-cast concrete slabs. Table 8.2 below provides an overview of the proposed separating floor / ceiling construction between plant rooms and residential dwellings.

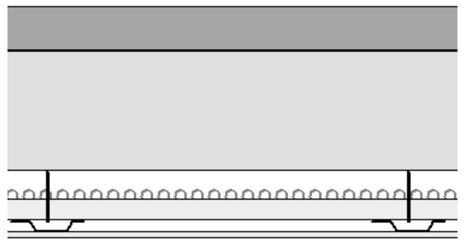
Ref	Illustration of Construction	Description	Predicted Performance dB (Rw + Ctr)
Plant to Residential		• 75mm Screed • 200mm Precast Concrete Slab • MF Grid to form minimum 100mm Void • 50mm mineral wool within the void • 1 x 12.5mm Plasterboard	65*
*Calculated in INSUL noise prediction software.			

Table 7.2: Separating Floor / Ceiling – Plant to Residential

7.3.1 Plant Room Noise Limits

Any mechanical plant with moving parts needs to be fixed to the structure using resilient anti vibration mounts, to minimize reradiated noise into dwellings through structural vibration. The manufacturer should be able to advise on appropriate mounts or mitigation methods.

Noise limits have been imposed upon plant rooms which are situated below residential dwellings, based upon the proposed separating floor / ceiling construction, such that internal noise level targets in adjacent spaces are met. It is the responsibility of the M&E engineers to ensure that this target is adhered to. MACH should be informed if these limits are to be exceeded. The value given below is the reverberant sum of all plant units.

Source Room	Receiver Room	Separating Construction(s)	Source Room Noise Limit
Plant Room	Bedroom (1st Floor)	Refer Table 8.1	NR 69

Table 7.3: Building Services Noise Limits

8.0 BUILDING SERVICES

Please note that Building Services noise does not fall under MACH's responsibility, however this section outlines some areas of risk in the design, and provides appropriate methods to reduce this risk. The advice provided is for general design advice across the project, and not limited to the specific examples shown in the figures.

8.1 MVHR Noise Break-Out of Cupboards via Partitions

There are a number of instances in dwellings in which MVHRs are located on a separating wall to a bedroom, which is a risk of disturbance to future occupants. It is recommended to relocate the MVHR to another cupboard that is not adjacent to any sensitive spaces. If this is not possible, it is recommended to reposition the MVHR to a wall that is not shared with a bedroom.

As additional risk mitigation, it is also recommended that separating walls between MVHR cupboards and Bedrooms or Living Areas are upgraded where possible. It is recommended that the surrounding partitions are upgraded to a R_w 50dB partition, however it is important to note that a different performance may be suitable, depending on the specific noise levels of the MVHR unit. Note that this is an improvement beyond the minimum requirements of building regulations.

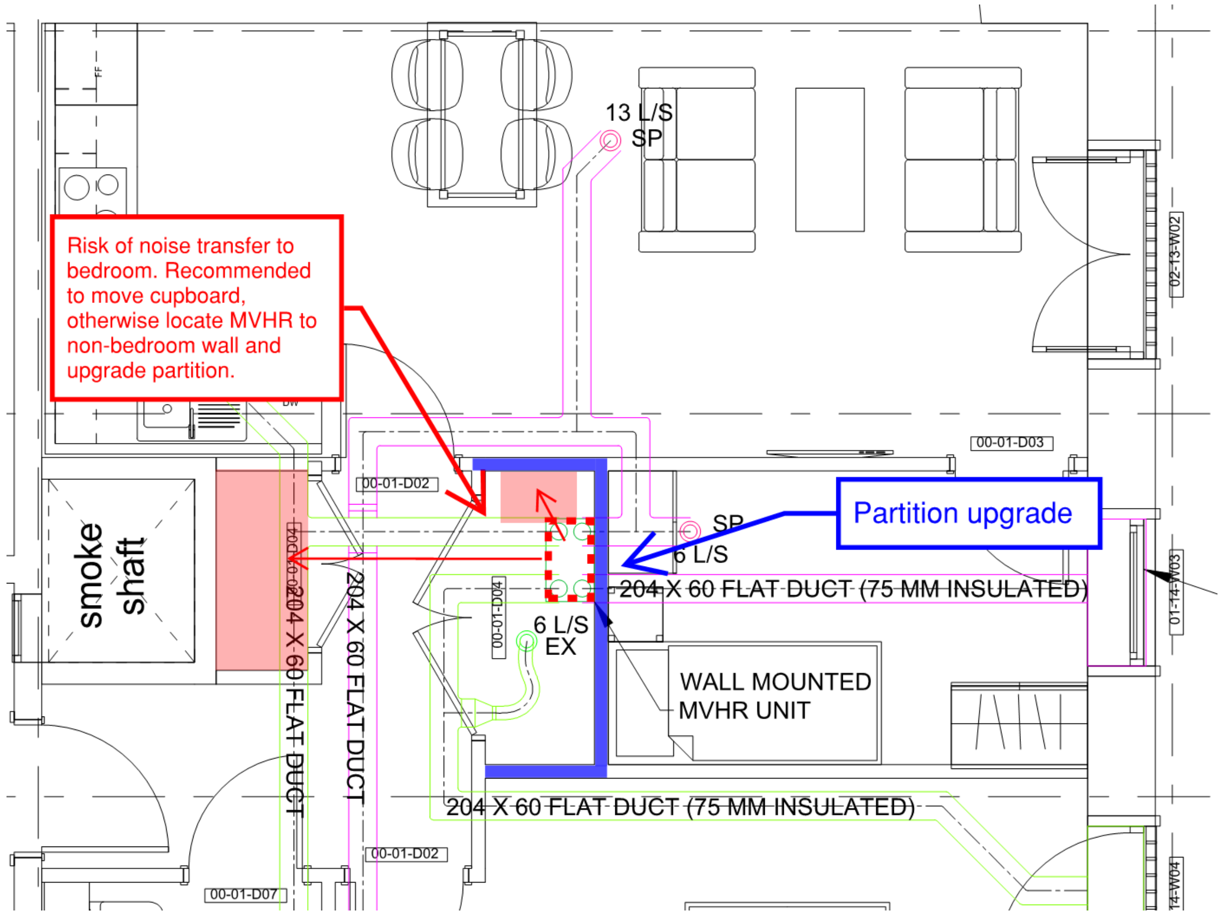


Figure 8.1: Comments to building services layouts – MVHR cupboards adjacent to bedrooms

8.2 MVHR Noise Break-Out of Cupboards via Doors

In a number of dwellings, the MVHR cupboard opens directly on to the Living Area. As the ventilation requirements of the cupboards may require an undercut to the door, this will likely negate any acoustic rating of the door. As such, either the MVHR unit itself needs to be suitably quiet that an acoustic door isn't required, or an alternative ventilation path can be provided. It may be possible to provide ventilation to the hallway instead, as shown in the mark-up below.

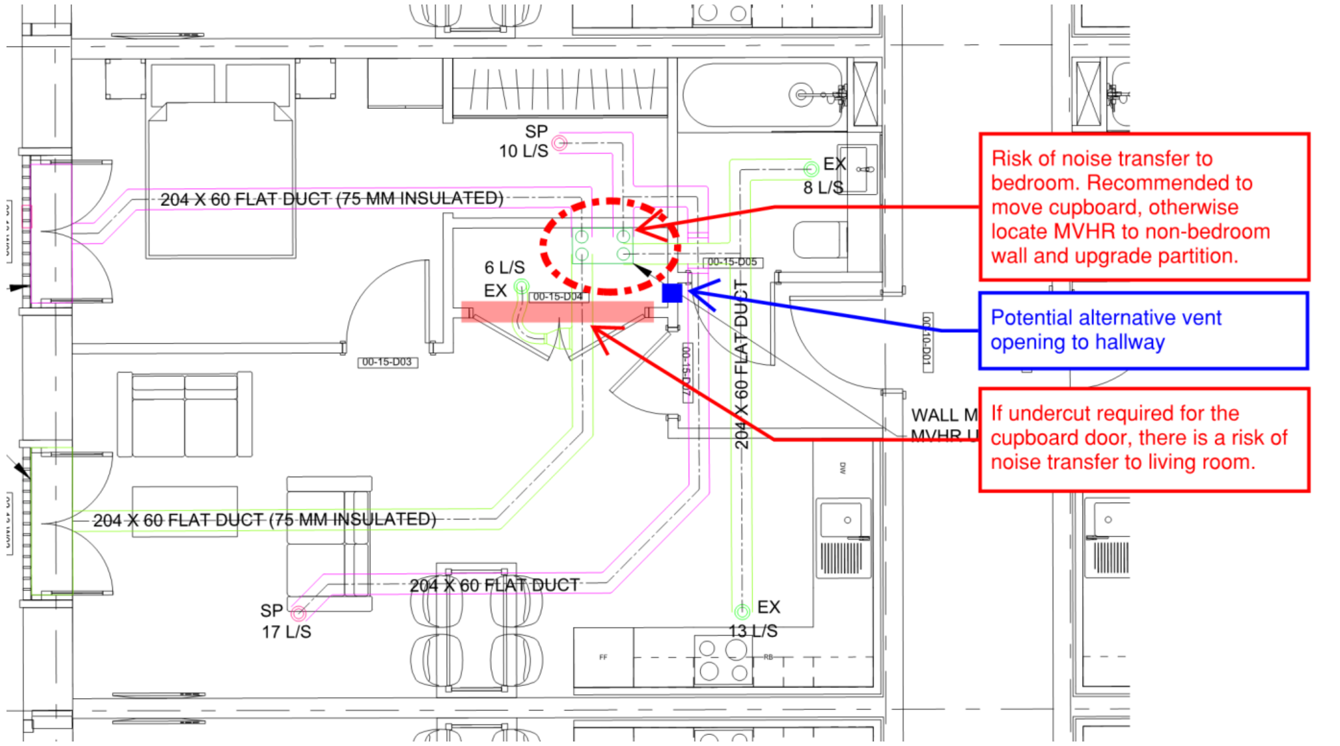


Figure 8.2: Comments to building services layouts – MVHR cupboard door

The accumulative M&E noise from the ductwork and unit break-out should comply with the maximum levels specified within Table 2.3.

8.3 Cross-Talk via Ductwork

It is important that any ductwork or other building services do not compromise the acoustic performance of internal partitions within dwellings. Internal partitions are required to achieve Rw 40dB, and as such services detailing should be designed so that it does not degrade the partition performance.

Ductwork should ideally be located above doorways, to minimise flanking. Cross-talk should be considered in the design, and attenuators may be required.

9.0 ASSESSMENT OF FLANKING

Appendix A provides an overview of the principles of sound insulation and flanking transmission. This section of the report provides a detailed flanking assessment between adjacent dwellings and to plant rooms. Proprietary modelling software (Bastian) has been used to calculate the sound insulation between adjacent rooms, taking into account flanking transmission via the internal fabric of the building as well as other internal elements.

9.1 Horizontal Transfer – Dwelling to Dwelling

The below figures and tables provide a summary of the flanking assessment carried out, in which it is found that the sound insulation performance between dwellings is predicted to be comfortably above minimum building regulations requirements.

Figure 9.1: Location of flanking assessment – dwelling to dwelling

Element	Description Summary
Separating Wall	Type A - 200mm Pre-cast concrete
External Wall	150mm Pre-cast concrete inner leaf
Corridor Wall	Type A - 200mm Pre-cast concrete
Floor	200mm Pre-Cast Concrete Plank with 75mm screed
Ceiling	1 x 15mm Plasterboard, 290mm ceiling void with no insulation

Table 9.1: Flanking Elements

Location	Minimum On-site Requirements (dB $D_{nT,w}+C_{tr}$)	Predicted Performance (dB $D_{ntw} + C_{tr}$)
Horizontal – Dwelling to Dwelling	⩾ 45	52

Table 9.2: Flanking Assessment Results

9.2 Horizontal Transfer – Dwelling to Plant Room/Store

The figures and tables below provide a summary of the flanking assessment carried out between dwellings and adjacent plant/store rooms. The proposed lining system to the wall increases the overall performance by 4dB, which is seen to provide suitable mitigation against risk of disturbance from activities within the bike/bin stores, as well as from any plant noise.

Figure 9.2: Location of flanking assessment – plant room to dwelling

Element	Description Summary
Separating Wall	200mm Pre-cast concrete with independent wall lining, 20mm cavity, 50mm mineral wool, 2 x 15mm plasterboard
External Wall	150mm Pre-cast concrete inner leaf
Corridor Wall	200mm Pre-cast concrete
Floor	200mm Pre-Cast Concrete Plank with 75mm screed
Ceiling	1 x 15mm Plasterboard, 290mm ceiling void with 200mm insulation

Table 9.1: Flanking Elements

Location	Minimum On-site Requirements (dB $D_{nT,w}+C_{tr}$)	Predicted Performance (dB $D_{ntw} + C_{tr}$)
Horizontal – Plant to Dwelling	⩾ 45	56

Table 9.2: Flanking Assessment Result

9.3 Vertical Transfer – Dwelling to Dwelling

A vertical assessment has been carried out to assess any potential flanking across the separating floors. It is shown the predicted performance is comfortably above building regulations requirements.

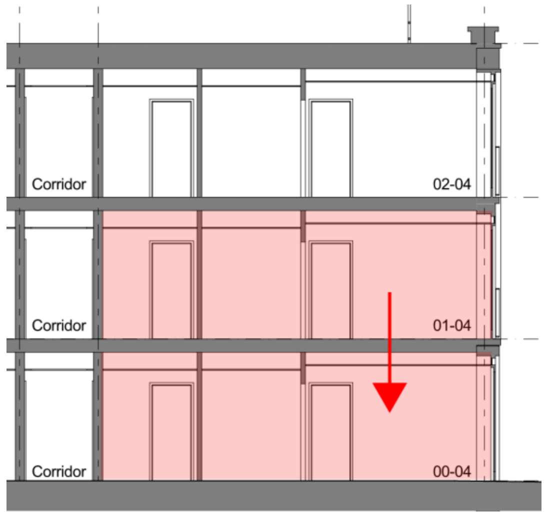


Figure 9.3: Location of flanking assessment – dwelling to dwelling (section)

summarised in the table below.

Element	Description Summary
Floor	200mm Pre-Cast Concrete Plank with 75mm screed
Ceiling	1 x 15mm Plasterboard, 290mm ceiling void with no insulation
Separating Wall	200mm Pre-cast concrete
External Wall	150mm Pre-cast concrete inner leaf
Corridor Wall	200mm Pre-cast concrete

Table 9.1: Flanking Elements

Location	Minimum On-site Requirements (dB $D_{nT,w}$+C_{tr})	Predicted Performance (dB D_{ntw} + C_{tr})
Vertical – Dwelling to Dwelling	⩾ 45	59

Table 9.2: Flanking Assessment Results

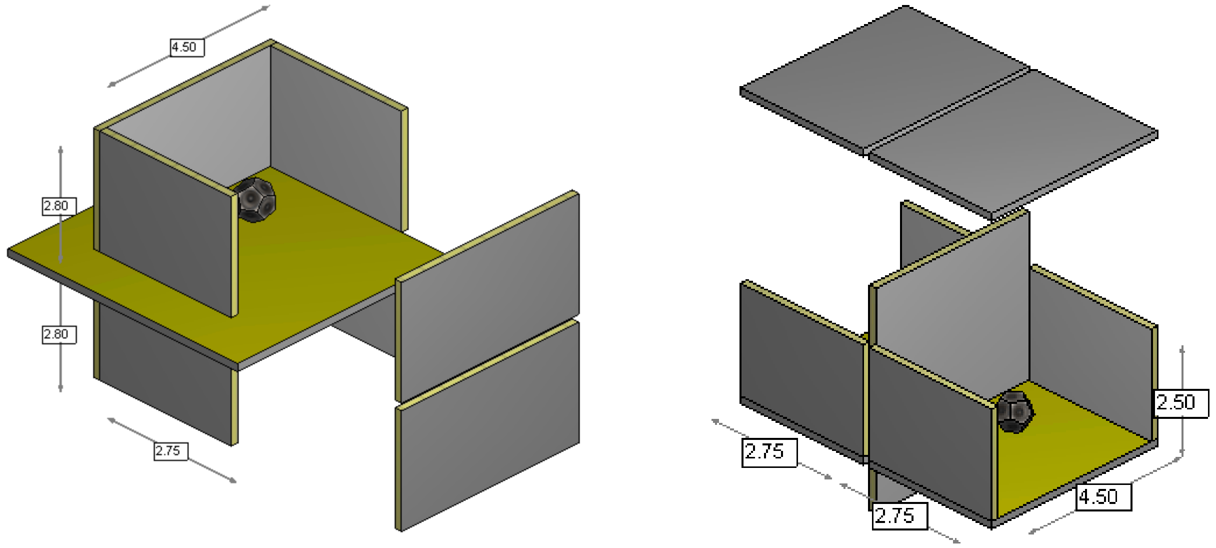


Figure 9.1: Bastian Modelling (Indicative of Modelling for this Development)

9.4 Flanking Through Stud Walls, Risers and Other Elements

Note that there may be numerous areas which require acoustic consideration when the detailed design of this scheme is developed. Although the structural elements provide the necessary sound insulation performance, detailing of stud walls, service risers and other plasterboard lined elements will need to be carefully considered. MACH will provide advice as required to develop a full set of details for any areas of acoustic risk.

10.0 PLASTERBOARD LINING TO RISERS

Wall linings are currently shown on the partition plan (Type F) as a single layer of plasterboard on an independent lining system. that all risers to dwellings should be at least 2 layers of 12.5mm plasterboard, with 50mm mineral wool within the cavity.

Where risers are located in cupboards, a single layer of plasterboard with 50mm mineral wool is suitable.

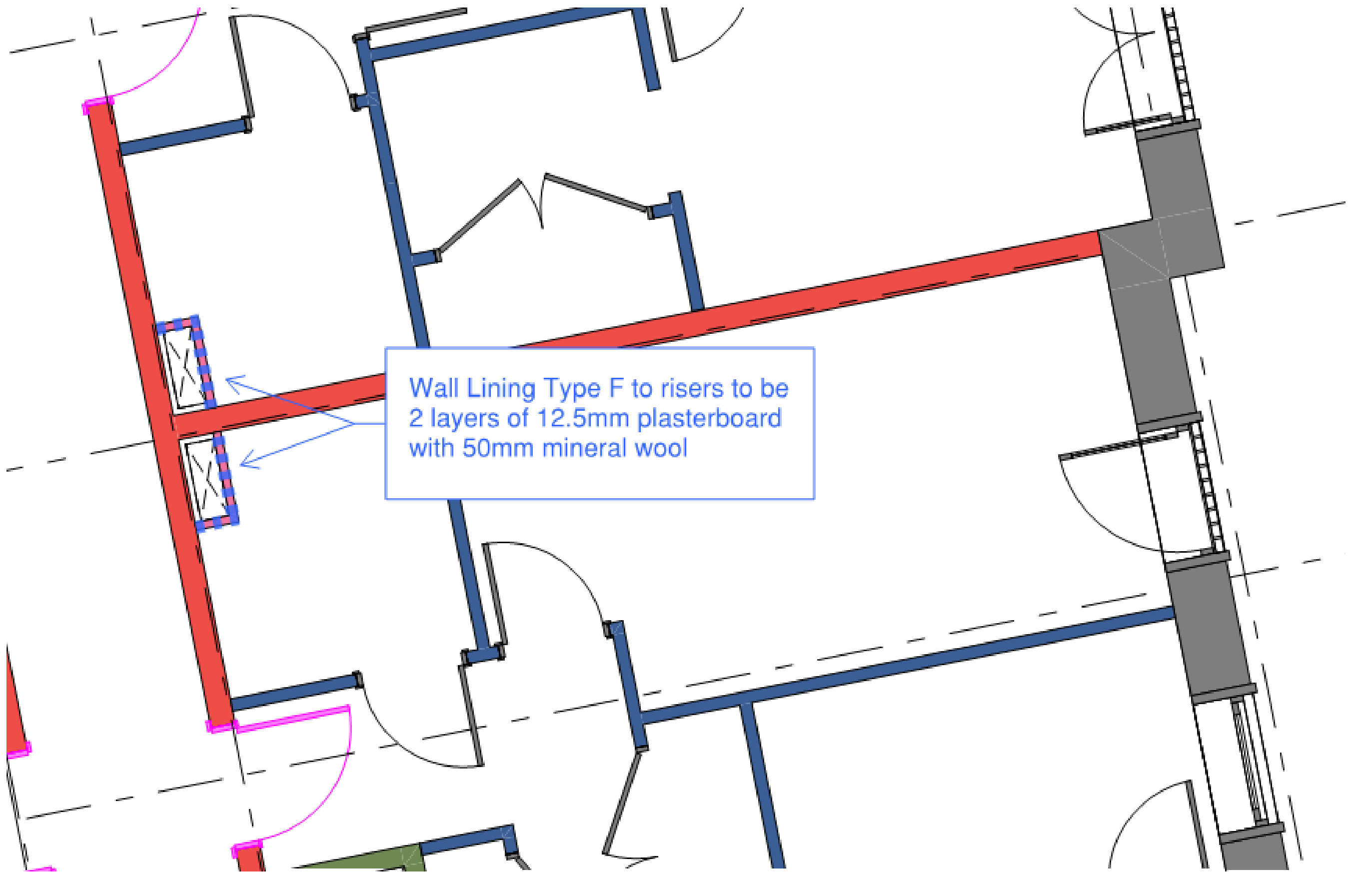


Figure 10.1: Wall linings to risers

11.0 SECTION DETAIL – BETWEEN DWELLINGS

The figure below shows the current proposed section detail between dwellings above the Juliet balcony doorsets. To mitigate sound insulation flanking across the floor detail, it is required that a solid layer is included, which is shown in the detail below as a 15mm Calcium Silicate Board. To provide suitable mitigation, the board needs to be solid with no perforations, with a minimum surface mass of 10kg/m^2.

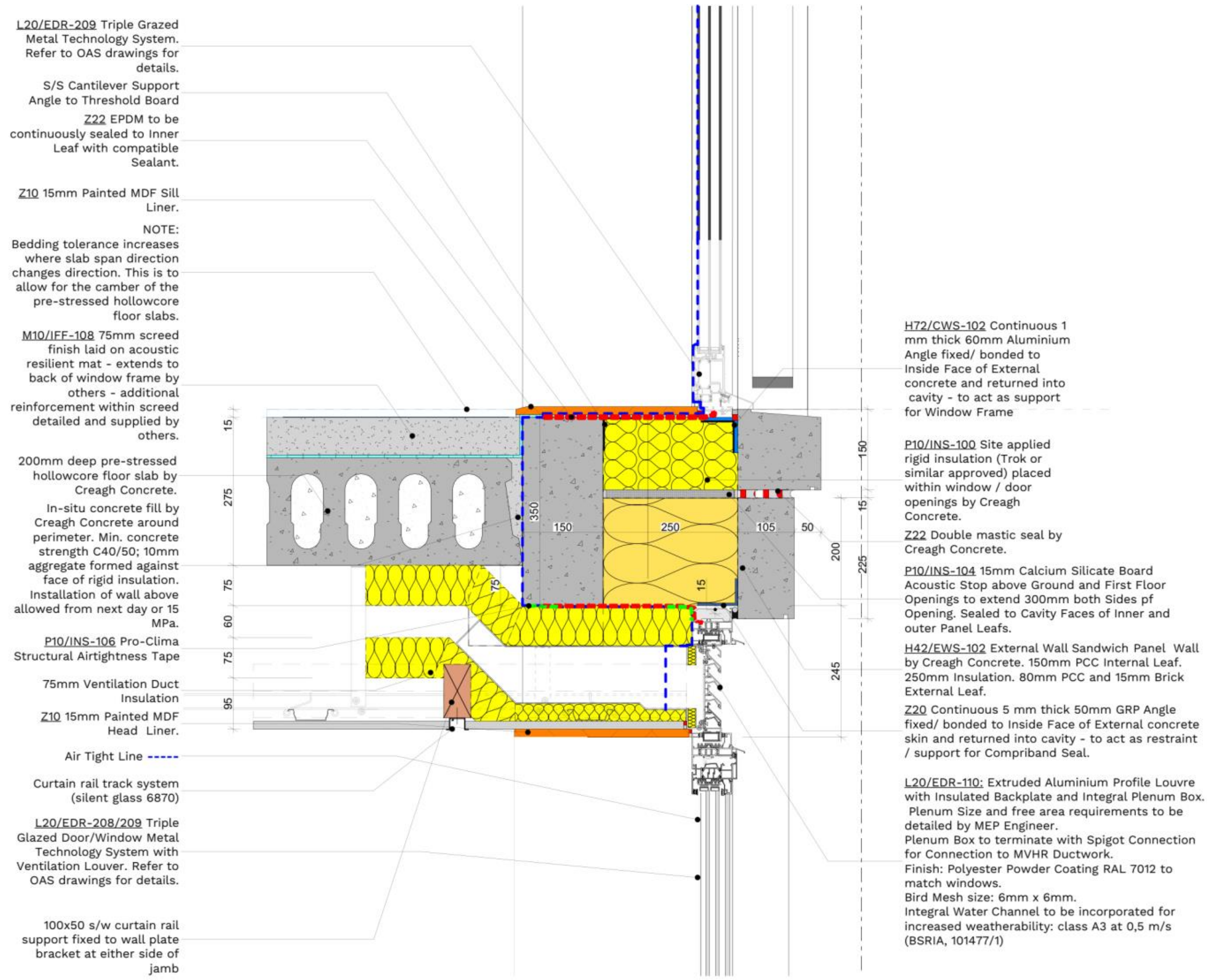
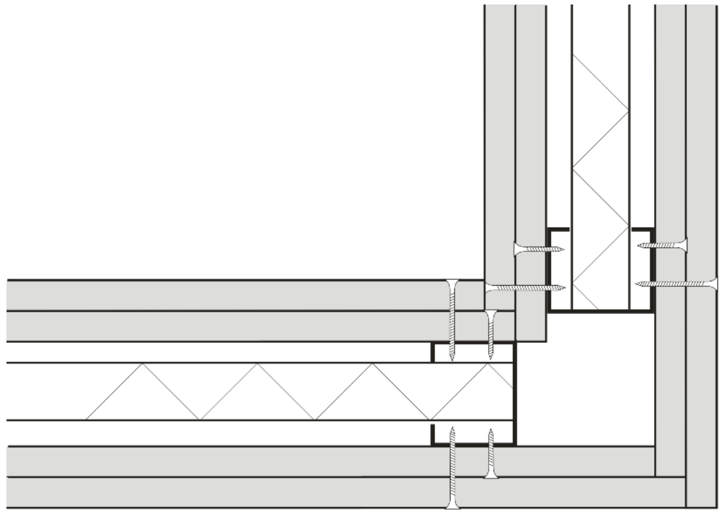


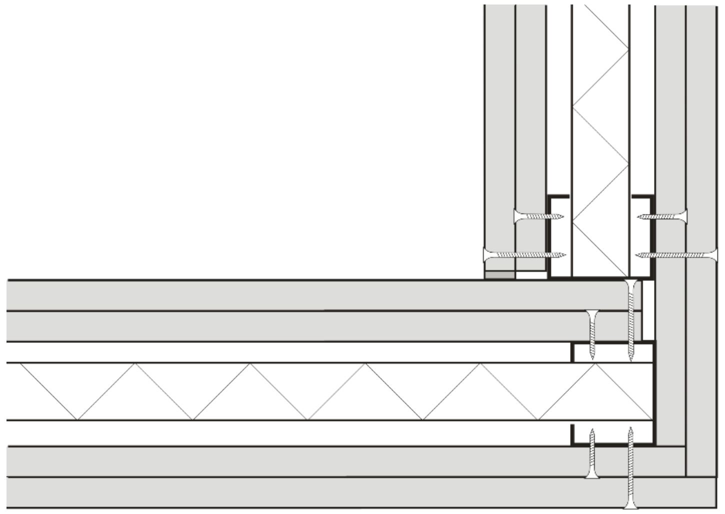
Figure 11.1: Section detail between dwellings

12.0 INTERNAL WALL JUNCTIONS

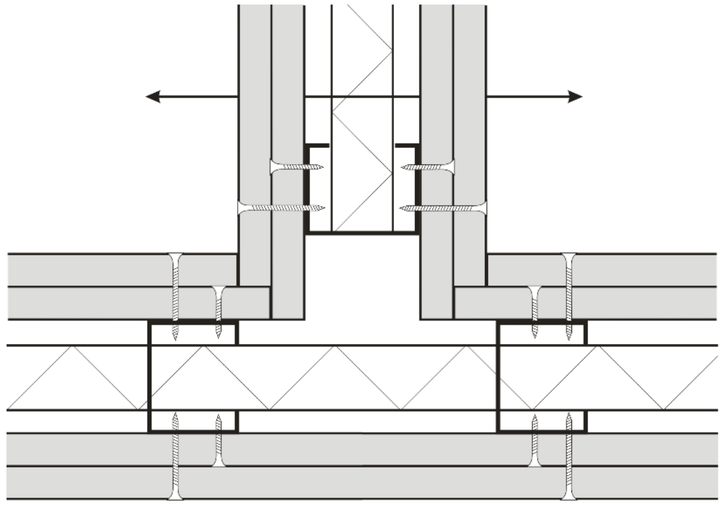
There are no restrictions for internal (Regulation E2) wall junctions and therefore internal walls can simply abut separating and external walls. However, in order to achieve a reasonable level of sound insulation the following junction details are suggested.



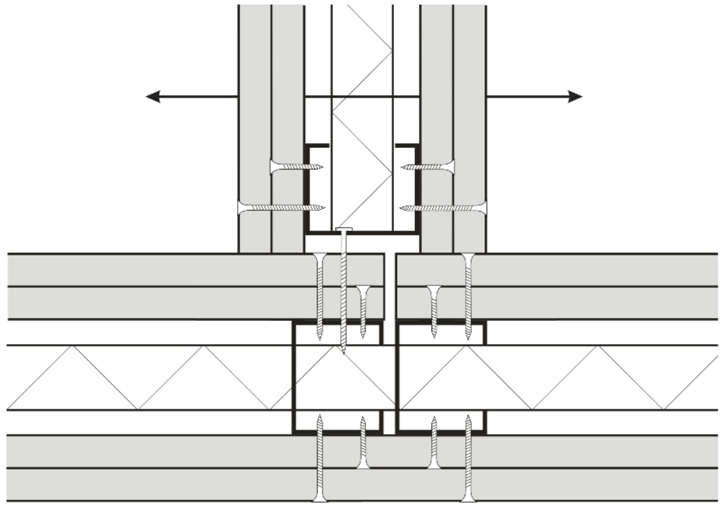
Single Stud – L Junction - Jointed



Single Stud – L Junction – Built-in



Single Stud – T Junction - Jointed



Single Stud – T Junction – Split Wall

13.0 ELECTRICAL PENETRATION DETAILS

No service penetrations should be made through separating floors, i.e. between occupied spaces, except for services runs for bathrooms or kitchen facilities, and all services should enter the room via a corridor, and not pass directly from room to room.

13.1 Recessed Sockets and Switches

All sockets and switches should be staggered by 150 mm and be detailed and sealed in such a way that the acoustic integrity of the separating partition is not compromised.

The table below outlines possible options to maintain the acoustic integrity where electrical sockets and switches are proposed.

Separating Wall Scenario	Detailing Options
Sound insulation requirement 45 – 50 dB D_{ntw} (+C_{tr})	≥150mm staggered sockets Putty Pads Acoustic Back Box Plasterboard backing, as per Robust Standard Details guidance, see Figure 13.1
Sound insulation requirement > 50 dB D_{ntw} or sockets back to back	Plasterboard backing, as per Robust Standard Details guidance, see Figure 13.1

Table 9.1 Recessed socket/switch detailing

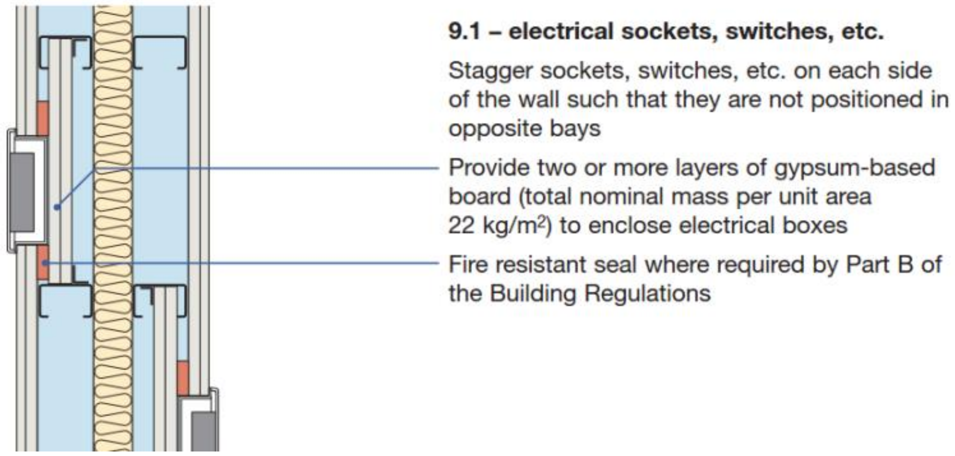


Figure 13.1 RSD Plan Plasterboard Backing Detailing

13.2 Cables

Electrical cables should not penetrate separating walls. All electrical services should therefore enter apartments from the shared corridors and circulation space. Figure 9.13.2 illustrates a suitable detail where cables penetrate partitions.

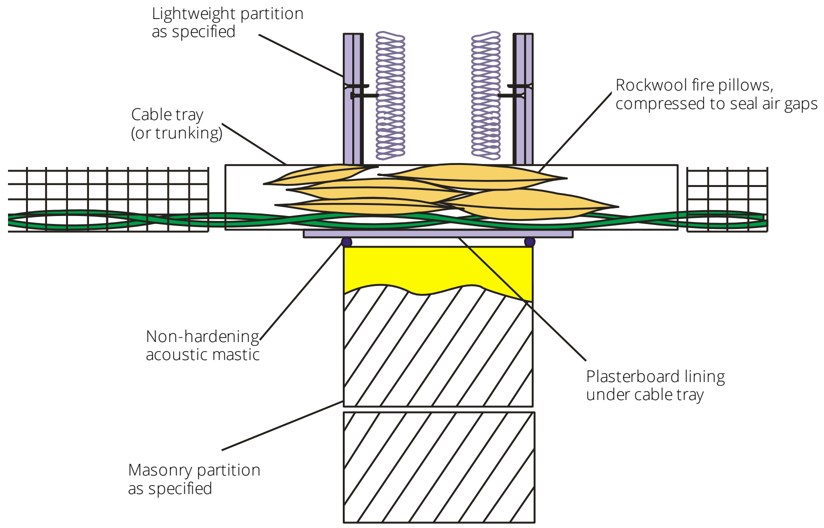


Figure 9.13.2 RSD Cable Tray and Trunking Detailing

13.3 Lighting

Penetrations in ceilings for lighting are not considered to provide acoustic issues to this project. It is however advised that penetrations are limited to 100mm dia, or 100mm in either direction.

14.0 SVP AND RAINWATER PIPE PENETRATIONS

Where SVP and rainwater pipe penetrate separating elements, they have the ability to compromise the sound insulation performance between dwellings as well as generate noise. This section therefore provides guidance for pipe penetrations.

14.1 General

In all instances SVP and Rainwater pipes should be boxed in for the full height of each room and with a minimum boxing with a mass per unit area 15kg/m^2. Within the boxing, either the services should be lagged, or the enclosure should be lined with unfaced mineral fibre insulation ≥25mm. Additionally, enhancements may be necessary in order prevent disturbance to residents where services run through habitable rooms or direction changes are unavoidable. In such case the following guidance is advised.

	Vertical		Direction Change	
	Rainwater	SVP	Rainwater	SVP
Non-Habitable Spaces bathroom / cupboards	HDPE ≥25mm Insulation Plasterboard boxing 15kg/m^2	HDPE ≥25mm Insulation Plasterboard boxing 20kg/m^2	HDPE ≥25mm Insulation & Plasterboard boxing 15kg/m^2 MF Ceiling 8kg/m^2 OR >50mm insulation MF Ceiling 25kg/m^2	HDPE ≥25mm Insulation & Plasterboard boxing 20kg/m^2 MF Ceiling 8kg/m^2 OR >50mm insulation MF Ceiling 37.5kg/m^2
Kitchen Bathrooms	HDPE ≥25mm Insulation Plasterboard boxing 15kg/m^2	HDPE ≥25mm Insulation Plasterboard boxing 20kg/m^2	Avoid HDPE ≥25mm Insulation Plasterboard boxing 20kg/m^2 MF Ceiling 10kg/m^2	Avoid Acoustic Pipe ≥25mm Insulation Plasterboard boxing 25kg/m^2 MF Ceiling 10kg/m^2
Bedroom Living Rooms	Avoid Acoustic Pipe 50mm insulation Plasterboard boxing 20 kg/m^2	Avoid Acoustic Pipe 50mm insulation Plasterboard boxing 37.5kg/m^2	Avoid unless no alternative Acoustic pipe 50mm insulation Plasterboard boxing 20kg/m^2 MF ceiling 20kg/m^2	Avoid unless no alternative Acoustic Pipe 50mm insulation Plasterboard boxing 37.5kg/m^2 MF ceiling 20kg/m^2

Table 10.1 Acoustic guidance SVP and Rainwater pipes

In addition to the guidance within the table above, table provides guidance where changes in direction are required.

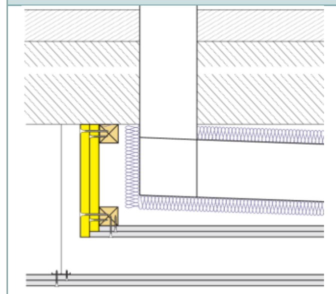
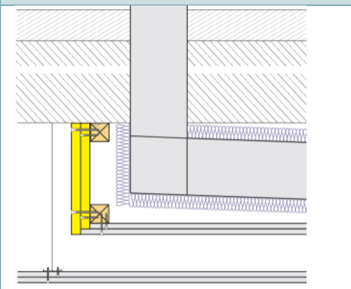
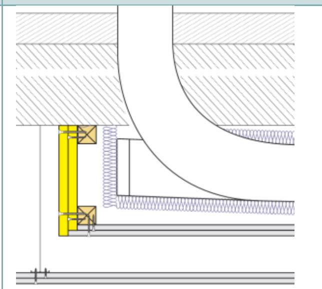
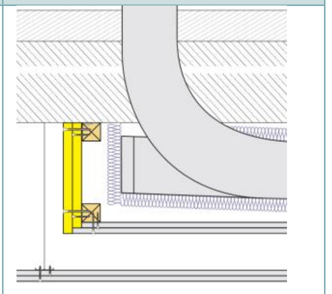
HDPE 90^0 Bend	Acoustic 90^0 Bend	HDPE Sweep	Acoustic Sweep
			
Performance: Least	Performance: Improved	Performance: Better	Performance: Best
Plastic pipe with narrow radius directional change	Enhanced pipe with narrow radius directional change	HDPE with increased radius reducing noise from impact	Enhanced pipe with increased radius reducing noise from impact

Table 10.2 Acoustic guidance SVP and Rainwater pipes

The acoustic sweep options provide the best acoustic performance and should be used where direction changes cannot be avoided and SVP drops multiple floors.

14.1.1 Acoustic SVPs

SVP's which provide enhanced acoustics performance include acoustic composite / multiwall systems or cast iron solutions, where cast iron is MACH's preferred option in order to reduce noise from SVP's.

14.1.2 Additional Guidance

The following additional guidance should also be followed:

- SVP and rainwater pipes within habitable rooms should be avoided as should changes in direction.
- Any boxing should be completely independent of the services and supporting structure.
- Where services penetrate separating floors, services must be fully independent of any floor or floating floors.
- SVP's should be resiliently supported to the structure
- Where changes in direction are unavoidable, boxing of the services should fully boxed to the next vertical run.
- If access panels are required then, the performance of these should have a mass per unit area (kg/m^2) equivalent to the boxing as described within. Table 10.1

15.0 REGULATION E3 – SOUND ABSORPTION IN COMMON AREAS

15.1 Acoustic Treatment Requirements

Regulation E3 of Approved Document E requires sound absorption to be provided to common areas which give direct access to dwellings. Compliance can be demonstrated by one of two methods. Method A requires an absorbent ceiling of minimum absorption Class C to 100% of the equivalent floor area. Method B requires a more detailed calculation if 100% of the ceiling cannot be covered, which can result in a smaller area of coverage if the floor is carpeted, depending upon the size of the space.

For this development, Method A will be employed. The marked drawings in Section 4.0 indicate the areas to which Regulation E3 will apply. These areas should be fitted with ceilings which meet sound absorption Class C.

15.1.1 Corridors - Proposed Ceiling Finishes

All corridors are proposed to include lay-in plank ceilings to all corridor areas adjacent to the proposed dwellings. It is assumed that the proposed ceiling finish will achieve at least Class C, and as such it is seen to comply with the Method A requirement of regulation E3, and no additional treatment is required.

15.2 Atrium

The room acoustic performance of the Atrium does not fall under Regulation E3 of building regulations, however it is understood that there is the aim of using the Atrium as a social area. As such it is important that the reverberation within the space is suitably controlled in order to make the space comfortable to be in, as well as to ensure occupants can communicate with each other.

15.2.1 Performance Targets

It is recommended that the atrium achieves a reverberation time of between 1.2 – 1.5s. This will minimise noise build-up within the area, as well as provide reasonable speech intelligibility.

15.2.2 Proposed Finishes

The proposed ceiling finishes are understood to be the following;

- Hard floor finish throughout
- Perforated plasterboard ceiling (21.7m^2)
  - Assumed absorption Class B (with mineral wool installed within cavity)
- Lay-in plank ceiling system (14.4m^2)
  - Assumed absorption Class A
- Standard plasterboard ceiling

15.2.3 Predicted Performance & Additional Acoustic Treatment

From the proposed finishes, the predicted reverberation time within the Atrium is 2.0s. This is longer than the recommended target of <1.5s and as such it is recommended that additional treatment is included within the space.

It is recommended that an additional 18m^2 Class A treatment is included within the Atrium to control reverberation. If possible, this should be installed as wall panels, spread uniformly and at low levels around the atrium. If the wall panels are installed at a high level this may reduce the effectiveness of the panels, and additional panels may be required.

It is important to note that this is not a requirement for compliance under building regulations, however would improve occupant comfort and promote the atrium as a social space.

16.0 NOISE BREAK-OUT ASSESSMENT

16.1 Nearest Noise Sensitive Receivers

The surrounding buildings include residential dwellings to the west leisure centre to the east and bowling alley and carpark to the south.

The site in relation to its surroundings and nearby noise sensitive receivers is presented in Figure 16.1.

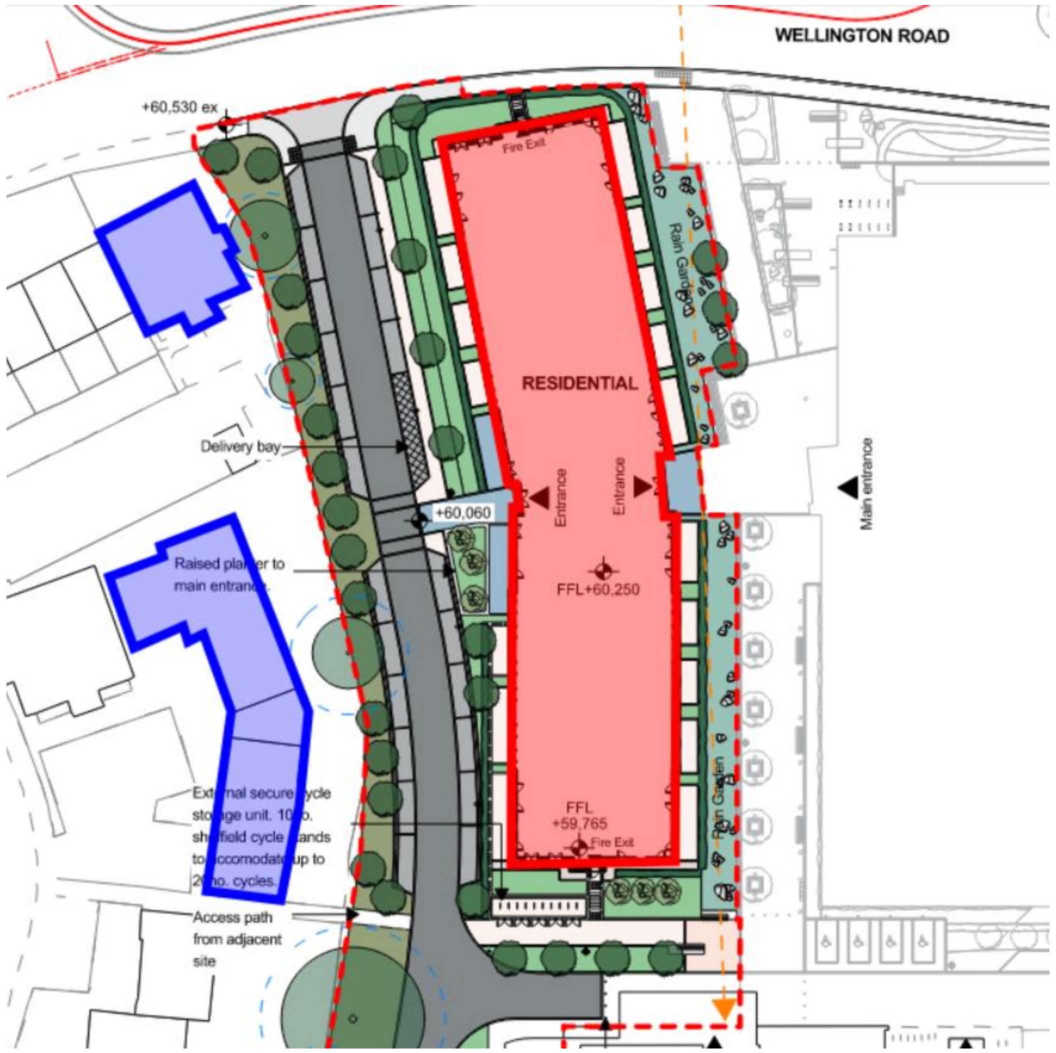


Figure 16.1: Proposed Site (Red) with Worst Affected Noise Sensitive Receivers (Blue)

Close proximity noise sensitive receivers that may be affected by the development are listed below.

Type	Location	Distance from Site Boundary (m)
Residential	Outfield Crescent - North	25
Residential	Outfield Crescent - South	28

Table 16.1: Nearest noise sensitive receivers

16.2 Design Target

It is understood that the local authority has set a specific plant noise limits as outlined below:

> *"The sound rating level (established in accordance with BS4142:2014) of any plant, machinery and equipment installed or operated in connection with this permission* ***shall not exceed, at any time, the prevailing background sound level at the nearest residential or noise sensitive property****. If the plant, machinery or equipment is to be enclosed details of the enclosure shall be sent to the local planning authority for their approval before the development commences. "*

As per the condition set by the local authority above, the plant noise rating level limit at the nearest noise sensitive receptor has been assessed against the existing background noise levels, L_{A90}. For the purposes of assessment, MACH Acoustics has used the typical daytime and night-time modal background noise level.

Plant noise break out should not adversely impact nearby residents but should also ensure that it does not impact the development itself. Therefore, plant noise break out must meet the following requirements.

Position	Time Period	Assessed Background Noise Level (dB L_{A90})	Plant Noise Rating Level Limit dB $L_{Ar,Tr}$	
			At Nearest Sensitive Receivers	At Nearest Window of Development
Fixed	Daytime (07:00 - 23:00)	44	44	45
	Night-Time (23:00 - 07:00)	37	37	45

Table 16.2: Plant Noise Limits

16.3 Items of Noise Generating Plant

Information on the proposed plant installations have been provided by EDP Environmental M&E engineers. The items of plant within each group, along with their locations and operational hours are as follows:

Reference	Type of Source	Manufacturer/ model	Location	Operational Hours
HP-01	Air Source Heat Pump/ Breakout noise	Mitsubishi Electric/ CAHV-P500YA-HPB	Roof plant compound (external)	24 hrs
HP-02	Air Source Heat Pump/ Breakout noise	Mitsubishi Electric/ CAHV-P500YA-HPB	Roof plant compound (external)	24 hrs
HP-03	Air Source Heat Pump/ Breakout noise	Mitsubishi Electric/ CAHV-P500YA-HPB	Roof plant compound (external)	24 hrs
AHU 01	Refuse Store/ Inlet and Exhaust Grilles	NUAIRE/ XBOXER XBC+45	Refuse store ceiling mounted (grilles to external)	24 hrs
AHU 02	Plantroom/ Inlet and Exhaust Grilles	NUAIRE/ XBOXER XBC+15	Plantroom ceiling mounted (grilles to external)	24 hrs
AHU 03	Cycle Store/ Inlet and Exhaust Grilles	NUAIRE/ XBOXER XBC+15	Cycle store ceiling mounted (grilles to external)	24 hrs

Table 16.3: Proposed items of noise generating plant

The following site plan shows the proposed plant installation.

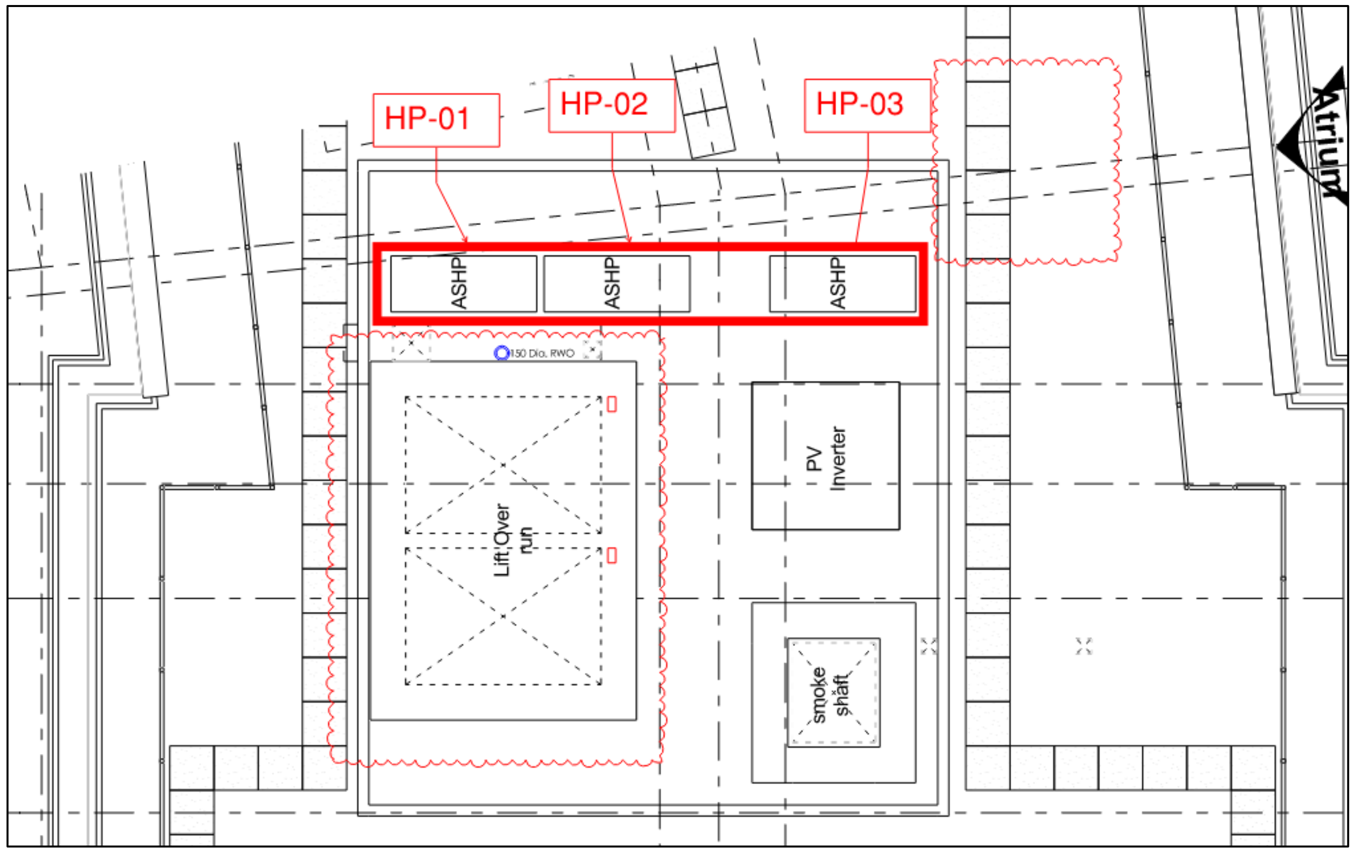


Figure 16.2: Roof plan showing proposed roof plant layout

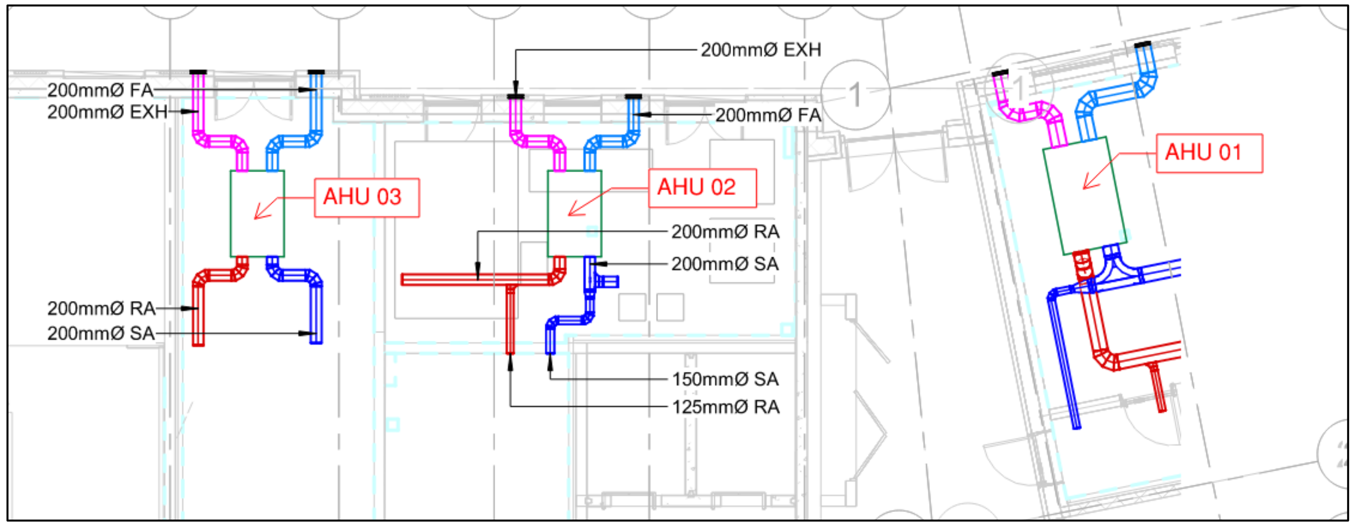


Figure 16.3: plan showing proposed ground floor plant layout

16.4 Plant Noise Data

The following noise levels for the individual items of plant are presented below. All data is based on manufacturers data. All plant noise data sheets are included within Appendix C.

Unit Reference	Noise Data Type	Duty Rate	Sound Levels, dB, at Octave Band Centre Frequencies, Hz						
			63	125	250	500	1000	2000	4000
HP 01, HP 02, HP 03	Supply inlet In-duct L_i	100 %	78	73	69	65	59	55	57
AHU 01	Exhaust inlet In-duct Lw	100 %	77.0	69.0	69.0	58.0	58.0	56.0	48.0
	Exhaust outlet In-duct Lw	100 %	82.0	75.0	79.0	65.0	66.0	65.0	60.0
AHU 02, AHU 03	Exhaust inlet In-duct Lw	100 %	64.0	54.0	49.0	50.0	56.0	49.0	41.0
	Exhaust outlet In-duct Lw	100 %	69.0	67.0	59.0	61.0	62.0	58.0	53.0

Table 16.4: Plant equipment data

16.5 3D Acoustic Model

A 3D acoustic model of the development has been constructed in CadnaA to accurately predict noise break out from individual items of plant from the development at nearby noise sensitive receivers. CadnaA is an industry standard noise modelling software which calculates how sound travels over distance. The model considers reflections off hard surfaces, ground absorption, acoustic screening, and geometrical spreading. The calculations are performed in accordance with ISO 9613: Attenuation of sound during propagation outdoors.

The following assumptions have been made in the model, based on observation of the site and proposed development has identified the following features. These features will be included within the calculation model including any other additional parameters stated.

- Ground absorption has been set to acoustically rigid.
- Noise contour height is 1.7m above ground, which is considered representative of average height of a person standing.
- Topography of the site is assumed to be flat.
- Order of reflections has been set to 3.

A screenshot of the 3D noise model is illustrated below.

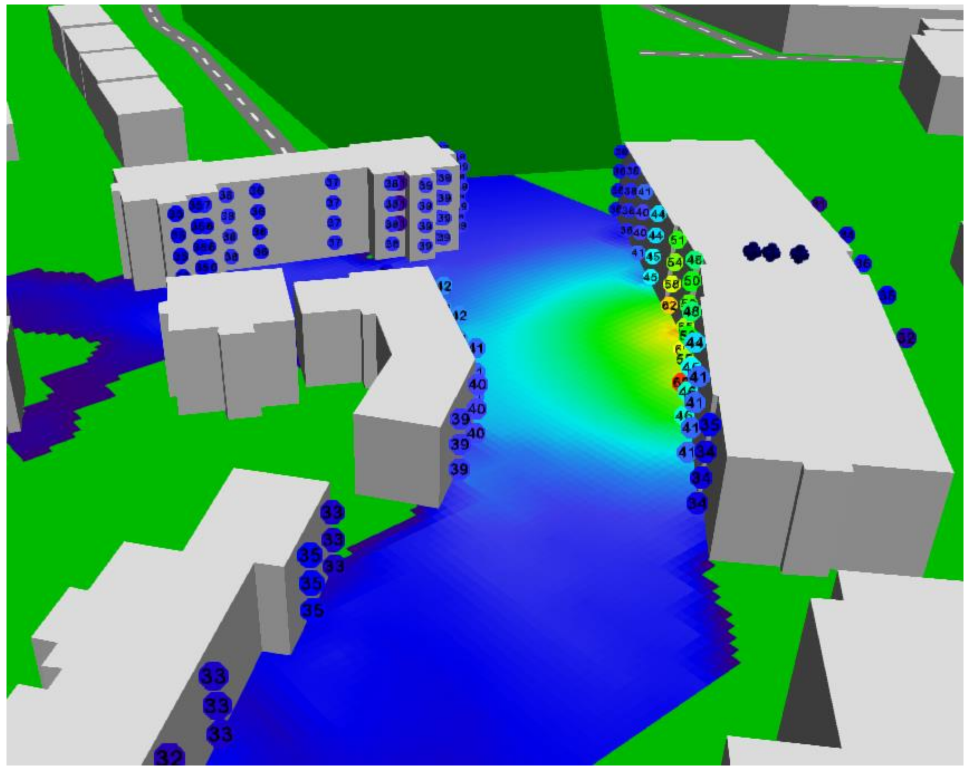


Figure 16.4: 3D Acoustic model with noise sources

16.6 Noise Impact Assessment (Proposed Installation)

The resultant noise map which calculates the combined specific noise level at each receiver is also presented below.

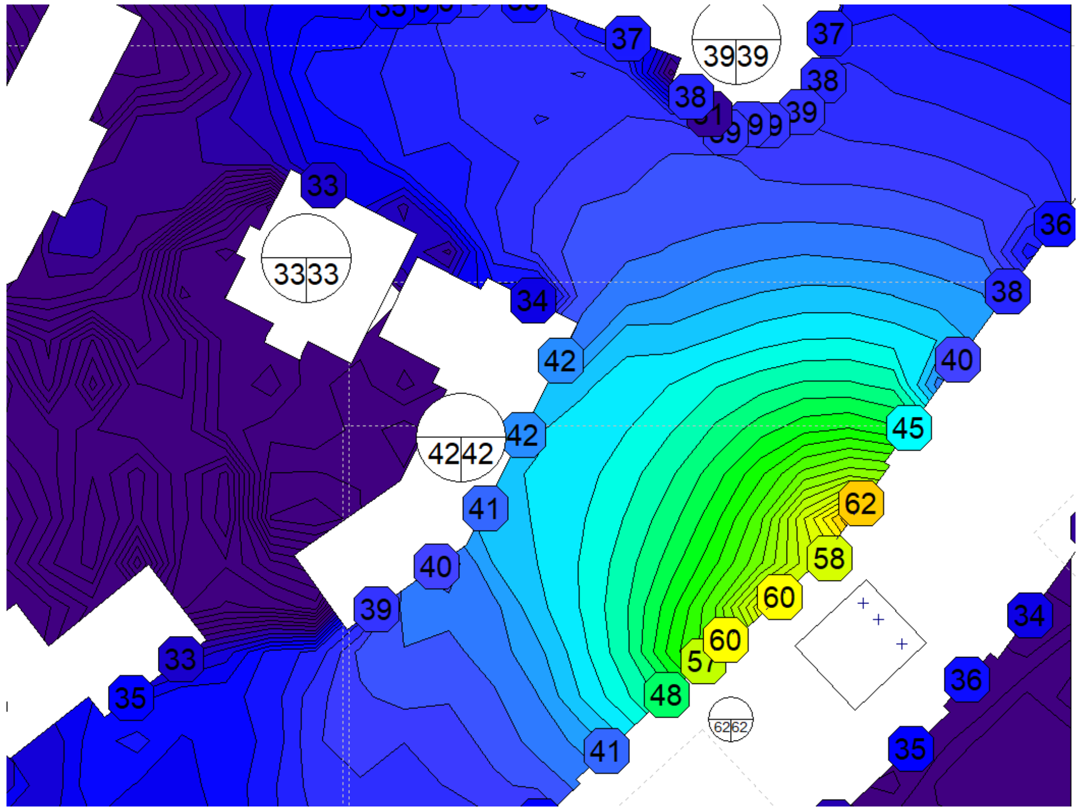


Figure 16.5: Proposed Installation Noise Map

The table below provides the calculated rating levels at the worst-affected noise sensitive receptors. It can be seen that the current proposals show that noise levels assessed at the worst affected NSR exceed the proposed criteria. As such, noise mitigation should be incorporated in the design in order to achieve compliance.

NSR Reference	Time Period	Background Noise Level (dB $L_{A90,T}$)	Criteria (dB)	Specific Noise Level (dB $L_{Aeq,T}$)	Feature Correction	Rating Level (dB $L_{Ar,Tr}$)	Assessment Outcome
Outfield Crescent	07:00 – 23:00	44	No louder than background	42	N/A	42	-2
	23:00 – 07:00	37		42	N/A	42	+5
At Nearest Window of Development	07:00 – 23:00	45		58	N/A	58	+13
	23:00 – 07:00	45		58	N/A	58	+13

Table 16.5: BS4142 assessment outcome

16.7 Acoustic Mitigation Strategy

16.7.1 In-duct Attenuators

Our assessment shows the ducted systems require in-duct attenuation. The following table presents the minimum insertion loss values these should achieve.

Unit Reference	Location	Minimum Insertion Loss, dB at Octave-band Frequency, Hz					
		125Hz	250Hz	500Hz	1kHz	2kHz	4kHz
AHU-01	Supply inlet	9	19	27	29	23	12
	Exhaust outlet	9	19	27	29	23	12
AHU-02	Supply inlet	9	19	27	29	23	12
	Exhaust outlet	9	19	27	29	23	12
AHU-03	Supply inlet	9	19	27	29	23	12
	Exhaust outlet	9	19	27	29	23	12

Table 16.6: Minimum required in-duct attenuator insertion losses

16.8 Noise Impact Assessment (Post-mitigation)

A noise map which shows the cumulative specific noise level at each NSR and a view of the nearest windows of the development is presented below. Each image below represents the relevant operational time of the plant equipment.

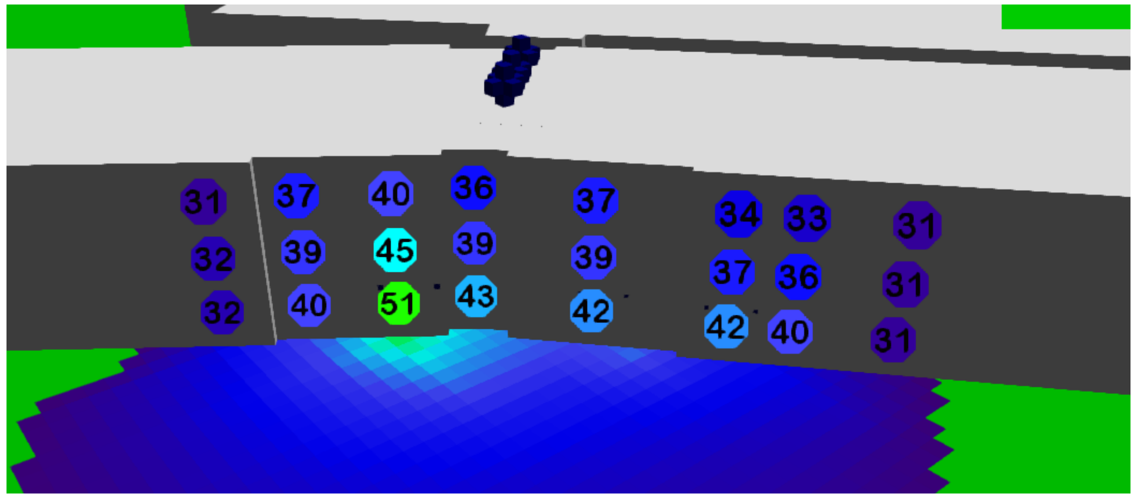


Figure 16.6: Figure showing the levels at the surrounding apartments to the specified plant

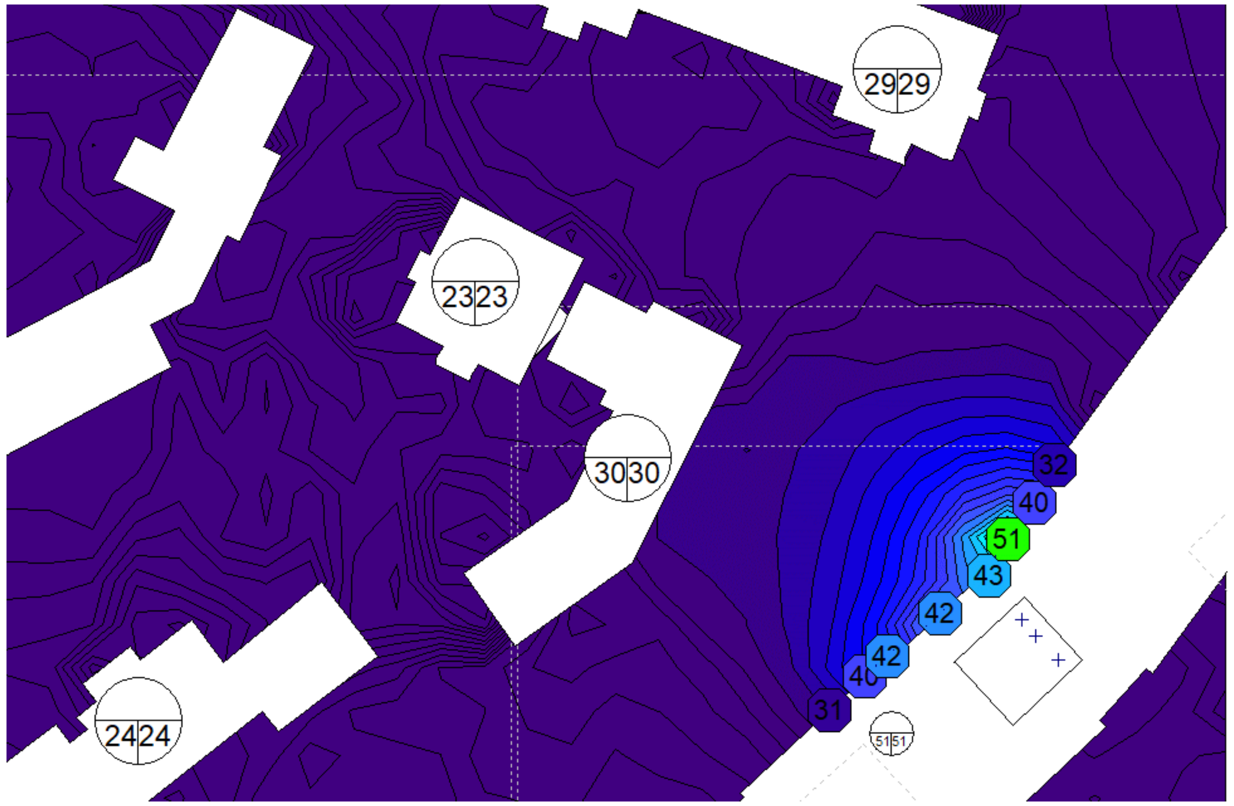


Figure 16.7: Plant noise prediction at nearest noise sensitive receiver during operational hours (08:00 – 18:00)

The table below provides the predicted plant noise rating level at the worst affected noise sensitive receptors, with the mitigation strategies implemented. Acoustic feature corrections have not been necessary.

NSR Reference	Time Period	Background Noise Level (dB $L_{A90,T}$)	Criteria (dB)	Specific Noise Level (dB $L_{Aeq,T}$)	Feature Correction	Rating Level (dB $L_{Ar,Tr}$)	Assessment Outcome
Outfield Crescent	07:00 – 23:00	44	No louder than background	35	N/A	30	-14
	23:00 – 07:00	37		35	N/A	30	-7
At Nearest Window of Development	07:00 – 23:00	45		45	N/A	45	0
	23:00 – 07:00	45		45	N/A	45	0

Table 16.7: Plant Noise Assessment Outcome

As can be seen in Table 16.7, providing that the recommended mitigation strategies are incorporated in the design of the building services installation, the cumulative noise levels generated by the plant equipment are compliant with the planning conditions from the local authority.

APPENDIX A – PRINCIPLES OF FLANKING TRANSMISSION

A1 Flanking Transmission

The sound insulation between two rooms is made up of the sum of the direct path and any flanking paths between the two rooms. The figure below indicates some of the flanking paths between two rooms.

Here it can be seen that the sound insulation between two spaces is not only dependent upon the construction of the separating wall or floor, but all the levels of separation provided by the building structure and the sound insulation across details.

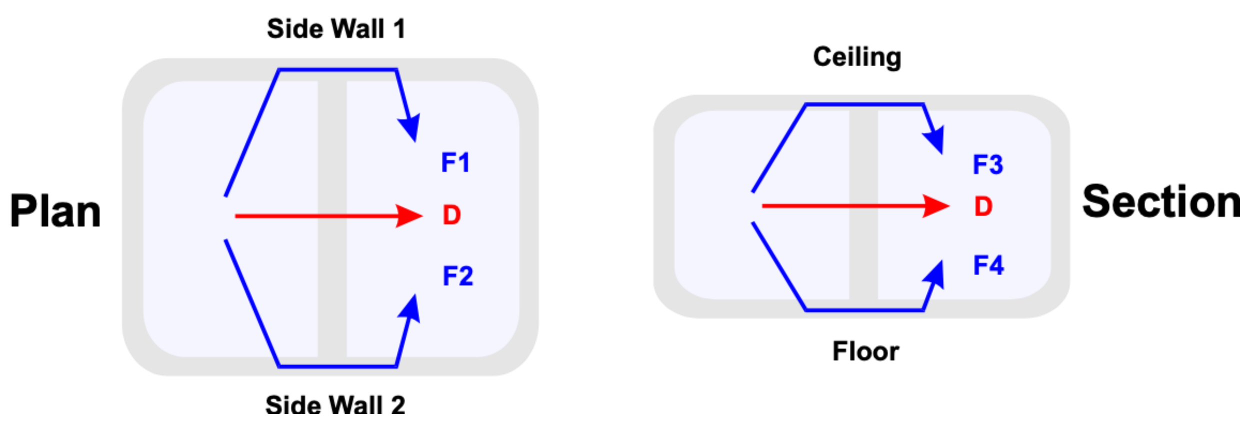


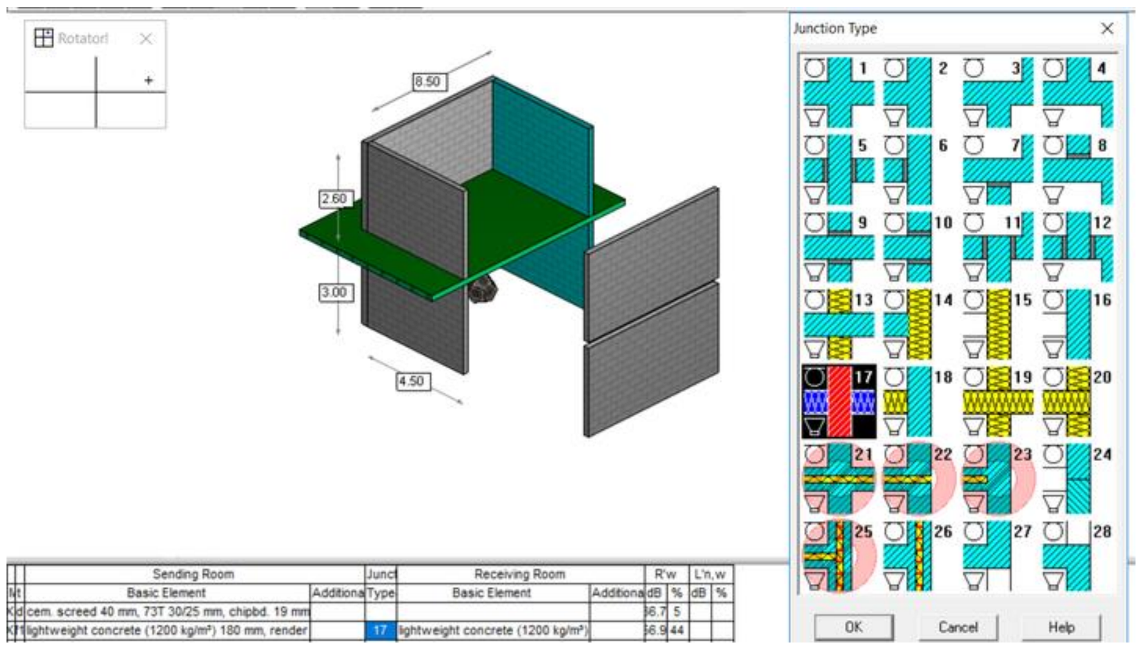
Figure 1 - Transition paths between rooms where:
D is the direct sound path, F1 Flanking via the sidewall 1, F2 Flanking via the Sidewall 2, F3 Flanking via the Ceiling, F4 Flanking via the Floor

A2 Passage of Sound through the Building Structure as Percentages

The passage of sound through the building frame is dependent upon a number of factors, including the mass of slab and walls, how these slabs/walls are supported (load bearing or non-load bearing), the finishes to the slab – MF ceiling / floating timber floors, wall linings and so on.

Such to assess the level of sound passing through the building structure, modelling to BS12354 'Estimation of acoustic performance in buildings from the performance of elements - Airborne sound insulation between rooms', can be undertaken, See the figure below, for an example of these calculations.

The advantage of this type of calculation is that the percentage of sound passing through the different elements forming the sound insulation across a separating element, can be understood. Knowing the percentage of sound passing through the different elements means that it is possible to identify the weakest links within a separating element.



APPENDIX B - THE PRINCIPLES OF SOUND INSULATION

B1 Sound Reduction of Monolithic Structures

The sound reduction across a simple monolithic structure, , such as concrete, a single layer of glass, blocks laid flat and so on, is simply dependent upon the mass of the structure. The heavier the structure; the harder it is to move, thus the grater the sound insulation provided by these structures.

These two videos illustrate the sound reduction through lightweight (https://www.youtube.com/watch?v=lqs-xw-Frok&feature=youtu.be) and dense block (https://www.youtube.com/watch?v=tW5HODhvelQ&feature=youtu.be) walls. These videos show that lightweight walls offer significantly less sound reduction, as a result of considerably more movement, due to the fact that it is lighter and, therefore, easier to move.

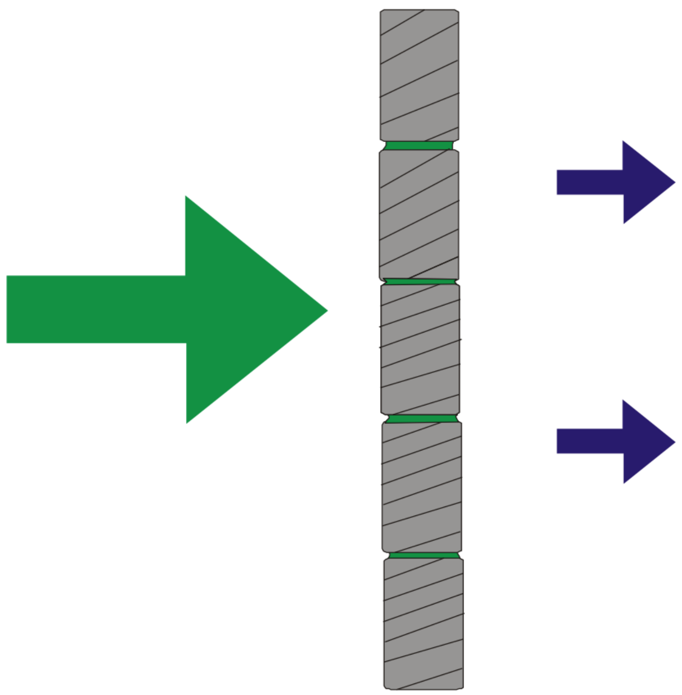
B2 Sound Reduction of Solid Structures

The passage of sound through a twin skin structure, stud wall, cavity block wall is proportional to the mass of the two skins making up the partition, plus the effect of the interconnecting element/(s).

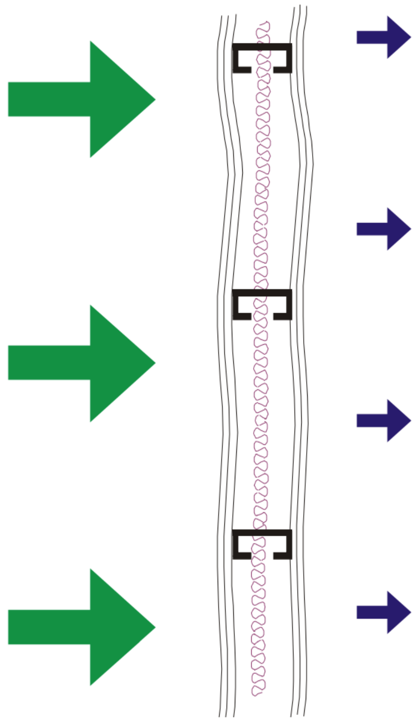
The sound reduction across a composite structure is dependent upon the ease with which the first skin, the skin exposed to the sound, moves. This is a function of the skins mass.

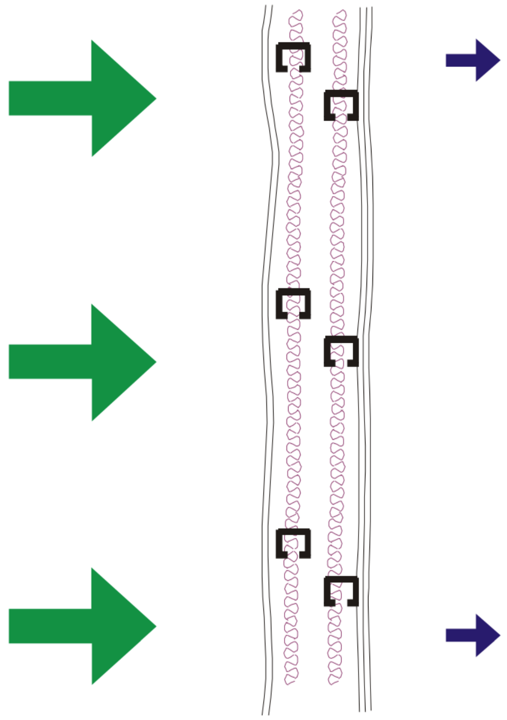
The sound/ vibration then passes through the connecting structures between the skins, thus broken structure pass less sound. From here the sound reduction of the composite wall is then dependent upon the mass of the second skin.

As an example a single (https://www.youtube.com/watch?v=ZtbVv6Io--w&feature=youtu.be) and twin stud (https://www.youtube.com/watch?v=Cg-ph6B99Lw&feature=youtu.be) wall perforce better, simply because the interconnectivity of a twin stud wall is less than for a single stud wall.



Doubling of mass adds 6 dB to sound insulation of a wall



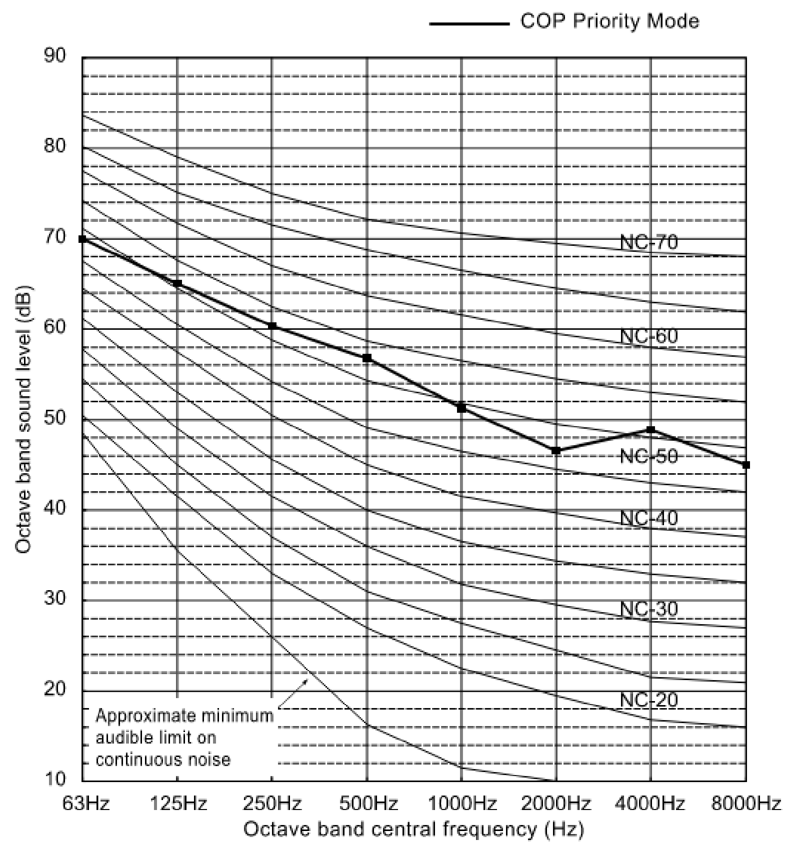


APPENDIX C – M&E EQUIPMENT

C1 Mitsubishi – CAHV-P500YA-HPB

Sound Pressure Level: 59.0 (COP Priority Mode)

Operation condition… Spring, Autumn: Outdoor temp.: 16°CDB/12°CWB, Inlet water temp.: 40°C, Outlet water temp.: 45°C
Winter: Outdoor temp.: 7°CDB/ 6 °CWB, Inlet water temp.: 65°C, Outlet water temp.: 70°C

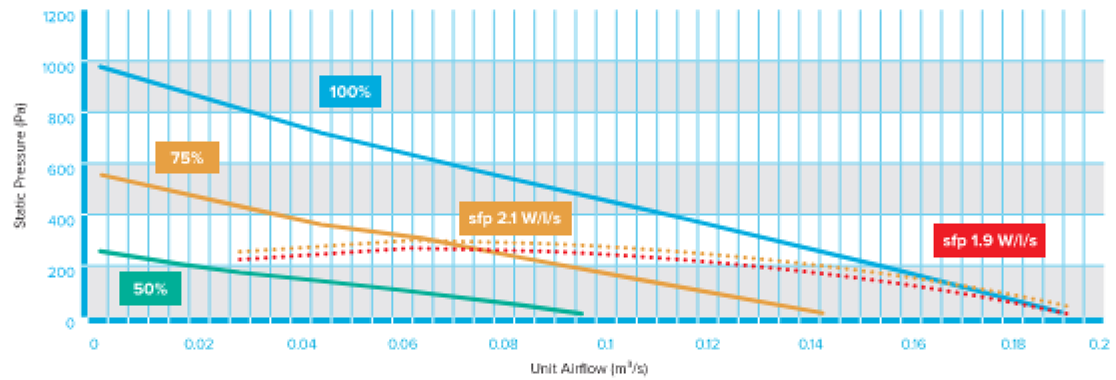


C2 Nuaire Xboxer xbc+15

XBOXER XBC+ 15

PERFORMANCE & TECHNICAL INFORMATION

PERFORMANCE CHART



TECHNICAL INFORMATION

HEATER TYPE	VOLTAGE	PHASE	FREQUENCY	INPUT POWER (W)	FAN SPEED (rpm)	FLC (A)	SC (A)	MAX OPERATING TEMPERATURE (°C)	UNIT WEIGHT (kg)
LPHW	230	1	50	340	4000	2.8	2.8	40	187
Electric*	230	1	50	3340	4000	16	16	40	195
None	230	1	50	340	4000	2.8	2.8	40	183

Relevant to BC, ES, CO or AT control types. *Inlcudes 3kW electric heater.

SOUND DATA

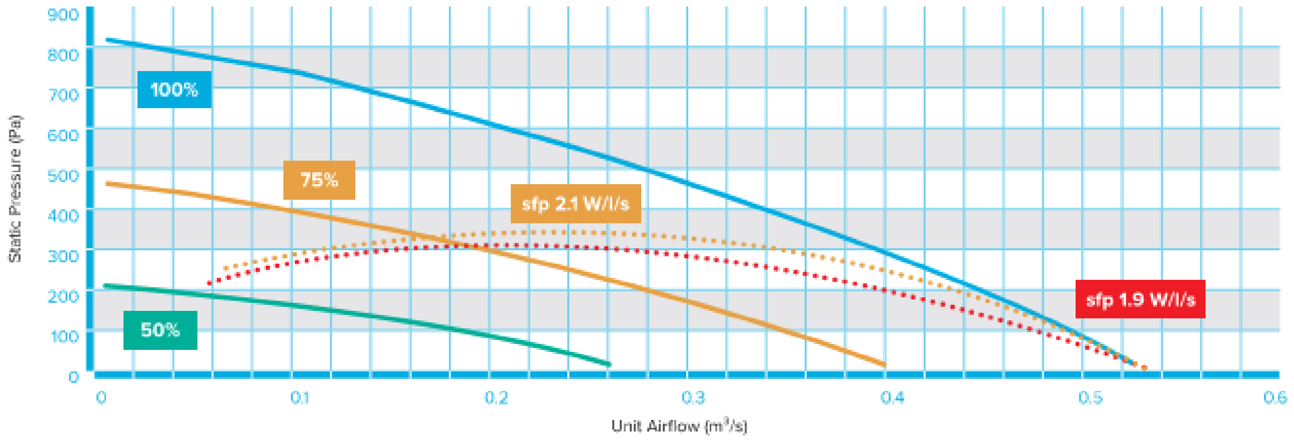
FAN SPEED	SOUND POWER LEVELS (db re 1 pW)	FREQUENCY (Hz)								SPHERICAL dBA@3m
		63	125	250	500	1K	2K	4K	8K	
100%	Induct Intake	70	60	55	56	62	55	47	43	26
	Induct Supply	75	72	65	66	668	64	59	57	
	Induct Discharge	75	73	65	67	68	65	60	58	
	Induct Extract	69	59	55	55	61	55	45	41	
	Casing Radiated	61	57	42	43	41	37	34	23	
75%	Induct Intake	64	54	49	50	56	49	41	37	20
	Induct Supply	69	66	59	60	62	58	53	51	
	Induct Discharge	69	67	59	61	62	59	54	52	
	Induct Extract	63	53	49	49	55	49	39	35	
	Casing Radiated	555	5511	336	377	335	3311	28	<20	
50%	Induct Intake	55	45	40	41	447	40	32	28	<20
	Induct Supply	60	57	50	51	53	49	44	42	
	Induct Discharge	60	58	50	52	53	50	45	43	
	Induct Extract	54	44	40	40	46	40	30	26	
	Casing Radiated	46	42	27	28	26	22	<20	<20	

C3 Nuaire Xboxer xbc+45

XBOXER XBC+ 45

PERFORMANCE & TECHNICAL INFORMATION

PERFORMANCE CHART



TECHNICAL INFORMATION

HEATER TYPE	VOLTAGE	PHASE	FREQUENCY	INPUT POWER (W)	FAN SPEED (rpm)	FLC (A)	SC (A)	MAX OPERATING TEMPERATURE (°C)	UNIT WEIGHT (kg)
LPHW	230	1	50	1100	2400	6.9	6.9	40	291
Electric*	230	1	50	5600	2400	27	27	40	298
None	230	1	50	1100	2400	6.9	6.9	40	287

Relevant to BC, ES, CO or AT control types. *Inlcudes 4.5kW electric heater.

SOUND DATA

FAN SPEED	SOUND POWER LEVELS (db re 1 pW)	FREQUENCY (Hz)								SPHERICAL dBA@3m
		63	125	250	500	1K	2K	4K	8K	
100%	Induct Intake	83	75	75	64	64	62	54	45	35
	Induct Supply	87	80	85	71	72	71	66	62	
	Induct Discharge	88	81	85	71	72	72	66	64	
	Induct Extract	84	75	76	63	64	63	53	44	
	Casing Radiated	74	65	62	47	45	44	40	29	
75%	Induct Intake	77	69	69	58	58	56	48	39	29
	Induct Supply	81	74	79	65	66	65	60	56	
	Induct Discharge	82	75	79	65	66	66	60	58	
	Induct Extract	78	69	70	57	58	57	47	38	
	Casing Radiated	68	59	56	41	39	38	34	23	
50%	Induct Intake	68	60	60	49	49	47	39	30	20
	Induct Supply	72	65	70	56	57	56	51	47	
	Induct Discharge	73	66	70	56	57	57	51	49	
	Induct Extract	69	60	61	48	49	48	38	29	
	Casing Radiated	59	50	47	32	30	29	25	<20	