

AtkinsRéalis



RIBA Stage 3 Acoustic Design

His Majesty's Courts and Tribunals Service

09 September 2025

2025/JAN/01

HMCTS SOVEREIGN HOUSE

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This document has 56 pages including the cover.

Document history

Document title: RIBA Stage 3 Acoustic Design

Document reference: 2025/JAN/01

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	1 st Issue	JWT	MO	DB	SM	28/03/2025
2.0	Added Future Developments	JWT	JM	DB	DB	09/09/2025

Client signoff

Client	His Majesty's Courts and Tribunals Service
Project	HMCTS SOVEREIGN HOUSE
Job number	5230782
Client signature/date	



Contents

Executive Summary	7
1. Introduction	8
1.1 Project Overview	8
1.2 Construction Design and Management (CDM) Regulations 2015	8
2. Acoustic Design Criteria	9
2.1 Policy and Design Guideline	9
2.1.1 Court and Tribunal Design Guide	9
2.1.2 Reading Borough Local Plan 2019	10
2.2 Internal Ambient Noise Levels	10
2.3 Internal Sound Insulation	11
2.3.1 Airborne Sound Insulation	11
2.3.2 Impact Sound Insulation	14
2.4 Reverberation Time	15
2.5 External Plant Noise Emissions	16
3. Noise Survey & Sound Insulation Testing	17
3.1 Noise Survey	17
3.1.1 Survey Overview	17
3.1.2 Survey Instrumentation	17
3.1.3 Site Description	18
3.1.4 Measurement Positions	20
3.1.5 Weather Conditions	20
3.1.6 Survey Results	20
3.2 Sound Insulation Testing	22
3.2.1 Testing Overview	22
3.2.2 Test Results	23
4. External Noise Impact Assessment	24
4.1 Noise Modelling and Plant Noise Level Predictions	24
4.2 Noise Sources	24
4.3 Mitigation	26
4.4 Results	27
5. Façade Noise Ingress Assessment	28
6. Internal Sound Insulation	29
6.1 Overview	29
6.2 Partitions	29
6.3 Internal Door Sets	31
6.4 Floors	32



6.5	Ceilings.....	32
6.6	Flanking Sound Transmission.....	32
6.6.1	General Considerations	32
6.6.2	Flanking via Partition Junctions	33
6.6.3	Flanking via Floors	33
6.6.4	Flanking at Heads and Bases of Partitions	33
6.6.5	Flanking via Columns.....	34
6.6.6	Services Penetrations	35
6.7	Lift Noise and Vibration	37
6.7.1	Noise and Vibration External to Car	37
6.7.2	Internal Partition	37
6.8	Internal Sound Insulation Compliance	38
7.	Room Acoustic Design	39
7.1	Overview	39
7.2	Design Proposals	39
7.3	Absorption Specification.....	39
7.3.1	General.....	39
7.3.2	Absorptive Classes	39
7.3.3	3D Model Overview	40
7.3.4	3D Model Predicted Reverberation Time.....	40
7.3.5	3D Model Predicted Speech Intelligibility.....	41
8.	Building Services Noise and Vibration	42
8.1	Overview	42
8.2	Building Services Internal Noise	42
8.2.1	Air Handling Units	42
8.2.2	Fan Coil Units.....	42
8.2.3	Services Penetrations	43
8.2.4	Crosstalk Attenuation	43
8.2.5	Vibration Isolation.....	43
9.	Summary and Next Steps	44
9.1	Overview	44
9.2	External Plant Noise Emissions	44
9.3	Internal Noise Levels.....	44
9.4	Internal Sound Insulation	44
9.5	Control of Reverberation	44
Appendix A.	Glossary of Acoustic Terms.....	46
Appendix B.	Noise Survey Time Histories.....	49
Appendix C.	Sound Insulation Mark-Ups.....	52
Appendix D.	Vibration Isolation	55



Tables

Table 2-1 IANL upper noise limits for noise break-in from external sources and building services	10
Table 2-2 Matrix of the $D_{nT,w}$ requirements for partitions and floors which do not contain doors	12
Table 2-3 CTDG room classifications	13
Table 2-4 Sound insulation performance requirements across partitions containing doors	14
Table 2-5 Room specific impact generated noise transmission limits	15
Table 2-6 Reverberation time requirements	15
Table 2-7 Plant noise emission limits at nearest noise sensitive receptors	16
Table 3-1 Survey instrumentation	18
Table 3-2 Measurement details	20
Table 3-3 Measured ambient noise levels at positions MP1 and MP2 (façade incident)	21
Table 3-4 Measured individual event noise levels at positions MP1 and MP2	21
Table 3-5 Representative background noise levels at positions MP1 and MP2 (façade incident)	21
Table 3-6 Sound insulation test schedule	22
Table 3-7 Measured airborne sound insulation	23
Table 3-8 Measured impact sound insulation	23
Table 4-1 Sound power levels used for noise model	26
Table 4-2 Required insertion losses for louvre	26
Table 4-3 Required insertion losses for attenuators	26
Table 4-4 Plant noise predictions with mitigation measures	27
Table 6-1 Internal wall constructions	29
Table 6-2 Typical door constructions	31
Table 7-1 Acoustic performance of proposed absorptive ceilings	40
Table 7-2 Predicted reverberation time: Hearing Room 7	40
Table D-1 Vibration isolation selection chart, reproduced from CIBSE Guide B4	55



Figures

Figure 3-1 Existing site plan	18
Figure 3-2 - Existing and proposed site plan	19
Figure 3-3 Second Floor Testing Areas (XXXXXX-XXXX-RTR-02-DR-A-0102-S1-D0100-Existing Second Floor Plan).....	22
Figure 4-1 Noise sources and assessment positions	25
Figure 6-1 Partition junction detail (indicative only)	33
Figure 6-2 Detail - Partition around column 1 – vertical section (indicative only).....	34
Figure 6-3 Detail - Partition around column 2 – vertical section (indicative only).....	35
Figure 6-4 Detail - Cable tray penetration (indicative only)	36
Figure 6-5 Detail - Pipe or duct penetration (indicative only)	36
Figure B-1 MP1 Time History (Façade Incident)	50
Figure B-2 MP2 Time History (Façade Incident)	51
Figure C-1 Ground Floor Sound Insulation Mark-Up.....	52
Figure C-2 First Floor Sound Insulation Mark-Up.....	53
Figure C-3 Second Floor Sound Insulation Mark-Up	54



Executive Summary

AtkinsRéalis have been commissioned to support the RIBA Stage 3 design of Sovereign House, Vastern Road, Reading for the Reading Tribunals Court.

The project criteria developed in RIBA Stage 2 have been set out and provided in this report.

The acoustic design information presented in this report has been developed to support the RIBA Stage 3 design and the key findings can be summarised as follows:

- The acoustic performance of the existing external building fabric is expected to be suitable to achieve the project acoustic design criteria.
- The proposed building services system, if designed with best practice noise and vibration controls, are expected to be capable of achieving the project acoustic design criteria for internal noise levels.
- The proposed building services systems with external plant noise emissions are expected to meet the Local Authority planning requirements if the recommended mitigation measures are installed. The assessment has considered future residential developments in the vicinity of the site.
- The proposed partition constructions have been reviewed and are expected to achieve the required sound insulation ratings. It is however also recommended to include a minimum 25mm mineral fibre within all partition constructions.
- The existing floor constructions are expected to achieve the project design criteria for impact and airborne sound transmission between floors. A resilient gasket is recommended to mitigate flanking transmission between floors via the structural columns. Appropriate detailing will be required in areas of glazing with lightweight spandrel panels.
- The acoustic detailing for junctions and penetrations has been provided within this report. These should be developed during RIBA Stage 4 and co-ordinated with the architectural and wider design team to ensure acoustic integrity and buildability.
- All currently proposed finishes in rooms are expected to achieve the reverberation time requirements with the exception of all consultation rooms and the small meeting room. To achieve reverberation time requirements in these spaces, the consultation rooms and small meeting room mineral fibre ceilings should be of Class A performance.
- With the recommendations set out in this report, the requirements of the CTDG, BREEAM Hea 05 and Pol 05, and the Local Authority will be able to be achieved.



1. Introduction

1.1 Project Overview

His Majesty's Courts and Tribunals Services (HMCTS) have purchased Sovereign House in Reading (Vastern Road, RG1 8BT) to rehouse the current Reading Tribunals Court.

The building is proposed to include 8 new Hearing Rooms alongside other typical court-relevant spaces. A new lift is also proposed to be constructed along the northern façade.

The proposed design does not propose major works to the external fabric.

A fully mechanical ventilation strategy is proposed, to include new ventilation layout, fan coil units, air handling units, toilet extract fans and chiller to be installed.

A glossary of acoustic terms used within this report is included in Appendix A.

This report sets out the performances required to obtain BREEAM 2014 Refurbishment and Fit-Out acoustic credits under the categories Hea 05 and Pol 05 of the BREEAM UK Refurbishment and Fit-Out scheme, where a total of four credits are available.

1.2 Construction Design and Management (CDM) Regulations 2015

AtkinsRéalis does not make recommendations on specific manufacturer products or construction methods related to acoustic design, although this report may make references to products or methods that could meet the relevant acoustic parameters. The material/method specifications would be prepared by others. Health and safety requirements associated with the use of specific materials or methods, as advised by the material supplier/manufacturer and/or defined in the relevant safety regulations, must be taken into account in the risk assessment.

Example risks and mitigation associated with the use of materials commonly suggested for acoustic design purposes are listed below:

- Manual handling of heavy materials such as dense concrete blocks or plasterboard – appropriate manual handling protocols should be followed.
- Handling irritants such as mineral wool – appropriate personal protection equipment should be worn and proper ventilation provided in the space.
- Exposure to construction noise – appropriate hearing protection should be worn or quieter methods and/or equipment considered.

This is not an exhaustive list and the health and safety requirements for any proposed materials or equipment need to be considered.



2. Acoustic Design Criteria

This section describes the policy and guidance documents relevant to the project and details the acoustic design criteria, which have been developed in line with these documents and best practice.

The design criteria given are the same as in our RIBA Stage 2 report but are provided here for completeness.

2.1 Policy and Design Guideline

2.1.1 Court and Tribunal Design Guide

Appendix C of the Court and Tribunal Design Guide Version 3.0 (CTDG) April 2023 covers the acoustic design criteria that are important for court and tribunal buildings and recommends acoustic criteria for:

- Internal noise levels.
- Sound insulation between rooms.
- Impact sound insulation.
- Room acoustics (control of reverberation).
- External noise emissions.

Despite the provision of a range of acoustic criteria, it is acknowledged within the document that alternative performance requirements may be sought, due to the existing building constraints.

“It is appreciated that when refurbishing an existing building there may be instances where the constraints of the building mean that it is not practicable to achieve the acoustic requirements in all areas. Any such instances should be highlighted during the design process in order for an alternative performance requirement to be agreed with the HMCTS client team. It is intended that any such alternative performance requirement would be based on what is reasonably practicable to achieve whilst minimising the impact on acoustic performance”. BREEAM UK Refurbishment and Fit-Out 2014

It is understood that the development is considered as a ‘Law Court’ building type according to BREEAM UK Refurbishment and Fit-Out 2014 and aspires to achieve a rating of ‘Excellent’. In this instance, there are two categories relevant to acoustics: Health and Wellbeing – Hea 05 Acoustic Performance, and Pollution – Pol 05 Noise Attenuation. The BREEAM criteria form the minimum acoustic requirements for this project.

2.1.1.1 Hea 05 Acoustic Performance (3 credits)

The Hea 05 category refers to the building’s acoustic performance, where up to three credits are available for Law Court buildings.

To achieve these credits the performance standards detailed in Section 28 of the Court Service Design Guide CSDG, HMCTS, 2010 (now replaced by the CTDG) are to be achieved in relation to internal ambient noise level, sound insulation and room acoustics. Where proposed room types for the Sovereign House refurbishment are not detailed in the CTDG, criteria will be developed from alternative standards or best practice experience.

2.1.1.2 Pol 05 Noise Attenuation (1 credit)

The Pol 05 category refers to noise emissions from fixed installations on the development, such as building services plant affecting nearby noise sensitive receptors. One credit is available under this category.



To achieve this credit, where there are noise sensitive receptors within 800m of the development a noise impact assessment is to be carried out in accordance with British Standard BS 7445. To obtain the single credit the noise level from the fixed installations associated with the assessed building must be shown to be at least similar to the existing background sound level (difference no greater than +5dB during the day (07:00-23:00) and +3dB at night (23:00-07:00)) at the nearest noise sensitive receptor.

2.1.2 Reading Borough Local Plan 2019

The Reading Borough Local Plan 2019 is the document that governs council development up to 2036. The Local Plan sets out general planning policies among which Policy EN 17 defines the noise emissions limits for any new noise generating equipment. The policy states:

“Where noise generating equipment is proposed, the noise source specific level (plant noise level) – which is the measured noise level with no correction factors (e.g. due to tonality features) included – should be at least 10 dBA below the existing background level as measured at the nearest noise sensitive receptor”.

2.2 Internal Ambient Noise Levels

Suitable Internal Ambient Noise Levels (IANLs) are required for clear communication of speech between users of the building, and to provide an appropriate environment where activities requiring concentration can be carried out undisturbed. The IANL is a product of noise levels from external noise intrusion and internal noise levels from building services. Therefore, in order to achieve appropriate IANL inside each space, the building envelope and ventilation strategy must be designed and constructed to provide sufficient sound insulation from external noise and building services noise must be suitably controlled.

Meeting the noise limits set out in this section will meet the requirements for the internal noise level credit of BREEAM Hea 05. Table 2-1 below provides IANL upper limits for noise break-in from external sources in rooms which are mechanically ventilated, alongside noise limits for the building services.

Table 2-1 IANL upper noise limits for noise break-in from external sources and building services

Room Name	Noise Limit for Building Services NR (dB)	Noise limit for Break-in from External Sources $L_{Aeq,30min}$ (dB)*
Hearing Room / Meeting Room	30	35
Advocates / Consultation Room / Judge's Room / Judicial Lounge / Judicial Office / Members Room / Office for Visiting Judiciary / Prayer and Contemplation Room / Security Control Room	35	40
HMCTS Workplace / Lobby / Medical Room / Public and Restricted Circulation / All Waiting Rooms and Areas / Queuing / Reception / Restricted Entrance	40	45
WCs / Services and Comms	45	50

*Transient noise resulting from external noise intrusion should not normally cause the values of $L_{A1,30min}$ to exceed the $L_{Aeq,30min}$ criterion for each space given in the table above by more than 20 dB.



The CTDG includes recommendations for noise resulting from rain impact on roofs. As the development includes a dedicated level for plant installation on the top floor above rooms intended for general use, there will be no noise sensitive rooms directly exposed to rain noise on the roof. Therefore, consideration of rain impact noise is not expected to be necessary.

The CTDG adds that *“where a room has been rated as ‘Sensitive’ to noise break-in, the noise from the building services system can be useful to mask break-in from adjacent areas. In these rooms, the noise from the mechanical ventilation system should be controlled so that the value of NR is no more than 5 lower than the upper limit for the space (i.e. where the criterion is NR35, the noise level from the building services should be no lower than NR30). Where rooms are naturally ventilated or the building services systems are particularly quiet, it may be necessary to install an electronic speech masking system in order to achieve this required standard. In rooms that are adjacent to those rated ‘Confidential’ or ‘Private’, the noise from the building services should be controlled so that the NR is no more than 5 lower than the upper limit for the space”.*

2.3 Internal Sound Insulation

Airborne sound transmission between spaces must be controlled to minimise noise disturbance inside spaces, especially where a level of privacy is required. Therefore, all elements of the separating structure must be considered, along with structure borne and flanking sound transmission. Meeting the CTDG sound insulation criteria specified below will satisfy the requirements to obtain BREEAM Hea 05 credits.

2.3.1 Airborne Sound Insulation

The airborne sound insulation performance requirement for each separating element has been derived from the CTDG based on the internal room types, their privacy requirements, sensitivity to noise breakthrough from adjacent areas and typical level of noise expected to be generated within the room.

The CTDG matrix to determine the sound insulation performance requirements across partitions (which do not contain doors) and floors is reproduced in Table 2-2. The airborne sound insulation requirement is presented as the $D_{nT,w}$ in dB, which is the minimum weighted standardised level difference between rooms.



Table 2-2 Matrix of the $D_{nT,w}$ requirements for partitions and floors which do not contain doors

Privacy Requirement of Source Room	Typical Level of Noise Generated in Source Room	Sensitivity of Noise Break-in of Adjacent Room		
		Sensitive	Moderately Sensitive	Not Sensitive
Confidential	High	55	50	50
	Medium	50	50	50
	Low	50	45	45
Private	High	55	50	45
	Medium	50	45	45
	Low	45	45	40
Moderately Private	High	50	45	40
	Medium	40	40	40
	Low	40	35	35
Not Private	High	50	45	35
	Medium	45	40	35
	Low	40	35	35



Each room has assigned classification set out in the CTDG, the classifications relevant to this project, taken from the CTDG, are set out below:

Table 2-3 CTDG room classifications

Room Type	Privacy Requirement	Sensitivity to Noise Break-through from Adjacent Spaces	Typical Source Noise Levels
Advocates Robing Room	private	moderately sensitive	low
Consultation Room	private	moderately sensitive	medium
Hearing Room	confidential	sensitive	high
HMCTS Workplace	private	not sensitive	medium
Judge's Room	private	moderately sensitive	low
Judicial Lounge	moderate privacy	not sensitive	medium
Judicial Office	private	moderately sensitive	low
Lobby	not private	not sensitive	low
Medical Room	confidential	moderately sensitive	low
Meeting Room	private	moderately sensitive	medium
Member's Room	moderate privacy	not sensitive	medium
Office for Visiting Judiciary	private	moderately sensitive	low
Prayer and Contemplation Room	private	moderately sensitive	low
Queuing	not private	not sensitive	high
Reception	not private	not sensitive	medium
Public and Restricted Entrances	not private	not sensitive	low
Security Control Room	moderate privacy	not sensitive	low
Services*/Comms	not private	not sensitive	low
Waiting Areas	not private	not sensitive	high
All Waiting Rooms	moderate privacy	moderately sensitive	low
All Circulation	not private	not sensitive	low
All Storage/Ancillary Spaces/Services/Comms	not private	not sensitive	low
All WCs	private	moderately sensitive	low

*We have been informed that services rooms are to be electrical only.

For partitions that contain doors which separate from circulation and waiting areas, the recommended minimum airborne sound insulation performance is set out in Table 2-4, which reproduces the table included in CTDG Appendix C. In this case, the performance is defined in terms of weighted sound reduction index R_w dB.



Table 2-4 Sound insulation performance requirements across partitions containing doors

Source Room	Receiving Room	Sound Insulation Requirement of Partition (R_w , dB)	Sound Insulating Requirement of Doors
Custody Areas	Courts and Hearing Rooms	50	Acoustic Lobby*
Public Circulation Areas, Waiting Room	Courts and Hearing rooms	50	Acoustic Lobby*
	Space classed as Confidential or those with High Sensitivity to noise from adjacent areas	45	40
	Space classed as Private	40	35
	Space with Moderate privacy requirements	40	30
	Space classed as Not Private	No requirement	No requirement
Non-public circulation and waiting areas, jury waiting areas, managed circulation areas	Hearing Rooms	45	40
	Jury Retiring Rooms	50	Acoustic Lobby*
	Space classed as Confidential or as Sensitive to noise break-in from adjacent areas	45	40
	Space classed as Private	40	30
	Space classed as Moderately Private	40	30
	Space classed as Not Private	No requirement	No requirement

*Where acoustic lobbies are required, each door set of the lobby should have a sound insulation performance of at least R_w 35 dB and partitions forming the lobby at least R_w 45 dB. If the partitions do not extend from slab to soffit, then the lobby should incorporate a sound insulating lid which achieved a performance of at least R_w 45 dB. The lobby should include an acoustically absorbent ceiling of Class A absorptive properties.

The sound insulation mark-ups in Appendix C consider the above guidance and provide airborne sound insulation requirements for the adjacencies currently proposed for the scheme.

2.3.2 Impact Sound Insulation

Noise from impacts on floors above rooms which are sensitive to noise breakthrough from other areas should be controlled to achieve the levels given in Table 2-5, when measured in accordance with BS EN ISO 16283-2:2020 and rated in accordance with BS EN ISO 717-2:2020. The noise transmission limits from impacts are defined in terms of weighted standardised impact sound pressure level $L'_{nT,w}$ in dB.



Table 2-5 Room specific impact generated noise transmission limits

Room	Maximum Impact Generated Noise Level, $L'_{nT,w}$ dB
All Hearing Rooms	55
Advocates / Consultation Rooms / Judge's Room / Judicial Office / Medical Room / Meeting Rooms / Office for Visiting Judiciary / Prayer and Contemplation Room / All Waiting Rooms	60
Lobby / All Circulation / All Waiting Areas / Queuing / Restricted Entrance / Security Control Room / WCs	65

The above noise transmission limits would usually be achieved where the floor finishes in a given space are proposed to be carpeted.

2.4 Reverberation Time

Reverberation times are required to provide a suitable environment for clear communication between occupants and the intelligibility of electroacoustic audio and video systems. Table 2-6 reproduces the reverberation time upper limits specified in Appendix C of the CTDG. The reverberation time requirements are specified for each type of room and achieving these criteria will allow the relevant BREEAM Hea 05 credit to be obtained.

Table 2-6 Reverberation time requirements

Room	Reverberation Time Upper Limit (s)*
Small Hearing Room (<500m ³)	$T_{Av} \leq 0.8$, averaged from 250 Hz to 2 kHz $T_{30} \leq 1.0$, at every octave band in this range
Consultation Room (small & medium)/Meeting Room (small)	$T_{Av} \leq 0.6$, averaged from 250 Hz to 2 kHz
Consultation Room (large)/ Prayer-Contemplation Room/ Rooms/Members' Room/Judicial Workstation/Jury Retiring Room/Meeting Room	$T_{Av} \leq 0.8$, averaged from 250 Hz to 2 kHz
Waiting Area (including Jury Waiting Areas)/Wellbeing Room/Judicial Lounge/SCSS Medical Examination Room HMCTS Workplace	$T_{Av} \leq 1.0$, averaged from 250 Hz to 2 kHz
Circulation	$T_{Av} \leq 1.2$, averaged from 250 Hz to 2 kHz

*If there are project specific constraints within existing buildings which mean it is not possible to provide sufficient acoustic absorption to achieve the criteria, then some relaxation of this criteria may be acceptable. Any such relaxation would need to be considered on a case-by-case basis for each project, provided that reasonable measures have been taken to minimise the impact within the constraints of the existing building. The reason for seeking a relaxation should be clearly recorded as a derogation for HMCTS to consider, along with the design teams' proposals for minimising any impact on the use of the space.



2.5 External Plant Noise Emissions

The CTDG guide recommends that when establishing the noise limits for external noise emissions from the building, Local Authority requirements and BREEAM Pol 05 requirements should be considered. Moreover, the external noise emissions from mechanical equipment should be controlled so that noise breaking back into the building does not exceed the levels in Table 2-1.

However, the CTDG states that the limits for external noise emissions should be determined based on whichever of the above-mentioned requirements is the most onerous to achieve. For this reason, the Reading Borough noise policy is set as the design criterion to be achieved by any new mechanical services plant with external noise emissions proposed to serve the building.

The Reading Borough Local Plan – Policy EN17: Noise Generating Equipment states that:

“Where noise generating equipment is proposed, the noise source specific level (plant noise level) should be at least 10dBA below the existing background level as measured at the nearest noise sensitive receptor....”

Plant noise emission limits have been set in line with the results of the noise survey carried out and set out in the table below for the nearest noise sensitive receptors at the existing and future developments surrounding the site. The nearest noise sensitive receptors are shown in Figure 3-2 The noise survey, results and derivation of the plant noise emission limits are discussed in Section 3 of this report.

Table 2-7 Plant noise emission limits at nearest noise sensitive receptors

Receptor	Plant Noise Assessment Criterion (L _s , dB)	
	Day (07:00-23:00)	Night (23:00-07:00)
AP1 – 51 Vastern Road	48	35
AP2 – Most Exposed Residence at Thames Court	37	32
AP3 – Rear of properties along Lynmouth Road	37	32
AP4 –Residence of Development to West (Block B)	48	35
AP5 – Residence of Development to West (Block C)	37	32
AP6 – Most exposed residence of development to East (Waterfront)	37	32



3. Noise Survey & Sound Insulation Testing

3.1 Noise Survey

3.1.1 Survey Overview

The noise survey methodology and results are summarised below.

The aim of the survey was to establish the existing environmental noise levels at the locations corresponding with the building façades and background noise levels at locations representative of the sensitive receptors that may potentially be affected by noise from the proposed building services.

The survey was conducted between Tuesday 13th August to Thursday 22nd August 2024 and was unattended. Internal measurements of background noise level were made as part of the sound insulation testing.

The key noise level descriptors recorded during the survey were:

- $L_{Aeq,T}$ and $L_{eq,T}$ in octave bands, representing ambient noise levels.
- $L_{A01,T}$, related to individual noise events.
- $L_{A90,T}$, representing background noise levels.
- $L_{Amax,T}$, representing maximum sound levels.

Definitions of the above descriptors are provided in Appendix A .

3.1.2 Survey Instrumentation

Instrumentation used during the survey is listed in Table 3-1, with reference to unattended measurement positions shown in Figure 3-1 further below.

All sound level monitoring equipment has Class 1 accuracy and holds the current manufacturer's calibration certificates, available on request.

All microphones were fitted with windshields. The meters were calibrated before and after all measurements, with no significant differences noted in levels.



Table 3-1 Survey instrumentation

Measurement position	Equipment	Type	Serial number	Date of calibration
Position MP1	Sound level meter	01dB FUSION	12811	26/02/2024
	Microphone	GRAS 40CD	415859	26/02/2024
	Pre-amplifier	01dB Pre No22	1915116	26/02/2024
	Calibrator	01dB CAL31	93744	10/11/2023
Position MP2	Sound level meter	01dB FUSION	12817	10/11/2022
	Microphone	GRAS 40CD	383184	10/11/2022
	Pre-amplifier	01dB Pre No22	1915119	10/11/2022
	Calibrator	01dB CAL31	93745	22/11/2023

3.1.3 Site Description

Sovereign House faces out onto Vastern Road opposite Reading train station. To the rear of the building a substation, residential buildings and commercial offices are located. The nearest noise sensitive receptor, Thames Court, is located 40m from the rear of the building. An existing site map can be seen below in Figure 3-1.



Figure 3-1 Existing site plan



It is understood that two residential developments have been given planning permission either side of the site to the west and to the east. These developments are shown overlaid onto the existing site plan below with most exposed assessment positions added.



Figure 3-2 - Existing and proposed site plan

3.1.4 Measurement Positions

Table 3-2 Measurement details

Position	Measurement Type	Measurement Start Time	Measurement End Time	Microphone Position / Comments
MP1	Unattended	11:45 Tuesday 13 th August 2024.	12:45 Thursday 22 nd August 2024.	External façade incident measurement 1m from the northern façade at roof level, in full view of Vastern Road
MP2	Unattended	Thursday 14:30 15 th August 2024.	12:50 Thursday 22 nd August 2024.	External façade incident measurement 1m from the northern façade at roof level, in full view of the court's car park and Norman Place

3.1.5 Weather Conditions

When setting up and collecting the measurement equipment, the weather was noted to be of clear skies with little to no wind and dry roads. Publicly available weather data suggests the weather was suitable for the full period of the survey.

3.1.6 Survey Results

The noise climate around the site was dominated by road traffic noise from Vastern Road. The measurements at MP1 are representative of receptors subject to noise from Vastern Road, while the measurements at MP2 are representative of receptors screened from this noise and are set back from the road.

Time history graphs of the measured L_{Aeq} , L_{A90} and L_{AFmax} levels at measurement positions MP1 and MP2 are presented in Appendix BA summary of all measurements is provided in the tables below. The results are façade incident, including façade reflections.



Table 3-3 Measured ambient noise levels at positions MP1 and MP2 (façade incident)

Position	Period	Ambient Noise Level $L_{eq,T}$ (dB) across octave bands (Hz)								$L_{Aeq,T}$ (dB(A))
		63	125	250	500	1k	2k	4k	8k	
MP1	Day & Evening (07:00-23:00) T=16h	64	61	60	57	60	56	49	42	63
	Night (23:00-07:00) T=8h	57	53	51	51	55	50	42	35	57
MP2	Day & Evening (07:00-23:00) T=16h	54	50	47	44	43	39	34	28	48
	Night (23:00-07:00) T=8h	48	43	42	39	38	34	29	23	42

Table 3-4 Measured individual event noise levels at positions MP1 and MP2

Position	Individual Event Noise Level Day (07:00-19:00) $L_{A01,1h}$ * (dB)
MP1	75
MP2	60

*Modal value between 07:00-19:00, which is the period with highest noise levels

Table 3-5 Representative background noise levels at positions MP1 and MP2 (façade incident)

Position	Day (07:00-23:00)		Night (23:00-07:00)	
	Representative*, $L_{A90,15min}$ (dB)	Range, $L_{A90,15min}$ (dB)	Representative, $L_{A90,15min}$ (dB)	Range, $L_{A90,15min}$ (dB)
MP1	58	50-65	45	42-62
MP2	47	44-55	42	40-51

*Derived by statistical analysis as per BS4142.



3.2 Sound Insulation Testing

3.2.1 Testing Overview

Airborne and impact sound insulation tests were conducted on existing floors to establish sound insulation performance in general accordance with *ISO 16283-1:2014 – Field measurement of sound insulation in buildings and of building elements Part 1 Airborne sound insulation* and *ISO 16283-2:2020 – Acoustics – Field measurement of sound insulation in buildings and of building elements Part 2 Impact sound insulation* and with reference to additional guidance included in Association of Noise Consultants (ANC) Good Practice Guides.

Table 3-6 below shows the areas where tests were undertaken. It should be noted it was not possible to test the separating floor between first and ground floors due to contractor occupancy. It is therefore assumed that the floor construction is the same throughout the building.

Table 3-6 Sound insulation test schedule

Source Room	Receiving Room	Test Type	Notes	Construction Type
Open plan office area 1 on second floor (test area 1)	Open plan office area on first floor	Airborne Floor Impact Floor	Flanking noise noted through services riser	Concrete floor slab on profiled metal deck, carpet finish on raised access floor
Open plan office area 2 on second floor (test area 2)	Open plan office area on first floor	Airborne Floor Impact Floor		Concrete floor slab on profiled metal deck, carpet finish on raised access floor

For clarity, the image below shows the different areas on the second floor tested between second and first floor:

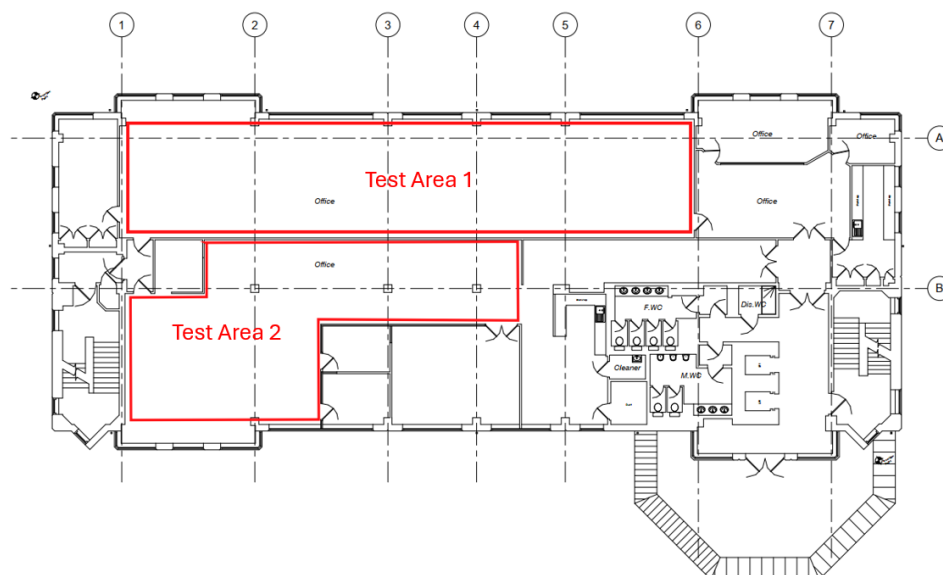


Figure 3-3 Second Floor Testing Areas (XXXXXX-XXXX-RTR-02-DR-A-0102-S1-D0100-Existing Second Floor Plan)



3.2.2 Test Results

The sound insulation test results are presented below. It should be noted that as the $D_{nT,w}$ value for airborne insulation represents a level difference, higher figures represent better performance. $L'_{nT,w}$ (for impact transmission) represents the transmitted noise level, hence smaller figures constitute better performance.

3.2.2.1 Airborne Sound Insulation

The measured airborne sound insulation of the tested floor sections are shown in Table 3-7:

Table 3-7 Measured airborne sound insulation

Test Reference	Source	Receive	$D_{nT,w}$ (dB)
AF1	Open plan office area 1 on second floor (test area 1)	Open plan office area on first floor	62
AF2	Open plan office area 1 on second floor (test area 2)	Open plan office area on first floor	65

Test AF1 was affected by flanking noise transmission via the nearby services riser, which was found not to be sealed between floors. The measured airborne sound insulation performance was found to be suitable to achieve the requirements.

3.2.2.2 Impact Sound Insulation

The measured impact sound insulation of the tested floor sections are shown in Table 3-8:

Table 3-8 Measured impact sound insulation

Test Reference	Source	Receive	$L'_{nT,w}$
IF1	Open plan office area 1 on second floor (test area 1)	Open plan office area on first floor	53
IF2	Open plan office area 1 on second floor (test area 2)	Open plan office area on first floor	50

Test area 1 and 2 had a concrete construction flooring with raised access floor and carpet finish. The $L'_{nT,w}$ measured for both tests shows the second floor flooring construction is suitable to achieve the impact sound insulation criteria.

The tests were conducted with raised access floors with carpet finish in place. These are understood to remain as part of the proposed design.



4. External Noise Impact Assessment

A digital three-dimensional noise model was developed using the SoundPLAN 9.0 proprietary computer program and used to calculate noise levels from the new plant at the nearest noise sensitive receptors.

Methodology and modelling assumptions are presented in the following sections together with the assessment of the predicted plant noise emissions against the adopted criteria.

4.1 Noise Modelling and Plant Noise Level Predictions

The specific noise levels $L_{s,T}$ associated with the proposed new plant were calculated using SoundPLAN 9.0, where sound propagation effects are calculated in accordance with the method presented in ISO 9613-1:1996. Considering that the site is located in an urban environment, the ground of the acoustic model was modelled as a hard surface with minimal ground absorption effect.

Baseline topography data (including existing building and road) has been assumed to be flat throughout due to the built-up nature of the area, while information about the new plant dimensions, location and noise data were received from the project's mechanical design team.

4.2 Noise Sources

The new plant with external noise emissions consists of an air handling unit (AHU01), toilet extract AHU (AHU03), chiller and one heat pump. The AHUs and extract fans are to be installed internally and ducted to atmosphere while the chillers and heat pump are to be installed externally. All plant with external noise emissions is to be installed at the roof level.

Existing plant is assumed to already have obtained planning permission so is not considered in this assessment where it is unaltered as part of the design. The ducting has, however, been amended for the existing AHU (AHU02) so this has been included in the assessment with the noise levels provided for AHU01 as no noise data has been provided for this unit.

We have been informed that all plant will only operate during building occupancy, with the chiller potentially operating marginally before these hours during the hottest months. Therefore, we have assessed the plant for daytime operation only (07:00-23:00, as per BS 4142:2014+A1;2019 *Methods for rating and assessing industrial and commercial sound*) as it is not expected to operate during night-time hours.

Information about the new plant is based on the following documents and drawings:

- Flakt Woods – AHU Submission
- Option 4 CGAF 090 HE LN With Dual Standard Pressure pumps – Product Report
- 377915_15380-BHK-RTC-00-D-M-0000 P01 – *Ground Floor Ventilation Layout*
- 377915_15380-BHK-RTC-01-D-M-0000 P01 – *First Floor Ventilation Layout*
- 377915_15380-BHK-RTC-02-D-M-0000 P01 – *Second Floor Ventilation Layout*
- 377915_15380-BHK-RTC-R3-D-M-0000 P01 – *Roof Plantroom Layout*

All AHUs are proposed to include attenuators as part of the installation.



Figure 4-1 shows the locations of the noise sources representing the new plant equipment within the context of the site and assessment positions.

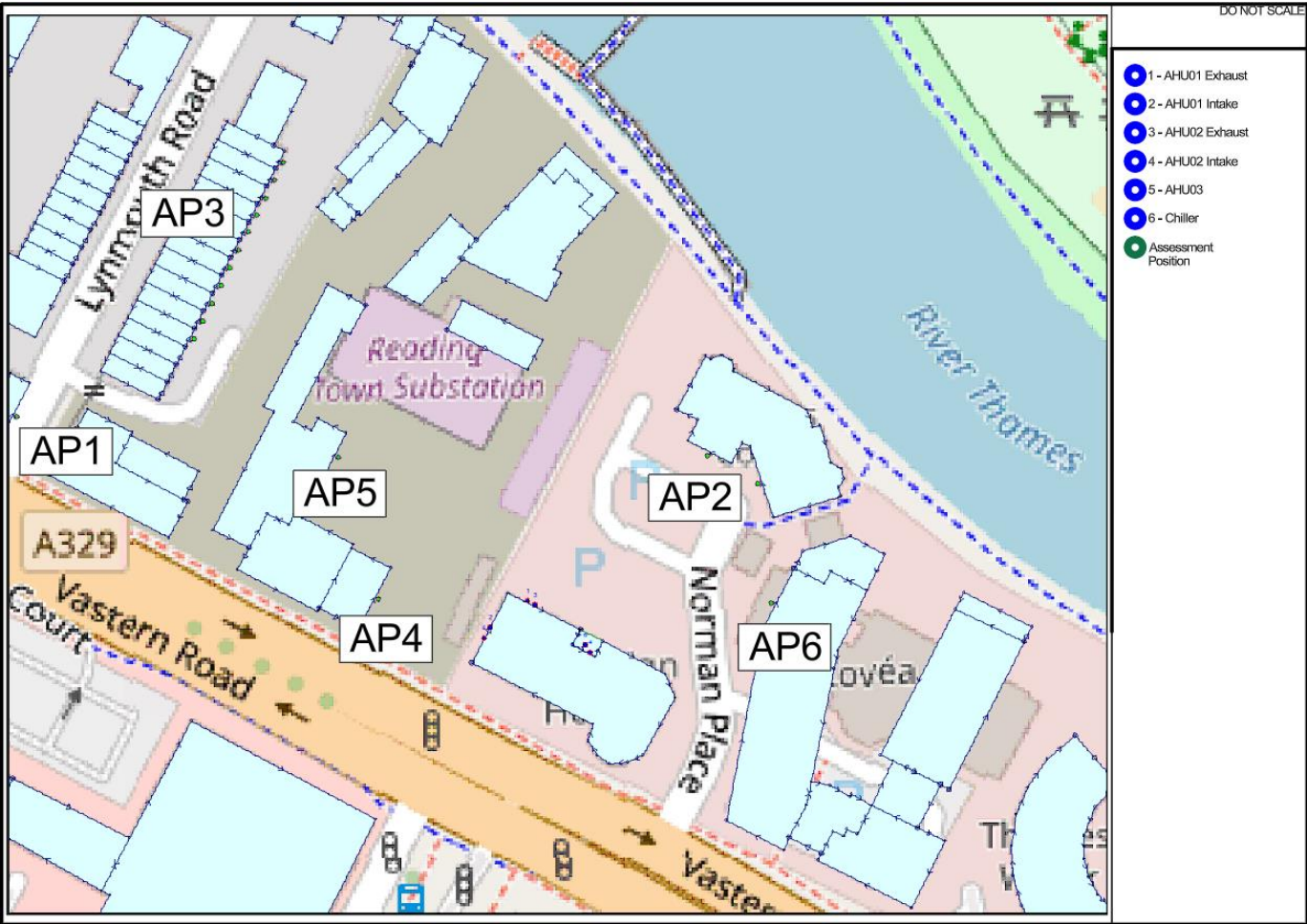


Figure 4-1 Noise sources and assessment positions

Table 4-1 below summarises the proposed plant Sound Power Levels (L_w) that were used in the noise model. The noise levels for the AHUs consider additional losses from the units to atmospheric termination including bend, duct and end reflection. These figures do not consider losses from attenuators.



Table 4-1 Sound power levels used for noise model

Noise Source		Sound Power Level (L _w , dB) across Octave Bands (Hz)							dB(A)
		63	125	250	500	1k	2k	4k	
Chiller		87	87	86	87	86	81	75	89
AHU01	Fresh air connection	49	56	59	59	52	49	45	59
	Exhaust connection	59	70	80	72	68	63	60	75
AHU02 (existing)	Fresh air connection	38	47	49	47	35	32	28	46
	Exhaust connection	50	62	71	61	52	47	44	64
AHU03	Fresh air connection	57	53	63	55	51	43	37	58
	Exhaust connection	58	59	70	65	68	65	61	72

4.3 Mitigation

It is currently proposed to install a louvre on the external plant area at roof level, as well as attenuators along the ductwork of the proposed AHUs. The following recommendations have been derived from our modelling results.

The below insertion losses are required of the louvre for the external plant area. The louvre should be at least as tall as the plant and as such, line of sight is obscured between the residences at Thames Court and the plant, and should span the width of the external plant area. It is expected that a 150mm acoustic louvre will meet the required insertion losses:

Table 4-2 Required insertion losses for louvre

Attenuation	Insertion Losses (dB) across Octave Bands (Hz)						
	63	125	250	500	1k	2k	8k
Louvre	4	5	7	12	16	16	16

The below insertion losses are required of the attenuators to AHU01 and AHU02 on all ductwork that terminates to atmosphere. It is expected that attenuators of 600mm length and 50% free area will meet the below requirements.

Table 4-3 Required insertion losses for attenuators

Attenuation	Insertion Losses (dB) across Octave Bands (Hz)						
	63	125	250	500	1k	2k	8k
All attenuators	1	2	7	10	11	9	7



4.4 Results

Table 4-4 presents the predicted noise levels at the assessment positions with the above mitigation measures installed. The shown specific levels L_s (dB) are the noise levels predicted at assessment positions due to the proposed plant only. The predictions are compared against the day time plant noise limits due to the operational hours of the plant. The Local Authority requirements are more onerous than the BREEAM Pol 05 requirements, as such, where Local Authority requirements are met, requirements for BREEAM Pol 05 are also met.

Table 4-4 Plant noise predictions with mitigation measures

Assessment Position (AP)	AP Description	Highest Predicted Noise Level at AP L_s dB(A) / (Limit)
AP1	51 Vastern Road	19 / 48
AP2	Thames Court	32 / 37
AP3	Rear of properties on Lynmouth Road	18 / 37
AP4	Block B (western development)	38 / 48
AP5	Block C (western development)	34 / 37
AP6	Most exposed residence on eastern development (Waterfront)	34 / 37

The results of the assessment show that the external plant noise emission limits are achieved with the recommended mitigation measures in place. The mitigation measures should include a louvre on the external plant area and attenuators on atmospheric-side ductwork that meet the insertion losses as set out in Section 4.3 above.



5. Façade Noise Ingress Assessment

It is understood that the existing building fabric is to be retained, as such, noise break-in will be limited by the existing façade performance.

To quantify existing IANLs within the existing buildings, short term attended noise measurements were taken internally. Measurements were undertaken along the southern façade of the building facing Vastern Road, with a measured average external façade incident ambient noise level of 63 dB(A) and a corresponding internal ambient noise level of 39 dB(A) with windows closed and under normal ventilation conditions. The internal measurement was observed to be dominated by mechanical services noise and to a lesser extent, noise break in from external sources.

Measurements taken along the northern façade of the building showed an average external façade incident ambient noise level of 48 dB(A) and a corresponding internal ambient noise level of 27 dB(A) with windows closed and under normal ventilation conditions. The internal measurement was observed to be dominated by mechanical services noise and to a lesser extent, noise break in from external sources.

An outline noise break-in assessment was also carried out for proposed rooms along facades, including Hearing Room 6, Claimants Waiting Room and a Judge's Room. The assessment includes assumptions for the existing constructions and associated sound insulation performance, including: standard thermal double glazing (R_w 30 dB) and typical brick and block constructions (R_w 51 dB), which represent the minimum likely performance of the existing façade. Calculations indicate that the internal ambient noise level criteria, listed in Table 2-1, are likely to be achieved in rooms along facades, with regard to external noise ingress. The IANL is predicted to be 32 dB(A) within Hearing Room 6 and Claimants Waiting Room, and 18 dB(A) within the Judge's Room.



6. Internal Sound Insulation

6.1 Overview

An assessment of the internal sound insulation has been carried out, with reference to the performance requirements of separating partitions, door sets, and separating floors.

The acoustic mark-up drawings in Appendix C show the minimum required laboratory sound insulation performance for each separating element. The acoustic rating is defined in terms of the weighted sound reduction index R_w which has been derived from the project acoustic design parameters set out in Section 2. The noise levels in plant rooms and comms/server rooms will be dependent on the noise generated by equipment installed within the rooms. The MEP team is required to confirm the noise levels at Stage 4, when plant selections are further developed. For these rooms, the sound insulation performance requirements for surrounding partitions and floors should be determined such that noise transmission to adjacent spaces does not cause the cumulative building services system noise levels defined in Section 2.2 to be exceeded.

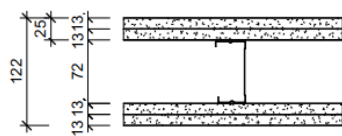
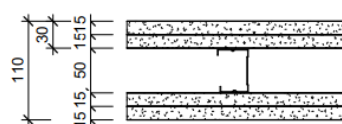
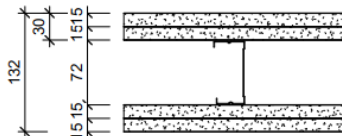
At this stage the following assumptions have been made regarding the expected maximum noise level inside plant rooms, comms/server rooms and service risers:

- NR65 for plant rooms and comms/server rooms
- NR60 within service risers

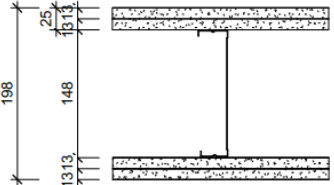
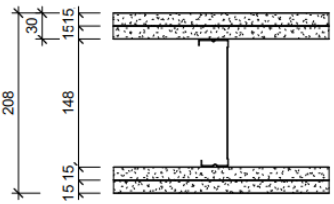
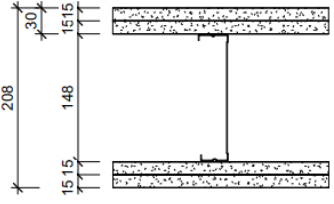
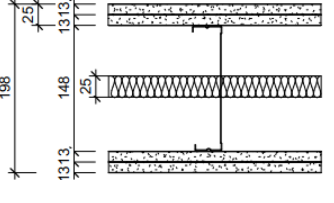
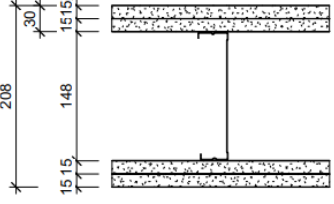
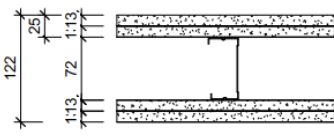
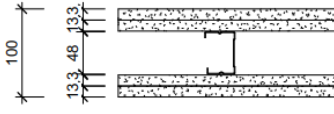
6.2 Partitions

Table 6-1 outlines the internal wall constructions proposed by the architect (drawing ref: 377915_15380-FMA-RTC-ZZ-D-A-9002 Rev P02). The constructions are expected to meet the criteria for airborne sound insulation between rooms as per the mark-up drawings in Appendix C, subject to suitable detailing and consideration of flanking transmission.

Table 6-1 Internal wall constructions

Reference	Sound Insulation Performance R_w (dB)	Partition Construction	Section	System Reference (British Gypsum White Book)
IP-01	45	2no. layers Gyproc Wallboard 12.5mm each side Gypframe 70 S 50 'C' stud @ 600mm centres		A206015
IP-02	45	2no. layers of Gyproc Wallboard 15mm each side Gypframe 48 S 50 'C' stud @ 600mm centres		A206004
IP-03	46	2no. layers of Gyproc Wallboard 15mm each side Gypframe 70 S 50 'C' stud @ 600mm centres		A206016



IP-04	50	2no. layers of Gyproc Wallboard 12.5mm each side Gypframe 146 S 50 'C' stud @ 600mm centres		A206027
IP-05	50	2no. layers of Gyproc Wallboard 15mm each side Gypframe 146 S 50 'C' studs @ 600mm centres		A206028
IP-06	56	2no. layers of Gyproc SoundBloc 15mm each side Gypframe 146 S 50 'C' studs @ 600mm centres		A206179
IP-07	55	2no. layers of Gyproc Wallboard 12.5mm each side Gypframe 146 S 50 'C' stud @ 600mm centres 25mm Isover Acoustic partition roll (APR1200) in cavity		A206210
IP-08	60	2no. layers of Gyproc SoundBloc 15mm each side Gypframe 146 S 50 AcouStuds @ 600mm centres 2mm Thistle Multifinish		A206A179SF
IP-09	45	As with IP-01, but with moisture resistant finish		A206015
IP-10	42	2no. layers of Gyproc Fireline 12.5mm each side Gypframe 48 AS 50 'C' studs @ 600mm centres		A206067

It should be emphasised that the above partitions have been proposed by the architect and have been assessed to be suitable to achieve the partition requirements. Alternative constructions are likely to achieve the performances required, though these should be reviewed by an acoustician prior to approval.

For plant room partitions and high performance partitions between sensitive rooms (R_w 50+ dB), it is required that a minimum 25mm acoustic insulation is included within the cavity of all proposed partition constructions to aid in mitigating lower frequency transmission through the partitions. In all other partitions, the above is considered suitable.



It should also be noted that inclusion of acoustic insulation within the cavities of partitions would also allow for thickness reduction of the partitions themselves in most cases. If thickness reduction is desired, the partition constructions should be re-selected in line with appropriate alternative constructions within the British Gypsum Whitebook.

Regarding construction IP-09, it must be ensured that the two layers of plasterboard used match the mass per unit area of the Gyproc Wallboard as proposed in construction IP-01.

6.3 Internal Door Sets

The marked-up layout plans attached in Appendix C show the location and required performance of acoustically rated doors.

Doors are typically the weakest point of a partition due to their limited mass, single layer construction and temporary nature of seals at the edges. Improved acoustic performance can be achieved through use of high mass doors, with full and effective seals at all edges including the threshold.

It is challenging to meet the same sound insulation value R_w of a wall, especially at higher performance requirements, without specifying heavier door sets. These are typically high-cost items and may be difficult to open. Alternatively acoustic lobbies can be used to achieve a higher performance.

Some typical door constructions that meet the requirements are given in Table 6-2 below:

Table 6-2 Typical door constructions

R_w Requirement	Example Construction
R_w 30 dB	44mm thick solid-core fire door of at least 27kg/m ² mass, closing onto a rebated frame with wipe or compression acoustic door seals to head, jambs and threshold. A substantial frame with an effective stop should be used, typically consisting of a 90mm x 40mm section with stops of at least 15mm.
R_w 35 dB	54mm thick solid-core fire door of at least 29kg/m ² mass, closing onto a rebated frame with wipe or compression acoustic door seals to head, jambs and threshold. A substantial frame with an effective stop should be used, typically consisting of a 90mm x 40mm section with stops of at least 15mm.
R_w 40 dB	Typically a specialist product and normally supplied as a complete door set. High performance seals might make the door hard to operate. The selected product should be reviewed for acoustic performance during the next stage of the project.

Doors incorporating 900mm x 17.5mm vision panels comprising 7mm fire resistant glass can typically achieve ratings of R_w 30-35 dB.

Doors to acoustic lobbies, such as those proposed to the hearing rooms must be fitted with a door set of minimum R_w 35 dB.

Should rooms be deemed to require a particularly high-level of acoustic privacy with respect to corridors at a later stage (e.g. meeting rooms), the relevant door sets may require upgrading in terms of acoustic performance during the next stage of the project.

It must be noted that if doors are under-cut or ventilation grilles are fitted, this is likely to result in reduced acoustic performance.



Specification of doors to plant rooms, comms/server rooms, and riser doors (and the associated host partitions), are subject to confirmation of noise levels in these rooms at the next stage once the final plant selections are known.

6.4 Floors

On-site measurements estimate an acoustic performance of the separating floors of at least $D_{nT,w}$ 62-65 dB for airborne sound insulation and $L'_{nT,w}$ 50-53 dB for impact sound insulation, which are both considered sufficient to meet the sound insulation requirements. It is understood that the existing floor constructions are to remain in the proposed design.

6.5 Ceilings

The on-site measurements suggest that the airborne and impact sound insulation requirements are met by the existing installed ceilings. Therefore, if the construction is not removed from, or elements of it are replaced with a similar new element with equivalent sound insulation performance, there is no requirement to install additional sound insulating ceilings.

It is proposed to replace ceilings throughout the scheme with primarily mineral fibre ceiling tile finishes. It is not expected that the proposed ceilings will reduce sound insulation performance across floors.

6.6 Flanking Sound Transmission

The acoustic detailing of suspended ceilings, junction and penetration details, along with high performance workmanship will be integral to the internal sound insulation performance of the completed development.

The various possible flanking noise transmission paths to be considered within the building have been set out below. Indicative details have been provided which should be developed based on detailed assessments of flanking noise at the next design stage.

The following subsections present an assessment of the principle acoustic flanking paths and areas of particular attention.

6.6.1 General Considerations

Careful design of junction details and quality workmanship will be required to control flanking noise to the required levels. Each scenario should be reviewed on a case-by-case basis.

Some general principles and good practises that are recommended to be followed in the design and construction of internal partitions, floors and ceilings to avoid excessive flanking noise transmission are set out below. Details should be developed at the next design stage and approved by the acoustician.

- Head gaps (if required) should be kept as small as possible (maximum 10mm) and be packed with a high-density acoustic insulating product.
- Flanking drywall partitions should not be continuous between sensitive spaces.
- Door sets rated at R_w 40 dB will need to be constructed in the following way:
 - The manufacturer or supplier of acoustic doors shall guarantee the specified SRI, in an installed condition on site.



- The acoustic doors shall be of hardwood or steel, and be complete with all seals and frames, and with furniture as specified.
- The door shall be provided with double neoprene/rubber compression, or knife-edge, seals to the head and jambs.
- Wiper seals will not be permitted at thresholds, doors should be fitted with drop seals that provide a full and effective seal.
- The door fastener or lock should be designed to ensure that the seals operate over the whole periphery of the door.

6.6.2 Flanking via Partition Junctions

In areas where higher performance partitions meet lower performance partitions, it is recommended that the inner leaf of the lower performing partition is broken and the lining of the higher performing partition should meet the outer leaf. An indicative detail is set out below:

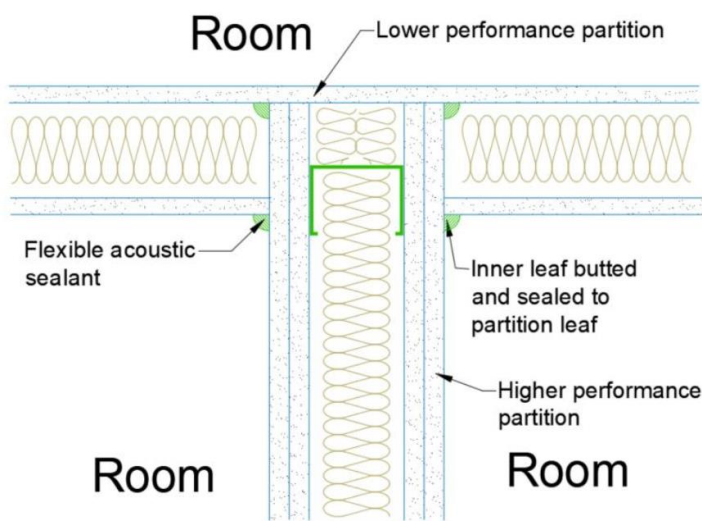


Figure 6-1 Partition junction detail (indicative only)

6.6.3 Flanking via Floors

Areas with glazing and spandrel panels are likely to be an acoustic weakness. Any cavity between the slab and transom should be stopped with an appropriate fire barrier and where possible, the plasterboard lining of the ceiling below should abut the external fabric as far as practicable. Airborne sound insulation testing was not carried out in spaces that included spandrel panels, though flanking here could present an issue in newly formed smaller sensitive rooms where the external wall meets spandrel panels.

6.6.4 Flanking at Heads and Bases of Partitions

It is recommended that all partitions are constructed slab to slab. This is paramount in achieving the performance requirements set out in the sound insulation mark ups in Appendix C.

6.6.5 Flanking via Columns

The sound insulation tests found minor flanking transmission through the structural columns throughout the development. For good practice, it is recommended to install resilient gaskets around columns meeting raised access floors.

In areas where partitions abut columns or columns are located along the length of the partition, they must be boxed out using the same lining of each leaf of the partition, ensuring that the board is fully and effectively sealed with an appropriate flexible acoustic sealant.

Example details of the boxing out mentioned above are set out in the figures below. The figures are indicative of a double boarded lining, though the linings of any other partition construction achieving the required sound insulation performance can be utilised.

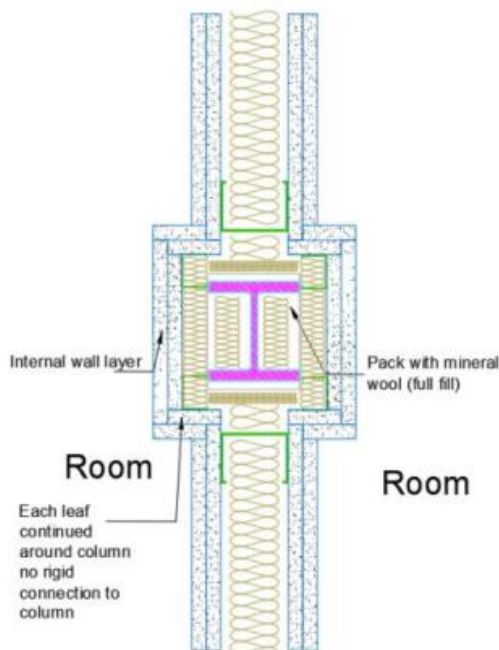


Figure 6-2 Detail - Partition around column 1 – vertical section (indicative only)

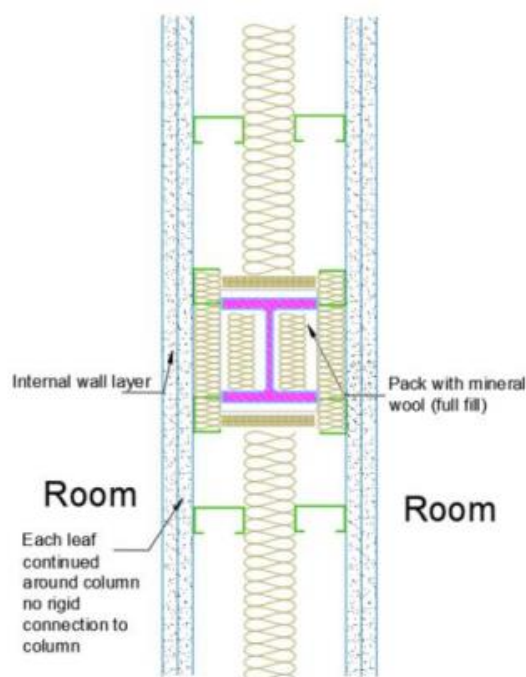


Figure 6-3 Detail - Partition around column 2 – vertical section (indicative only)

6.6.6 Services Penetrations

The penetration of walls separating noise sensitive areas is not recommended by mechanical and electrical services. This therefore applies to the partitions requiring a high sound insulation performance (50+ dB R_w).

Where any service penetrations through acoustically rated partitions are proposed and unavoidable, appropriate details to minimise sound transmission through pipe, cable tray and duct penetrations should be adopted. Wherever possible these should be located in lower performing partitions (40 and 45 dB R_w) or in locations where there are already acoustic weaknesses, such as above doors. The details below show suitable example solutions for duct and cable tray penetrations for lightweight partitions.

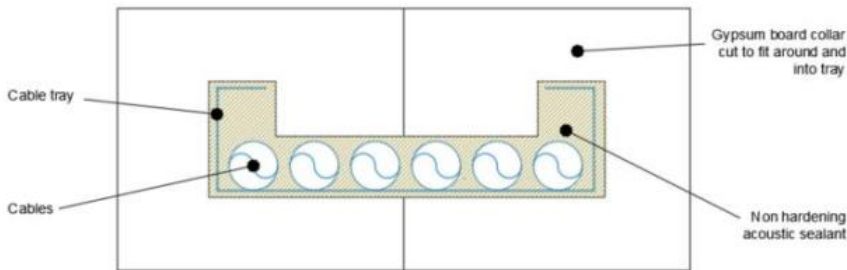
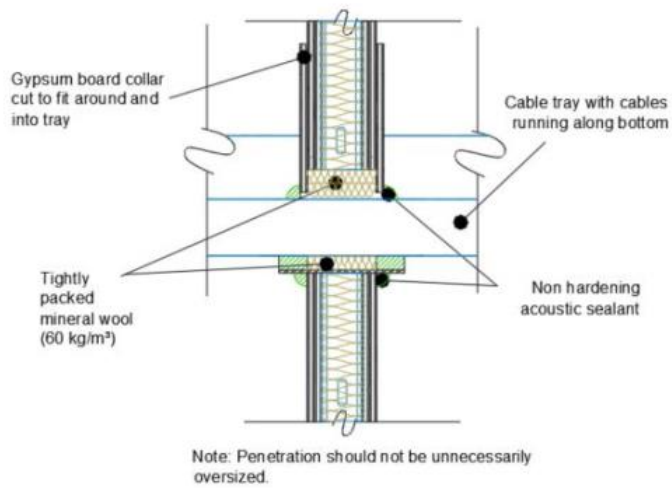


Figure 6-4 Detail - Cable tray penetration (indicative only)

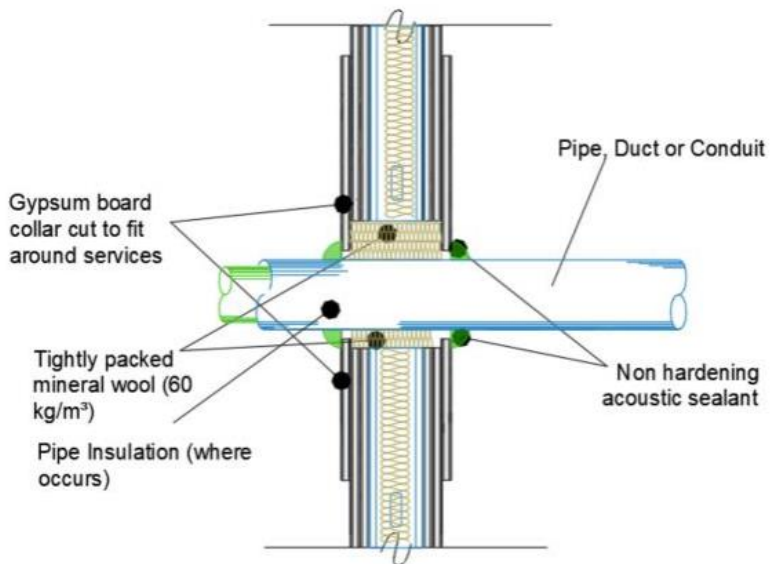


Figure 6-5 Detail - Pipe or duct penetration (indicative only)

It is important that the space between the pipe and sleeve are free of any foreign materials. The pipe must not contact the structure at any time and wedges cannot be used to maintain the pipe in position. The pipe must be approximately centred in the opening and the penetrations should not be unnecessarily oversized.

Electrical sockets should not be located back-to-back on opposite sides of a separating partition but should be staggered. They should be boxed in behind using either two layers of board or a suitable approved alternative product fitted.

6.7 Lift Noise and Vibration

A new lift is proposed as part of the development, to be installed external to the northern façade of the building within the existing car park.

6.7.1 Noise and Vibration External to Car

Vibration levels measured on the floor slabs shall not exceed “Curve 1.4” as defined by BS 6472:1992 “Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)”.

No perceptible vibration or re-radiated noise shall be permitted in any building outside the Client's demise.

In general, noise from the lift installation is controlled in accordance with the design criteria but in hearing rooms the criteria should be more stringent. Lift noise shall not exceed 30 dB L_{Amax} in hearing rooms or sensitive spaces.

Lift noise when measured in the lift lobby at 1.5m from the floor and 1.2m from the door face should generally not exceed 55 dB L_{Amax} at any time during the lift cycle, when measured with a precision grade sound level meter set to “fast” meter response. The above recommendations are taken from BS 8233:2014 *Guidance on sound insulation and noise reduction for buildings*.

6.7.2 Internal Partition

The currently proposed internal wall for the lift system is as follows:

- 140mm blockwork
- 70mm ‘C’ stud lined with 1no. layer 12mm plasterboard

It is recommended to include 50mm mineral wool (such as Isover Acoustic Partition Roll (APR1200)) within the cavity to increase the sound reduction index here as far as possible, which will in turn minimise noise from the lift into the adjacent spaces.



6.8 Internal Sound Insulation Compliance

The Contractor shall show evidence that the proposed partitions, floor and door elements are able to achieve the acoustic specifications provided for each respective element and have been tested to obtain measurements of Sound Reduction Index in accordance with *ISO 10140-1:2021 Acoustics – Laboratory measurement of sound insulation of building elements – Part 1: Application rules for specific products* and rated in accordance with *BS EN 717: Part 1: 2020 Acoustics – Rating of sound insulation in buildings and of building elements – Airborne sound insulation* to obtain a single figure weighting.

Once installed, sound insulation testing of partitions and floors should be undertaken to demonstrate compliance with the criteria near project completion. To demonstrate compliance, on-site measurements of key adjacencies (partitions and floors) shall be conducted by the acoustician following the principles of *BS EN ISO 16283-1:2014 Acoustics – Field measurement of sound insulation in buildings and of building elements Part 1: Airborne sound insulation* and *BS EN ISO 16283-2:2020 Acoustics – Field measurement of sound insulation in buildings and of building elements – Impact sound insulation*.



7. Room Acoustic Design

7.1 Overview

Acoustic calculations have been carried out for a sample of rooms to determine the minimum amount of acoustic absorption required within spaces and to validate that the reverberation time criteria set out in Section 2.4 can be achieved. Indicative 3D modelling has been undertaken for Hearing Room 7 to assess the current proposals in achieving the reverberation time criteria.

All finishes proposals have been provided by *Feilden and Mawson* architects.

7.2 Design Proposals

Calculations and modelling have been based on the current proposals, which are as follows:

- Hearing Rooms – Class A acoustic feature ceiling, Class C absorptive wall panels and plasterboard walls, carpet floor finish.
- General rooms, circulation spaces and bulkheads – Class C mineral tile ceiling with plasterboard margin, plasterboard walls, carpet floor finish.
- Offices, consultation, meeting rooms and managed spaces – Class C mineral tile ceiling with plasterboard margin, plasterboard walls, carpet floor finish.
- Corridors – Class C mineral tile ceiling with plasterboard margin, plasterboard walls, carpet floor finish

For the acoustic feature ceiling, mineral tile ceiling and perforated metal plank ceiling, Class A and Class C sound absorptive materials are proposed.

7.3 Absorption Specification

7.3.1 General

Calculations predict that the proposed finishes in the consultation rooms and small meeting room will not meet the reverberation time requirements. It will be necessary to incorporate additional absorptive material in these rooms.

It is recommended that the Class C mineral fibre tile in the consultation rooms and small meeting room is upgraded to Class A. This will result in reverberation time requirements being achieved.

7.3.2 Absorptive Classes

The minimum acoustic performance that the selected acoustic products should achieve, according to absorptive class, is presented in Table 7-1 below:



Table 7-1 Acoustic performance of proposed absorptive ceilings

Absorptive Class	Minimum Absorption Coefficient (α) at Octave Band Centre Frequency (Hz)					
	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Class A	0.4	0.7	0.9	0.9	0.9	0.8
Class C	0.2	0.4	0.6	0.6	0.6	0.5

Where commercial carpet has been proposed as a floor finish, it has been assumed that the carpet material will achieve a Class D performance minimum, similar to a typical 5mm needlefelt carpet.

7.3.3 3D Model Overview

Acoustic modelling has been undertaken for Hearing Room 7, the largest of the Hearing Rooms. The results and recommendations are considered indicative for all hearing rooms. Further analysis should be carried out during the next stage of the project to confirm the room acoustic criteria are met.

The 3D acoustic model has been prepared using proprietary room acoustic software Odeon 18 Combined and have been built to reflect the currently proposed design at RIBA Stage 3.

All Hearing Rooms are understood to have the same finishes, which are as follows:

- Carpeted floor
- Plasterboard walls with Class C acoustic wall panels (38% wall coverage on rear wall (judge's wall), 23% wall coverage on one side wall, 23% wall coverage on front wall)
- Plasterboard ceiling with area of Class A acoustic feature ceiling

7.3.4 3D Model Predicted Reverberation Time

The results of the reverberation time predictions undertaken for Hearing Room 7 with the currently proposed acoustic treatment is presented below in Table 7-2.

Table 7-2 Predicted reverberation time: Hearing Room 7

Room	Reverberation Time across Octave Bands (T_{30s} , (s))				Predicted T_{Av} (s)	Target T_{Av} (s)
	250 Hz	500 Hz	1 kHz	2 kHz		
Hearing Room 7	0.51	0.48	0.49	0.52	0.5	0.8

The calculations indicate that with the current proposals, and given that the finishes in all Hearing Rooms are the same, the reverberation time criteria in all Hearing Rooms are expected to be achieved.



7.3.5 3D Model Predicted Speech Intelligibility

The scenarios tested are as follows:

- Male and female speaker in front of room addressing seated audience at normal speech level, unreinforced
- Male and female speaker at rear speaking position of room addressing seated audience at normal speech level, unreinforced

As part of the modelling, the background noise level for the Hearing Room was set to NR30, to represent mechanical services noise present in the completed development.

The results for speech intelligibility in both scenarios relating to people speaking are predicted to be 0.7, which is a 'good' rating.

The Voice Evacuation System (VES) and subsequent Public Address and Voice Alarm (PAVA) assessment is outside of the scope of this report and has not been assessed.



8. Building Services Noise and Vibration

8.1 Overview

As part of the re-fit, some existing building services are to be retained and re-routed to serve the new areas and a new ventilation system will be placed to serve other areas. Detailed assessment of building services is out of scope, and the appointed Contractor must carry out detailed calculations at the next stage. Some best practice noise and vibration control measures are discussed below for the Air Handling Units and Fan Coil Units, and the Contractor shall demonstrate that the NR levels defined in Section 2.2 can be achieved.

8.2 Building Services Internal Noise

8.2.1 Air Handling Units

Careful selection, design of ductwork and limiting of flow velocities can avoid high noise levels from fans causing excessive HVAC noise into rooms.

Consideration shall be given to the following design practises to sufficiently limit noise transfer via ductwork from exceeding the room's NR limits:

- The selection of fans with low in-duct sound power levels. This can often be achieved by selecting higher power, lower speed fans.
- Limiting airflow velocities within ductwork to avoid regenerated (airflow) noise.
- The use of gradual bends/elbows and smooth fittings to avoid regenerated noise within the ductwork.
- The selection of appropriate in-duct attenuators to mitigate noise transfer from fans within supply, extract, return and exhaust ducts.
- Avoiding main duct routes via noise sensitive spaces, e.g. route via a corridor rather than via individual offices, with separate branches into each room.
- Acoustically lined and/or clad ductwork leading to local grilles/vents should fan noise be an issue.
- Acoustically lagging ductwork where needed to limit noise transfer into spaces.

8.2.2 Fan Coil Units

All Fan Coil Units are recommended to be located in corridors or above non-sensitive spaces, such as WCs or storage spaces.

Should units be located in the ceiling of the space they serve, or have only a short length of ductwork, noise from these units could be sufficiently tonal that it creates disturbances from time to time. Good design practises recommend selecting these units to provide sufficient cooling load at medium or low speed fan operation. It is also recommended that each Fan Coil Unit have at least 3-4 metres of acoustically lined ductwork on the intake and supply side of the units to allow the fan noise to be attenuated before entering the space being served.

Initial recommendations and allowances for the units shall include the following:

- Provide oversized, low speed units where possible.
- In noise sensitive spaces, provide variable speed control thus control over cooling and sound levels.



- Consider manufacturer's 'quiet' packages (quiet fans, enclosures, etc.) where possible.
- Provide 25mm thick acoustically lined ductwork within discharge plenums and for a distance of 3-4 metres downstream in all supply ductwork. The extent of acoustic duct lining must be coordinated based on a review of unit types (with sound data) and room layouts. Note that adequate lengths of ductwork must exist for the above acoustically lined ductwork to be feasible.

8.2.3 Services Penetrations

Services penetrations through separating walls and floors and related advice have been discussed in Section 6.6.6 above.

8.2.4 Crosstalk Attenuation

Crosstalk attenuation may be required between rooms sharing common ductwork to avoid the transfer of noise/speech that may cause disturbance to the adjacent rooms and/or loss of privacy due to conversations becoming audible. Lack of attenuation can lead to a compromise of the specified sound insulation between adjacent areas.

Mitigation of crosstalk noise can be achieved by the use of lined ducts, splitting the ducts into separate branches from a main feed, or by using crosstalk attenuators in the ducts between rooms.

Once drawings of grill locations are available, these must be reviewed by the Contractor and crosstalk attenuator specifications provided.

8.2.5 Vibration Isolation

All plant should be mounted using appropriately rated resilient anti-vibration mounts, to isolate them from the supporting structure as far as practicable.

Plant mounted on anti-vibration mounts should be isolated from any connected pipes and conduits by flexible connections to avoid the transfer of vibrational energy into the building structure.

Any services, ducts and pipework suspended from the structure near noise sensitive spaces should be attached via resilient anti-vibration hangers.

The CIBSE vibration isolation chart can be found in Appendix D for reference.



9. Summary and Next Steps

9.1 Overview

During the RIBA Stage 4 design, the acoustic design recommendations set out in this report should be further developed by the appointed Contractor into the overall design package submitted for construction. The design elements are detailed and discussed below, for each key acoustic element.

9.2 External Plant Noise Emissions

An assessment of external plant noise emissions has been carried out based on the current proposals, considering future residential developments in the area. With the recommended mitigation measures in place, the Local Authority and BREEAM Pol 05 requirements can be achieved.

9.3 Internal Noise Levels

The existing glazing has been found to be sufficient in achieving the required noise levels in the rooms due to noise break-in from external sources.

Detailed noise calculations should be carried out on a sample of the proposed building services systems to validate that the NR levels defined in Table 2-1 can be achieved.

9.4 Internal Sound Insulation

The architectural detailed design package should be checked and verified for compliance with the acoustic specifications defined in Appendix C. Junction and penetration details have been provided within this report, though these should be developed with the architectural and wider design team to ensure that the acoustic integrity is maintained.

Sound insulation testing of existing floors has been carried out, with airborne and impact sound insulation performance acceptable for the development. Replacement of existing ceilings is not expected to not reduce the sound insulation performance.

9.5 Control of Reverberation

Calculations and 3D acoustic modelling have been carried out to assess the current proposals and amount of acoustic absorption required to achieve the reverberation time limits in each room. All current finishes proposals are found to meet the reverberation time requirements with the exception of all consultation rooms and the small meeting room.

The Class C ceiling finish in all consultation rooms should be replaced with Class A to meet reverberation time requirements. Within the small meeting room, 4m² of Class C absorptive treatment should be included in the finishes proposals.

If there are project specific constraints to provide sufficient acoustic absorption at RIBA Stage 4, the appointed Contractor should confirm the acoustic design to define the minimum acoustic performance and any potential derogations.



APPENDICES

Appendix A. Glossary of Acoustic Terms

A-weighting *The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.*

dB *Decibel. The unit of sound level.*

dBA *The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.*

Class of Acoustic Treatment

The minimum random incidence sound absorption coefficients (α) required by an acoustic system in order to meet the sound absorber acoustic rating as defined in BS EN ISO 11654: 1997. The minimum performance specified in all octave-band frequencies shown in the table below must be achieved to comply with the Class requirement of the given material.

Sound Absorber Acoustic Rating	Octave Band Centre Frequency (Hz)					
	125	250	500	1k	2k	4k
Class A	0.5	0.7	0.9	0.9	0.9	0.8
Class B	0.4	0.6	0.8	0.8	0.8	0.7
Class C	0.2	0.4	0.6	0.6	0.6	0.5
Class D	0.0	0.1	0.3	0.3	0.3	0.2
Class E	0.0	0.0	0.15	0.15	0.15	0.1

$D_{nT,w}$ *Weighted standardised level difference: an on-site measure of partition performance, which is referenced to a standard reverberation time of 0.5 seconds.*

$D_{nf,w}$ *Weighted normalised flanking sound level difference: Laboratory measurement of the flanking transmission only i.e., without direct transmission through the element.*

$L_{Aeq,T}$ *The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level.*

The suffix "T" represents the time period to which the noise level relates, e.g.(15 min) would represent a period of 15 minutes and (2300-0700) would represent a measurement time between 11 pm and 7 am.



$L_{A01,T}$	The A-weighted noise level equalled or exceeded for 1% of the measurement period. This is commonly referred to as the background noise level. The suffix "T" represents the time period to which the noise level relates, e.g. (15 min) would represent a period of 15 minutes and (2300-0700) would represent a measurement time between 11 pm and 7 am.
$L_{A10,T}$	The A-weighted noise level equalled or exceeded for 10% of the measurement period. This is commonly referred to as the background noise level. The suffix "T" represents the time period to which the noise level relates, e.g. (15 min) would represent a period of 15 minutes and (2300-0700) would represent a measurement time between 11 pm and 7 am.
$L_{A90,T}$	The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level. The suffix "T" represents the time period to which the noise level relates, e.g. (15 min) would represent a period of 15 minutes and (2300-0700) would represent a measurement time between 11 pm and 7 am.
$L_{AFmax,T}$	The A-weighted maximum sound level. The highest level that occurs over a time period "T", with a specified time weighting. Typically used time weightings are fast "F" (with 125 ms duration used to establish the sound level) and slow "S" (1 s duration), resulting in $L_{AFmax,T}$ and $L_{ASmax,T}$ measurements respectively.
$L_{Ar,T}$	The Rating Level; the specific sound level plus any adjustment for the characteristic features of the sound.
$L'_{nT,w}$	Floor impact sound pressure level, called the "weighted, standardised impact sound pressure level", is a single number rating of a floor/ceiling assembly's ability to control structure-borne noise. It is the sound level in the receiving room when the floor/ceiling system is excited by a standard impact testing machine. The lower the $L'_{nT,w}$, the higher the sound insulation performance.
NR	Noise Rating. Guidance provided in BS 8233:2014 – Sound insulation and noise reduction for buildings, states that NR can be estimated from the $L_{Aeq,T}$ level using the following approximate relationship, in the absence of strong low frequency noise:

$$NR \approx L_{Aeq,T} - 6 \text{ dB}$$

It is important that the low frequency component of the noise is also considered.



R_w *Weighted sound reduction, which is a measure of the acoustic effectiveness of a building partition, door or other building element in blocking noise transmission from one side of the element to the other. This value is the result of measurements in acoustic laboratories in accordance with the relevant Standards. The higher the R_w , the better the acoustic performance of the building element. This metric is typically used to define the acoustic performance requirements of a building element for selection purposes.*

R'_w *Apparent weighted sound reduction, field measurements of the weighted sound reduction index. This value is an in-situ unit which considers on-site conditions such as flanking transmission and any other limitations.*

Sound Insulation

When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to ability of a material to stop sound travelling through it.

T_{mf} *Unit of measurement for Reverberation Time. The units consider the average reverberation time for the mid-octave frequencies 500Hz, 1kHz and 2kHz.*

T_{30} *Unit of measurement for Reverberation Time. The units consider the time it takes for sound to decay by 30dB.*



Appendix B. Noise Survey Time Histories



Noise Level Time History at Position MP1, 13 to 22 August 2024

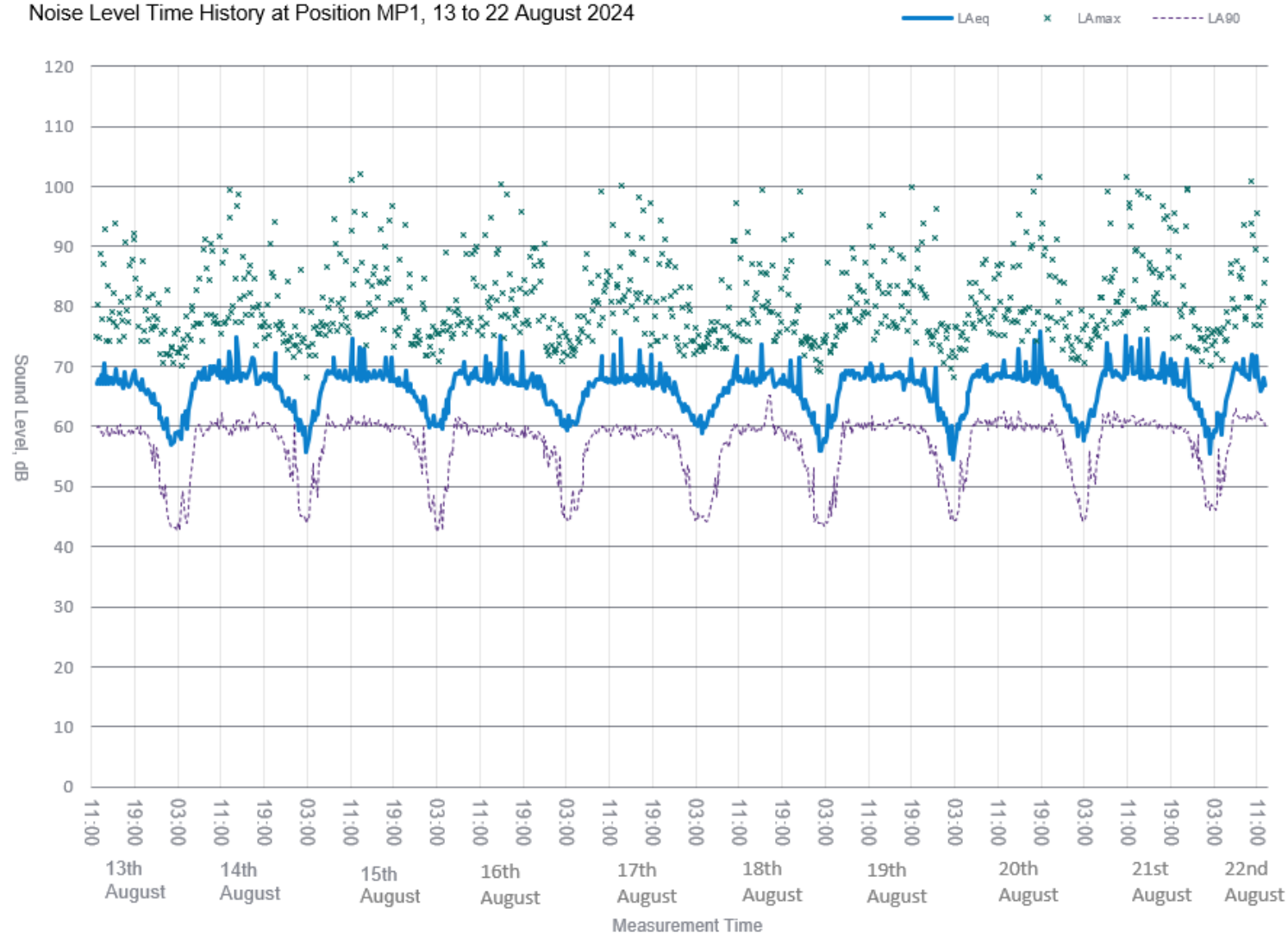


Figure B-1 MP1 Time History (Façade Incident)



Noise Level Time History at Position MP2, 15 to 22 August 2024

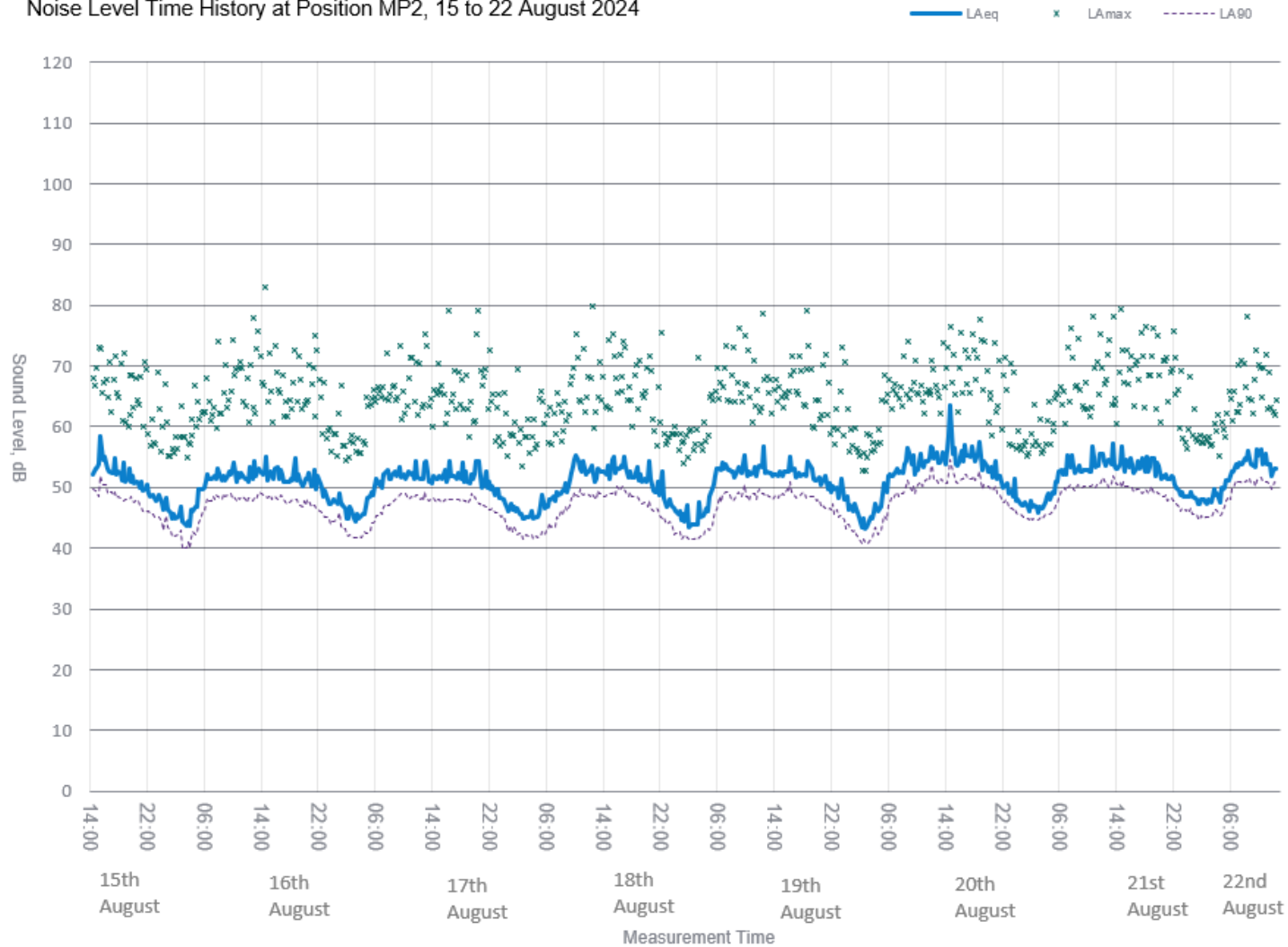


Figure B-2 MP2 Time History (Façade Incident)



Appendix C. Sound Insulation Mark-Ups



Figure C-1 Ground Floor Sound Insulation Mark-Up

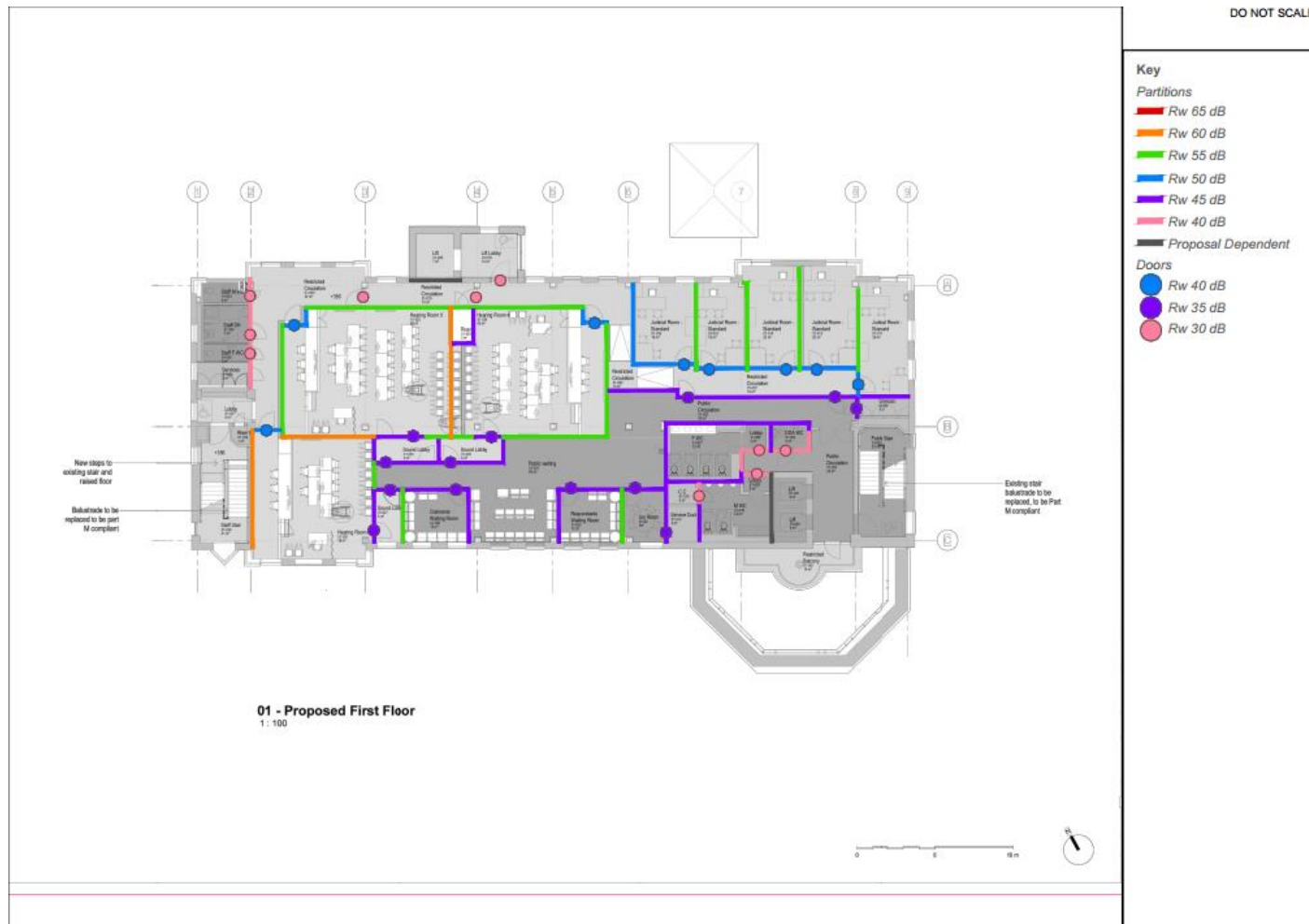


Figure C-2 First Floor Sound Insulation Mark-Up

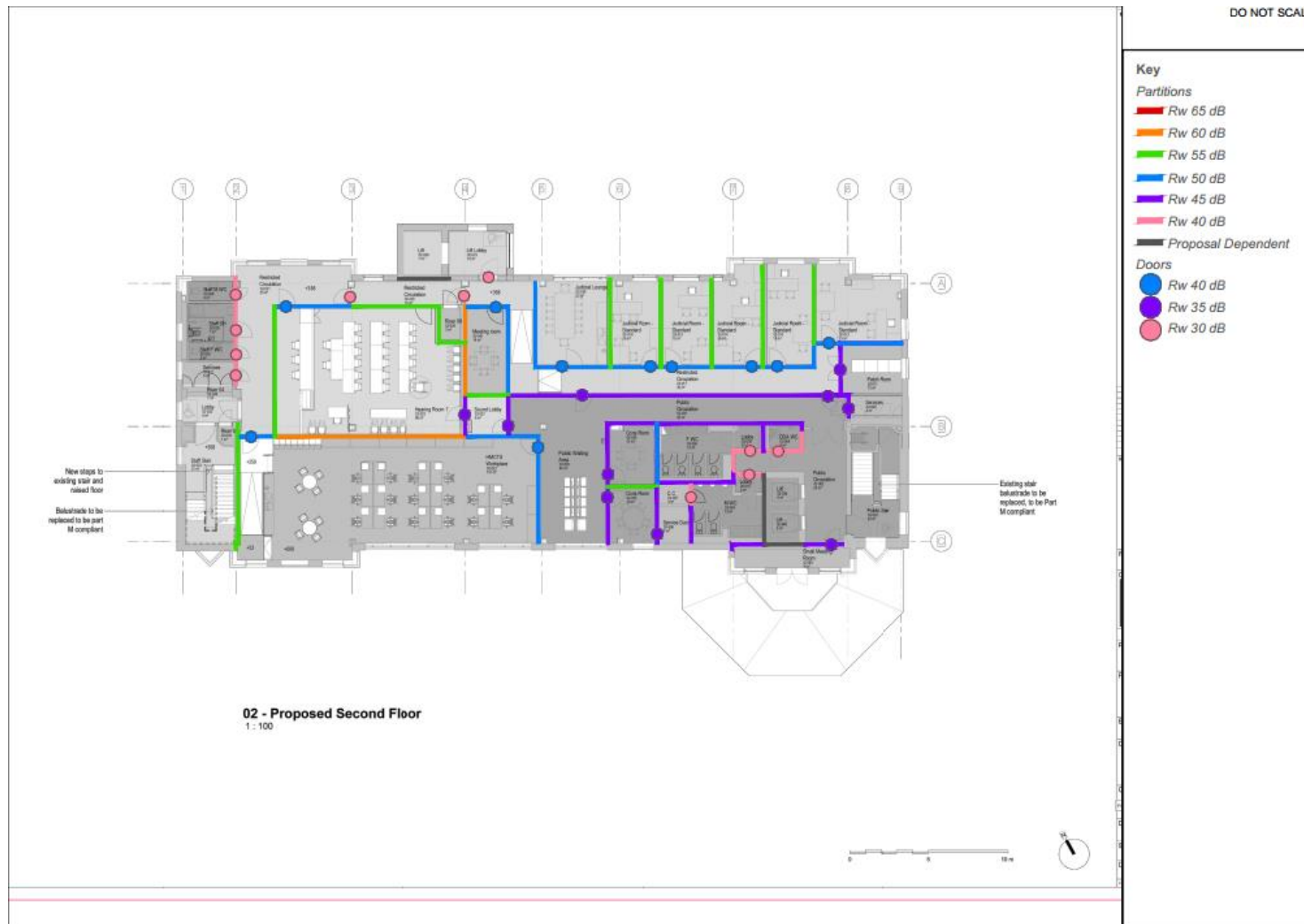


Figure C-3 Second Floor Sound Insulation Mark-Up

Appendix D. Vibration Isolation

This table is reproduced from CIBSE B4 to provide guidance for suitable vibration isolation of mechanical building services equipment. Manufacturer's guides should always be followed.

Table D-1 Vibration isolation selection chart, reproduced from CIBSE Guide B4

Table 4.56 Vibration isolation selection chart

Equipment	Basement			6 m floor span			9 m floor span			12 m floor span			15 m floor span		
	Minimum static deflection / mm	Mount type*	Base type [†]	Minimum static deflection / mm	Mount type*	Base type [†]	Minimum static deflection / mm	Mount type*	Base type [†]	Minimum static deflection / mm	Mount type*	Base type [†]	Minimum static deflection / mm	Mount type*	Base type [†]
Refrigeration machines:															
— absorption	6	F/N	—	20	S	—	40	L	SBB	40	L	SBB	40	L	SBB
— centrifugal, scroll	6	F/N	—	20	S	—	40	L	SBB	40	L	SBB	40	L	SBB
— open centrifugal	6	N	CIB	20	S	CIB	40	L	CIB	40	L	CIB	40	L	CIB
Reciprocating chillers:															
— 500–750 r/min	25	L	—	40	L	CIB	60	L	CIB	60	L	CIB	90	L	CIB
— >751 r/min	25	L	—	20	L	CIB	40	L	CIB	60	L	CIB	60	L	CIB
Reciprocating air or refrigeration compressors:															
— 500–750 r/min	25	S	—	40	S	CIB	60	S	CIB	70	S	CIB	90	S	CIB
— >751 r/min	25	S	—	20	S	CIB	40	S	CIB	60	S	CIB	70	S	CIB
Boilers or steam generators	6	F	—	12	S	SBB	20	L	SBB	40	L	SBB	70	L	SBB
Pumps (water):															
— close coupled <4 kW	6	N	SBB	12	S	CIB	20	S	CIB	20	S	CIB	20	S	CIB
— close coupled >4 kW	20	S	CIB	20	S	CIB	40	S	CIB	60	S	CIB	60	S	CIB
— base mounted <4 kW	9	F	CIB	12	S	CIB	40	S	CIB	50	S	CIB	60	S	CIB
— base mounted >4 kW	25	S	CIB	20	S	CIB	40	S	CIB	60	S	CIB	90	S	CIB
Packaged unitary air handling units (low pressure, <750 Pa)															
— suspended <4 kW	20	S	—	20	S	—	20	S	—	20	S	—	20	S	—
— suspended >4 kW, <500 r/min	30	S	—	40	S	—	40	S	—	50	S	—	60	S	—
— suspended >4 kW, >501 r/min	25	H	—	25	H	—	25	H	—	40	H	—	50	H	—
— floor mounted <4 kW	6	N	—	25	S	SBB	25	S	SBB	25	S	SBB	25	S	SBB
— floor mounted >4 kW, <500 r/min	12	S	SBB	40	S	SBB	50	S	SBB	50	S	SBB	60	S	SBB
— floor mounted >4 kW, >501 r/min	12	S	SBB	25	S	SBB	25	S	SBB	40	S	SBB	50	S	SBB
Axial fans (floor mounted):															
— <4 kW	6	N	—	25	S	SBB	25	S	SBB	25	S	SBB	25	S	SBB
— 4–15 kW, <500 r/min	12	S	SBB	40	S	SBB	50	S	SBB	50	S	SBB	60	S	CIB
— 4–15 kW, >501 r/min	12	S	SBB	25	S	SBB	25	S	SBB	40	S	SBB	50	S	SBB
— >15 kW <500 r/min	20	S	SBB	50	S	SBB	60	S	CIB	70	S	CIB	90	S	CIB
— >15 kW >501 r/min	12	S	SBB	25	S	SBB	30	S	SBB	40	S	SBB	50	S	SBB
Centrifugal fans (floor mounted) (low pressure, <750 Pa):															
— <4 kW	6	N	SFB	25	S	SFB	25	S	SFB	25	S	SFB	25	S	SFB
— >4 kW, <500 r/min	12	S	SFB	40	S	SFB	50	S	SFB	50	S	SFB	60	S	SFB
— >4 kW, >501 r/min	12	S	SFB	25	S	SFB	25	S	SFB	40	S	SFB	50	S	SFB
Centrifugal fans (floor mounted) (high pressure, >750 Pa)															
— <15 kW, 175–300 r/min	9	N	SFB	60	S	SFB	60	S	SFB	90	S	CIB	120	S	CIB
— <15 kW, 301–500 r/min	12	S	SFB	50	S	SFB	50	S	SFB	60	S	SFB	90	S	CIB
— <15 kW, >501 r/min	9	N	SFB	30	S	SFB	30	S	SFB	50	S	SFB	60	S	SFB
— >15 kW, 175–300 r/min	40	S	SFB	60	S	CIB	90	S	CIB	120	S	CIB	140	S	CIB
— >15 kW, 301–500 r/min	25	S	SFB	50	S	CIB	60	S	CIB	90	S	CIB	120	S	CIB
— >15 kW, >501 r/min	12	S	SFB	30	S	CIB	50	S	CIB	60	S	CIB	90	S	CIB
Cooling towers:															
— <500 r/min	12	L	SBB	12	L	SBB	50	L	SBB	60	L	SBB	90	L	SBB
— >501 r/min	9	F/N	—	9	F/N	—	25	L	SBB	40	L	SBB	60	L	SBB
Internal combustion engines (standby power generation):															
— <20 kW	9	F	CIB	12	S	CIB	50	S	CIB	60	S	CIB	60	S	CIB
— 20–75 kW	12	S	CIB	50	S	CIB	60	S	CIB	90	S	CIB	90	S	CIB
— >75 kW	25	S	CIB	60	S	CIB	90	S	CIB	120	S	CIB	120	S	CIB
Gas turbines (standby power generation):															
— <5 MW	6	F	CIB	6	F	CIB	6	F	CIB	9	F	CIB	9	F	CIB

The floor plan refers to the largest dimension between supporting columns. The equipment is assumed to be at mid-span.

* F = glass fibre, H = hanger, L = restrained spring, N = rubber, S = freestanding spring.

† SBB = steel beams, SFB = steel frame base, CIB = concrete inertia base.



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