# Plymouth Community Diagnostics Centre

# Acoustic Assessment for Spatial Coordination (RIBA Stage 3)

7th December 2023

inacoustic | **bristol**
20 Melrose Place, Clifton, Bristol, BS8 2NG
0117 325 3949 | www.inacoustic.co.uk | bristol@inacoustic.co.uk
inacoustic is a trading name of Inacoustic Ltd, registered in the UK 10873933

| Version | Comments | Date | Authored By | Checked By | Project Number |
|---|---|---|---|---|---|
| 1 | Acoustic Assessment | 17/11/2013 | Victor Valeron BEng MSc MIOA | Antony Best BSc (Hons) MIOA | 23-368 |
| 2 | Revision following comments on audiology rooms | 7/12/2013 | Victor Valeron BEng MSc MIOA | Antony Best BSc (Hons) MIOA | 23-368 |

This report has been prepared for the titled project or named part thereof and should not be used in whole or part and relied upon for any other project without the written authorisation of the author. No responsibility or liability is accepted by the author for the consequences of this document if it is used for a purpose other than that for which it was commissioned. Persons wishing to use or rely upon this report for other purposes must seek written authority to do so from the owner of this report and/or the author and agree to indemnify the author for any loss or damage resulting there from. The author accepts no responsibility or liability for this document to any other party than the person by whom it was commissioned.

The findings and opinions expressed are relevant to the dates of the site works and should not be relied upon to represent conditions at substantially later dates. If additional information becomes available which may affect our comments, conclusions or recommendations, the author reserves the right to review the information, reassess any new potential concerns and modify our opinions accordingly.

# Contents

## Figures

# Tables

# 1. INTRODUCTION

## 1.1. Overview

inacoustic has been commissioned to undertake an acoustic assessment for the proposed Community Diagnostics Centre (CDC) development at Colin Campbell Court, Plymouth City Centre, PL1 1TZ, to provide design advice at Spatial Coordination RIBA Stage 3.

The following technical acoustic assessment reviews the proposed design layout and provides advice in order to achieve the requirements of HTM-08-01, as well as BREEAM Hea05 and Pol05. The assessment is also informed by a detailed environmental sound and vibration survey undertaken around the Site.

The assessment is based on the revision of the relevant information within the 'Drawing Issue' provided by KTA Architects on 16th October 2023:

- 2258-KTA-XX-GF-D-A-0200-P6_Ground Floor Plan
- 2258-KTA-XX-01-D-A-0201-P5_First Floor Plan
- 2258-KTA-XX-02-D-A-0202-P6_Second Floor Plan
- 2258-KTA-XX-03-D-A-0203-P6_Third Floor Plan
- 2258-KTA-XX-04-D-A-0205-P1_Roof Plan
- 2258-KTA-XX-ZZ-D-A-0301-P3_GA Strategic Short Section

This noise assessment is necessarily technical in nature; therefore a glossary of terms is included in Appendix A to assist the reader.

Sound survey time history graphs are presented in Appendix B, with vibration survey and updated noise survey presented in Appendix C.

Appendix D presents indicative penetration details for the acoustic integration of mechanical and electrical services.

Appendix E provides mark-ups with the relevant acoustic performance requirements on Internal Sound Insulation, Noise Rating (NR) limits for building services and Indoor Ambient Noise Levels from External Sources.

This report has been prepared by Victor R. Valeron, who is a corporate Member of the Institute of Acoustics (IOA) with a BEng degree in Audio and Video and a Master's Degree in Environmental and Architectural Acoustics, with over 15 years of experience. Victor R. Valeron BEng, MSc, MIOA therefore qualifies as a Suitably Qualified Acoustician (SQA) as defined in the BREEAM UK New Construction 2018 technical manual. This report has been reviewed by Antony Best, who is a corporate Member of the Institute of Acoustics (IOA) with a BSc (Hons) degree in Acoustics, with over 13 years of experience. Antony Best BSc (Hons) MIOA also therefore qualifies as a Suitably Qualified Acoustician (SQA) as defined in the BREEAM UK New Construction 2018 technical manual.

## 1.2. Scope and Objectives

The scope of the acoustic assessment is to provide design advice at RIBA Stage 3 for the following topics, in order to achieve compliance with HTM-08-01 and BREEAM requirements:

- Internal noise levels from external sources;
- Internal sound insulation;
- Room acoustics;
- Vibration;
- Internal noise from mechanical and electrical services; and
- Environmental Noise Impact at off-site Noise-Sensitive Receptors.

# 2. Technical Guidance

## 2.1. Health Technical Memorandum 08-01: Acoustics

Health Technical Memoranda (HTMs) from the Department of Health give comprehensive advice and guidance on the design, installation and operation of specialised building and engineering technology used in the delivery of healthcare.

The focus of Health Technical Memorandum guidance remains on healthcare-specific elements of standards, policies and up-to-date established best practice. They are applicable to new and existing sites, and are for use at various stages during the whole building lifecycle.

HTM-08-01 states that '*Acoustic design is fundamental to the quality of healthcare buildings. Sound affects us both physiologically and psychologically. Noise, which can be defined as "unwanted sound", can increase heart rate, blood pressure, respiration rate and even blood cholesterol levels. Pleasant sounds help create a sense of well-being. Music can be used to treat depression, to reach autistic people and to calm and relax tense patients.*'

The document goes on to state that *'Good acoustic conditions improve patient privacy and dignity, and promote essential sleep patterns. Such conditions are key to healing. Good acoustic design brings other benefits in terms of patient and staff comfort and morale, as well as improved efficiency and usability of equipment.'*

HTM-08-01 sets out the minimum recommended acoustic criteria for healthcare premises and acknowledges that these criteria may not be appropriate for all projects.

## 2.2. BREEAM UK New Construction 2018

BREEAM UK New Construction 2018 is the technical manual that describes an environmental performance standard against which new, non-domestic buildings in the UK can be assessed and achieve a BREEAM New Construction rating.

BREEAM Health and Wellbeing *Hea05 Acoustic Performance* makes reference to HTM-08-01 with regards to the following acoustic criteria:

- Noise Intrusion
- Airborne and Impact Sound Insulation
- Room Acoustics
- Mechanical Services

Three credits are available under the Hea05 category for Healthcare Buildings. These concern to sound insulation, internal ambient noise levels and room acoustics. Compliance with HTM-08-01 criteria will commensurate achieving the BREEAM Hea05 credits.

One credit is available under the BREEAM Pol05 Reduction of Noise Pollution requirements. To achieve the credit, a noise assessment compliant with BS4142:2014 should be undertaken in order to calculate the noise rating level form the assessed building. The noise level from the proposed building, as measured in the locality of the nearest or most exposed noise-sensitive development, must be at least 5 dB lower than the background noise throughout the day and night.

It is noted that, in this instance, University Hospitals Plymouth NHS Trust have outlined that the building must achieve BREEAM excellent, with all acoustic credits being targeted.

## 2.3. British Standard 4142:2014+A1:2019

BS4142:2014+A1:2019 '*Methods for rating and assessing industrial and commercial sound'* sets out a method to assess the likely effect of sound from factories, industrial premises or fixed installations and sources of an industrial nature in commercial premises, on people who might be inside or outside a dwelling or premises used for residential purposes in the vicinity.

The procedure contained in BS4142:2014+A1:2019 for assessing the effect of sound on residential receptors is to compare the measured or predicted sound level from the source in question, the $L_{Aeq,T}$ 'specific sound level', immediately outside the dwelling with the $L_{A90,T}$ background sound level.

Where the sound contains a tonality, impulsivity, intermittency and other sound characteristics, then a correction depending on the grade of the aforementioned characteristics of the sound is added to the specific sound level to obtain the $L_{Ar,Tr}$ 'rating sound level'. A correction to include the consideration of a level of uncertainty in sound measurements, data and calculations can also be applied when necessary.

BS4142:2014+A1:2019 states: *"The significance of sound of an industrial and/or commercial nature depends upon both the margin by which the rating level of the specific sound source exceeds the background sound level and the context in which the sound occurs"*. An estimation of the impact of the specific sound can be obtained by the difference of the rating sound level and the background sound level and considering the following:

- *"Typically, the greater this difference, the greater the magnitude of the impact."*
- *"A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context."*
- *"A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context."*
- *"The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

During the daytime, the assessment is carried out over a reference time period of 1-hour, with a referencing period of 15 minutes used during the night. The periods associated with day or night, for the purposes of the Standard, are considered to be 07.00 to 23.00 and 23.00 to 07.00, respectively.

## 2.4. Other Guidance

### 2.4.1. The Acoustics of Sound Field Audiometry in Clinical Audiological Applications Practice Guidance, 2019

This Practice Guidance by the British Society of Audiology (BSA), dated March 2019, provides evidence-base and consensus on good practice for the acoustic design of facilities intended for sound field audiometry.

It clarifies that "*Sound field audiometry is a procedure to assess the hearing sensitivity of a person in which acoustic signals are presented through one or more sound sources in a room (i.e. not through earphones)*".

In terms of indoor ambient noise levels, it states the following:

*"The room should have low ambient noise. BS EN ISO 8253-2:2009 specifies maximum permissible ambient sound pressure levels for hearing threshold level measurements down to 0 dB HL which is usually achievable by the commission of a purpose-built audiology room. However, these levels can be difficult to achieve and, for practical purposes, it is reasonable to accept ambient sound pressure levels that are adequate for measuring hearing threshold level measurements down to 10 dB HL, still only achievable through specialist audiology room design. This entails adding 10 dB to the specified maximum permissible ambient sound pressure levels (see also Lutman, 1997). These levels are given in Appendix 1."*

The levels from Appendix 1 of the BSA Guidance are presented below.

TABLE 1: MAXIMUM PERMISSIBLE AMBIENT SOUND PRESSURE LEVELS (FROM BS EN ISO 8253-2:2009)

| Mid-frequency (Hz) | Maximum permissible level (dB SPL) |
|---|---|
| 31.5 | 60 |
| 40 | 53 |
| 50 | 46 |
| 63 | 41 |
| 80 | 36 |
| 100 | 32 |
| 125 | 25 |
| 160 | 18 |
| 200 | 12 |
| 250 | 10 |
| 315 | 8 |
| 400 | 6 |
| 500 | 5 |
| 630 | 5 |

| | |
|---|---|
| 800 | 4 |
| 1000 | 4 |
| 1250 | 4 |
| 1600 | 5 |
| 2000 | 5 |
| 2500 | 3 |
| 3150 | 1 |
| 4000 | -1 |
| 5000 | 1 |
| 6300 | 6 |
| 8000 | 12 |

** The ambient SPLs given in the table are the maximum that should be present when testing down to 250 Hz and to 0 dB HL. In practice, it is more realistic to aim to test down to 10 dB HL, in which case 10 dB can be added to these figures.*

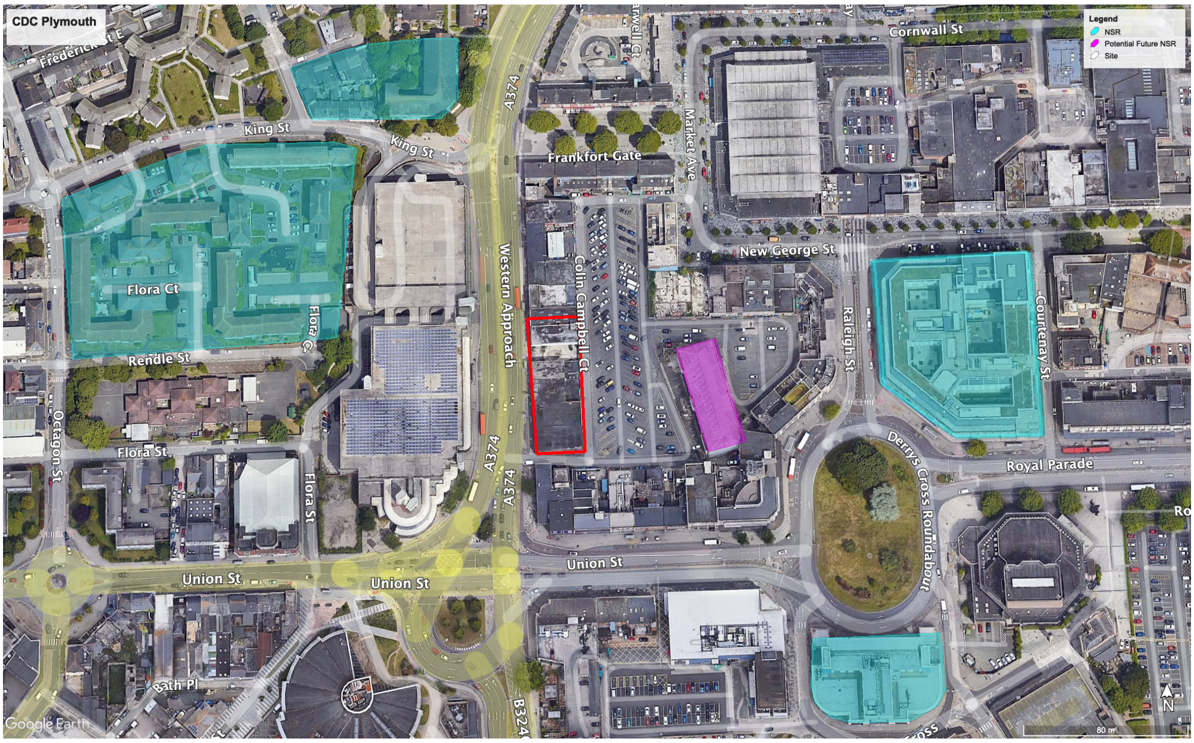
The guidance also recommends acoustic standards for maximum reverberation times within the Audiology Rooms, along with recommended layouts, and test environment.

## 3. Site Description

### 3.1. Site and Surrounding Area

The Development area is located at Colin Campbell Court, Plymouth City Centre, PL1 1TZ. The approximate red line Site boundary and surrounding area can be seen in Figure 1 below.

Figure 1: Development Site and Surrounding Area




The Site is bound by Western Approach Road to the west, a public car park to the east and commercial uses to the north and south.

The nearest existing Noise-Sensitive Receptors (NSRs) to the Proposed Development are residential dwellings on Flora Court and King Street, approximately 100m to the north west of the Site, and Hotel uses around Derrys Cross Roundabout, approximately 150m to the east and south east of the Site.

It is also understood that the commercial building to the east of the site might be converted to incorporate residential uses in the future. Therefore, this should be considered as potentially the closest NSRs, at approximately 50m from the Site boundary.

## 3.2. Proposed Development Overview

The Plymouth Community Diagnostic Centre (CDC) will provide significant diagnostic capacity in terms of imaging, physiological measurement, pathology and other services. Specifically, the CDC will provide the following services:

- Imaging
  - Computerised Tomography (CT Scanner)
  - Magnetic Resonance Imaging (MRI Scanner)
  - Ultrasound
  - X-Ray

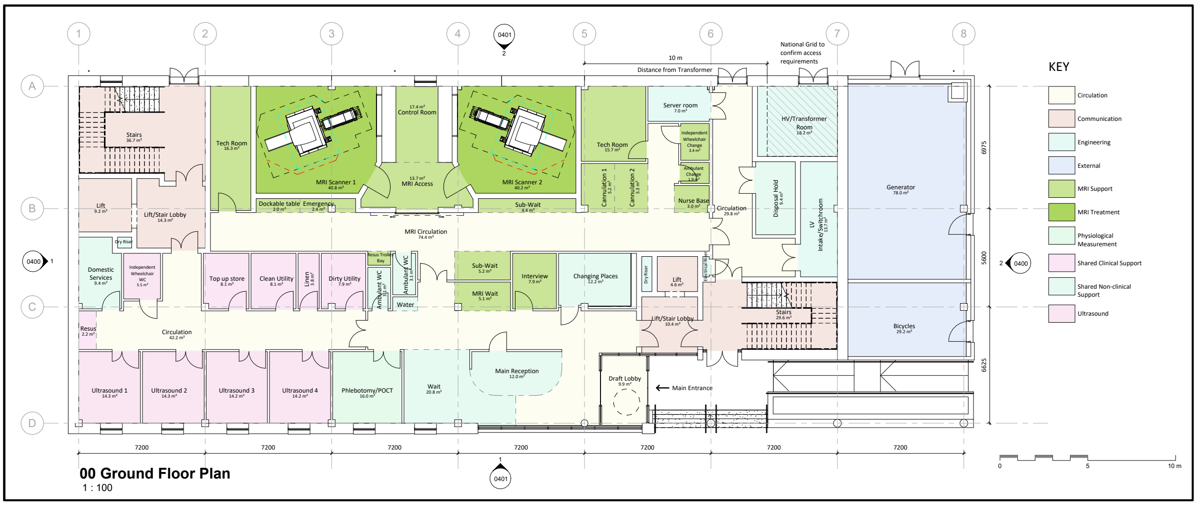
- Audiology
  - Audiological assessments
  - Fittings
  - Follow-ups

- Physiological Measurement
  - Echocardiography
  - Vascular Imaging
  - Electrocardiogram (ECG)
  - Ambulatory blood pressure monitoring
  - Pacemaker clinic
  - FeNo and Lung Function Tests, Spirometry including broncho-dilator response, some sleep investigations, Simple field tests.
  - Neurophysiology

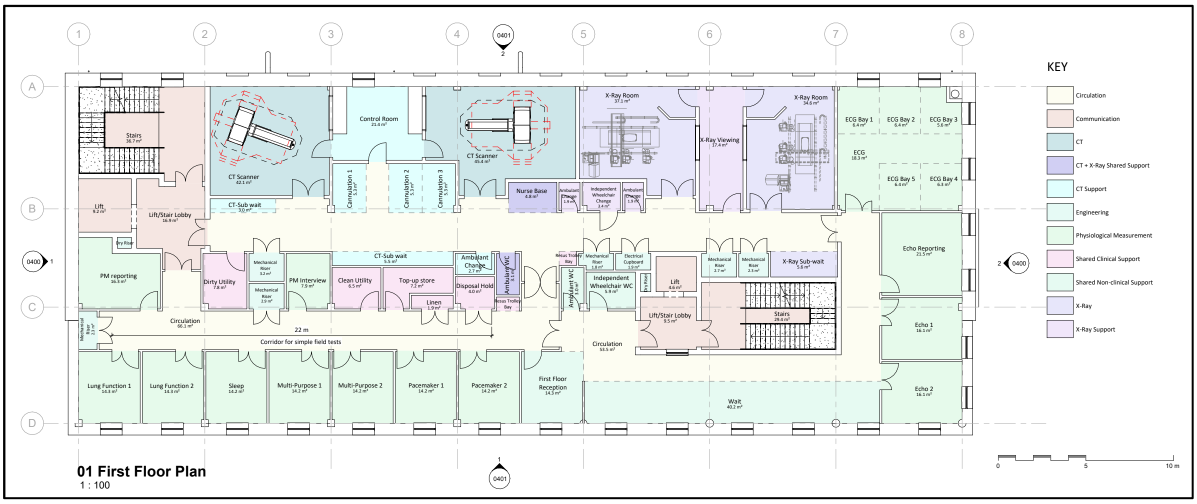
It is understood that the operational times of the development will be 7 days a week from 08:00 to 20:00, although some services might operate initially 5 days a week Monday to Friday from 09:00 to 17:00, with plans to increase service hours to long days and 7 day working over the next 3-5 years as the workforce and demand increase.

The Work-in-Progress Layout of the Development is presented in the following figures.

Figure 2: Ground Floor Layout



## Figure 3: First Floor Layout




## Figure 4: Second Floor Layout

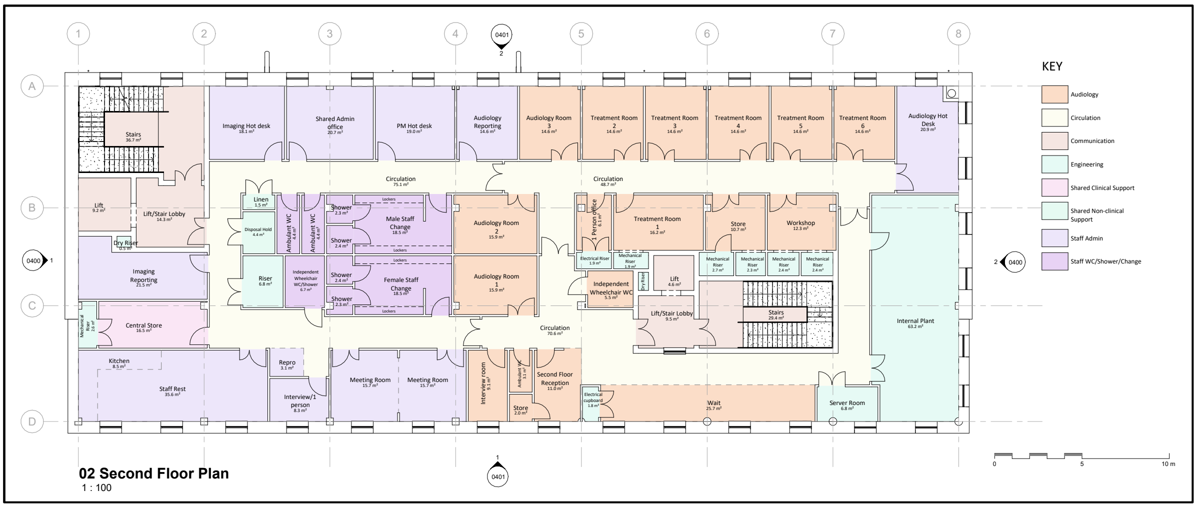


FIGURE 5: THIRD FLOOR LAYOUT

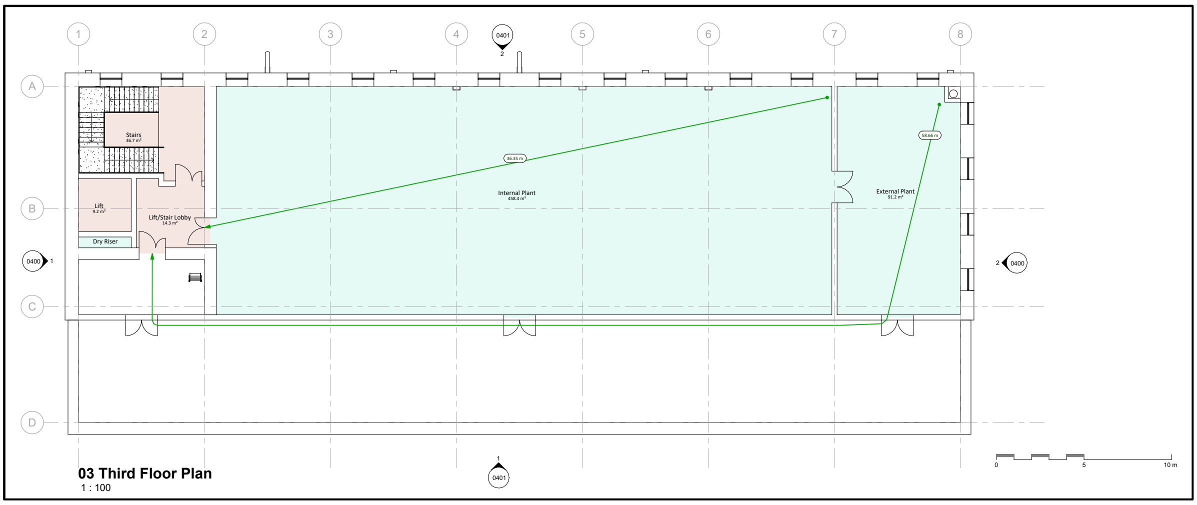
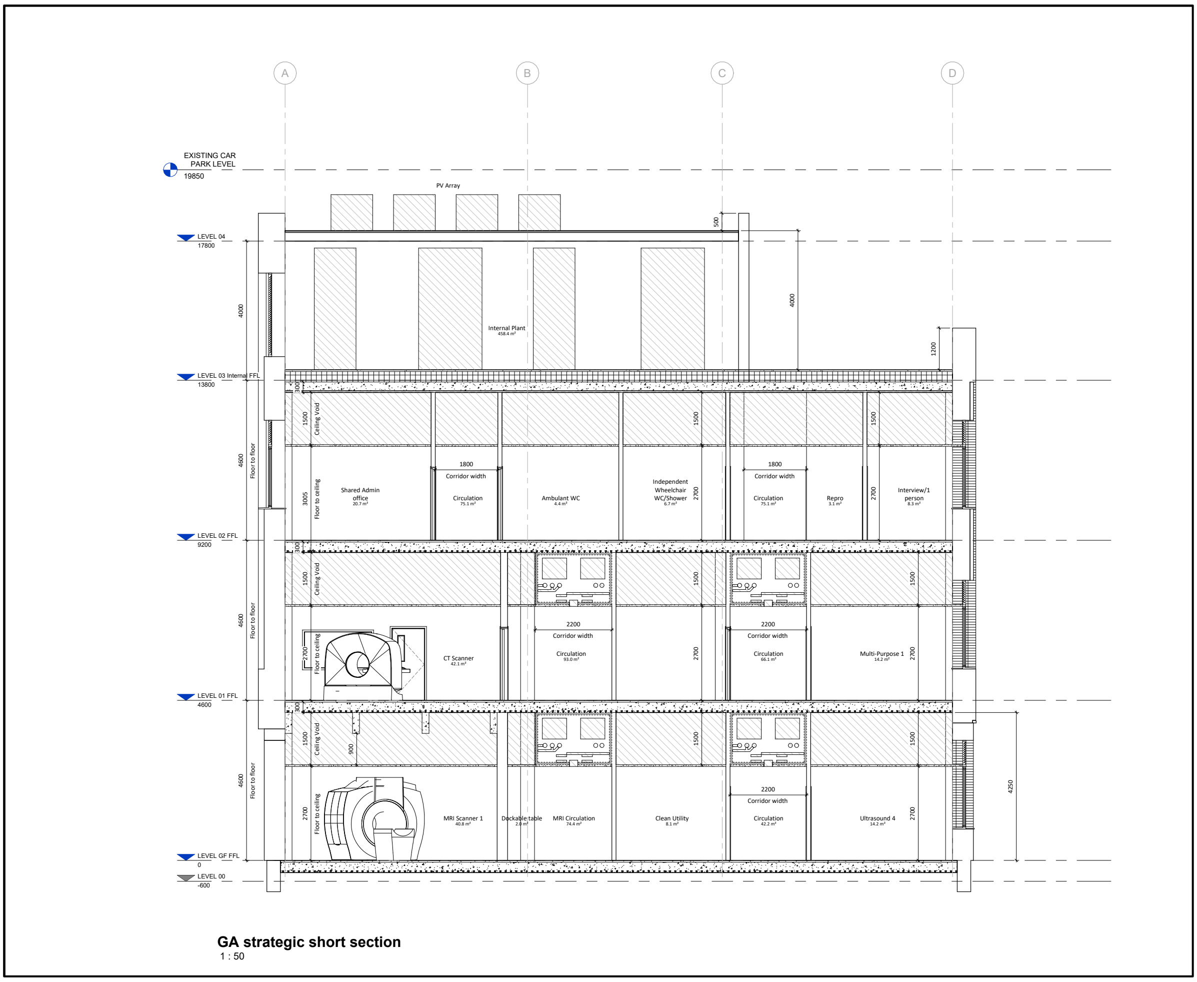



FIGURE 6: STRATEGIC SHORT SECTION



# 4. ENVIRONMENTAL SOUND SURVEY

The prevailing sound conditions in the area were determined by an environmental sound survey conducted during both daytime and night-time periods, between Friday 5th and Wednesday 10th November 2021.

## 4.1. Measurement Details

All noise measurements were undertaken by a consultant certified as competent in environmental noise monitoring, and in accordance with the principles of BS 7445[1].

All acoustic measurement equipment used during the noise survey conformed to Type 1 specification of British Standard 61672[2]. A full inventory of this equipment is shown in Table 2 below.

TABLE 2: INVENTORY OF SOUND MEASUREMENT EQUIPMENT

| Measurement Position | Make, Model & Description | Serial Number | Certificate Number | Calibration Expiry Date |
|---|---|---|---|---|
| MP1 | Rion NL-52 Sound Level Meter | 00965097 | 1110275 | 15/03/2023 |
| | Rion NH-25 Preamplifier | 65324 | | |
| | Rion UC-59 Microphone | 10223 | | |
| MP2 | Brüel & Kjær 2238 Sound Level Meter | 2812838 | 1107108 | 14/12/2022 |
| | Brüel & Kjær 4188 Microphone | 2793282 | | |
| All | Rion NC-74 | 34904966 | 1110274 | 15/03/2022 |

The sound measurement equipment used during the survey was field calibrated at the start and end of the measurement period. A calibration laboratory has calibrated the field calibrator used within the twelve months preceding the measurements. A drift of less than 0.2 dB in the field calibration was found to have occurred on the sound level meters.

The weather conditions during the survey were generally conducive to environmental noise measurement; it being dry, with wind speeds typically below 5 $ms^{-1}$. The rain gauge deployed on site registered rain periods from Tuesday 9th November 2021 at 21:00 onwards. These periods were not included in the assessed dataset.

Similarly, the period between 19:00-20:00 on 5th November 2021 was not used in the assessed dataset, as it was found mostly affected by noise from fireworks on bonfire night.

[1] British Standard 7445: 2003: Description and measurement of environmental noise. BSI

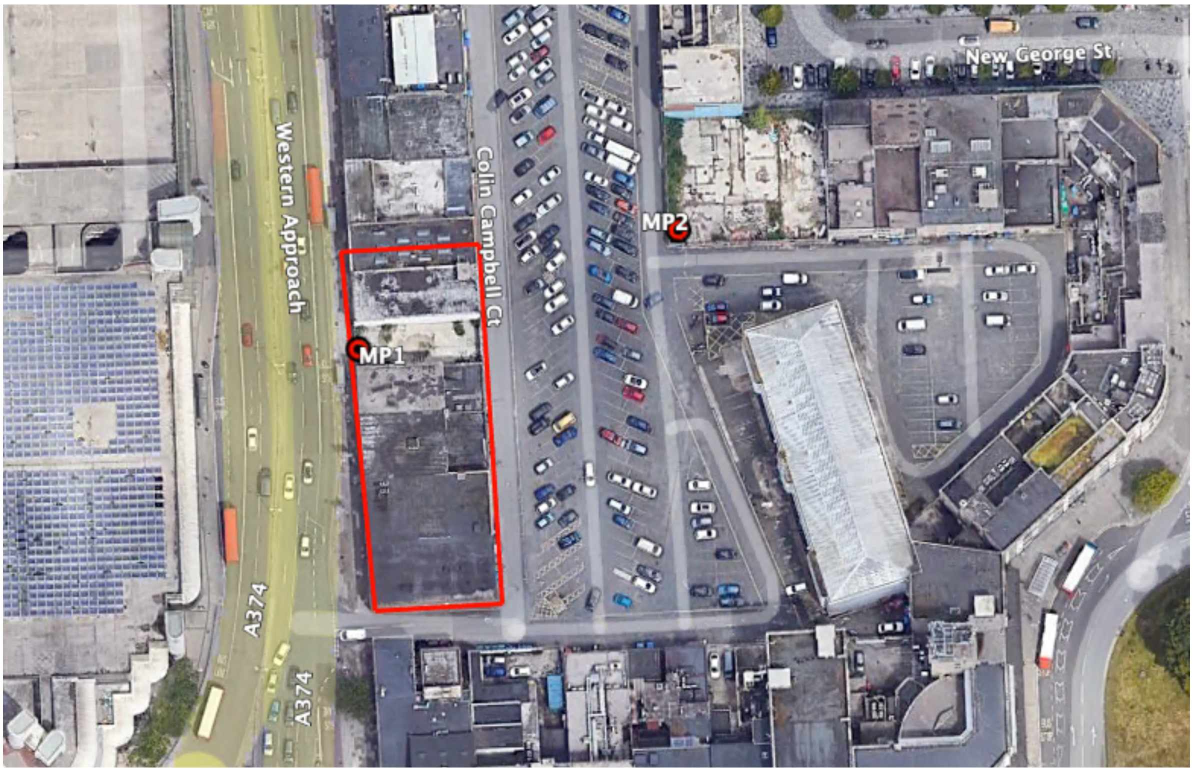
[2] British Standard 61672: 2013: Electroacoustics. Sound level meters. Part 1 Specifications. BSI.

The microphones were fitted with a protective windshield for the measurements, which are described in Table 3, with an aerial photograph indicating their location shown in Figure 7.

TABLE 3: MEASUREMENT POSITION DESCRIPTION

| Measurement Position | Description |
|---|---|
| MP1 | Daytime and night-time measurement of sound at a location representative of noise levels at the proposed front façade of the building.<br>The microphone was located at approximate 2.3 metres above local ground above the existing site hoarding, under free-field conditions, with direct view of the A374 Road (Western Approach) and close to a bus stop.<br>The sound environment at this location was dominated by road traffic using the A374 road. Natural sounds such as seagulls squawks and other birdsongs were also audible. |
| MP2 | Daytime and night-time measurement of sound at a location representative of noise levels at the rear of the proposed building. This position is considered to be representative of background sound conditions at the potentially closest NSRs to the site, as it is understood that the commercial building to the east of the site (City Furnishers) might be converted to incorporate residential uses in the future.<br>The microphone was located at approximate 2.3 metres above local ground above the existing site hoarding, under free-field conditions, with direct view of the existing Colin Campbell Court Car Park.<br>The sound environment at this location was dominated by cars and HGV movements at the car park and fans from nearby buildings. |

FIGURE 7: NOISE MEASUREMENT POSITIONS



## 4.2. Sound Indices

The parameters reported are the typical statistical index Background Sound Level, $L_{A90,T}$, as well as the average Equivalent Continuous Sound Level, $L_{Aeq,T}$ and the typical Maximum Sound Pressure Level, $L_{AFmax}$. An explanation of the sound units presented is given in Appendix A. The representative highest $L_{Aeq,1hour}$ is also presented in line with requirements from HTM-08-01.

The measured $L_{Aeq}$, $L_{AFmax}$, and $L_{AF90}$ sound levels are presented as time histories in a graph in Appendix B.

## 4.3. Summary Results

The summarised results of the environmental sound measurements, during the day and night-time periods, can be seen below in Table 4. Values have been rounded to the nearest whole number.

TABLE 4: SOUND MEASUREMENT RESULTS

| Measurement Position | Period | Average $L_{Aeq,T}$ (dB) | Highest $L_{Aeq,1Hour}$ (dB) | Typical $L_{AFmax}$ (dB) | Typical $L_{AF90,T}$ (dB) |
|---|---|---|---|---|---|
| MP1 | Day | 66 | 70 | 83 | 56 |
| | Night | 59 | 64 | 77 | 50 |
| MP2 | Day | 58 | 63 | 79 | 51 |
| | Night | 53 | 60 | 75 | 49 |

# 5. Vibration Survey and Updated Noise Survey

Due to the vibration sensitivity of specialist equipment within the Proposed Development, particularly Imaging and Scanner technology, a vibration survey has been undertaken at the site.

In addition, due to the fact that previously existing buildings fronting Western Approach have now been demolished, an updated noise survey has been undertaken to complement the original survey undertaken in November 2021 and summarised in the section above.

Attended Noise and Vibration measurements have been conducted on Wednesday 9th August 2023, during typical operational periods of the Proposed Development. Measurements have been undertaken by a consultant certified as competent in environmental noise monitoring, and, in accordance with the principles of BS 7445[3]. All acoustic measurement equipment used during the noise survey will conform to Type 1 specification of British Standard 61672[4].

## 5.1. Noise & Vibration Measurement Details

A full inventory of the equipment is shown in Table 5 below.

Table 5: Inventory of Noise & Vibration Measurement Equipment

| Measurement Position | Make, Model & Description | Serial Number | Certificate Number | Calibration Expiry Date |
|---|---|---|---|---|
| N&V 1-3 | Rion NL-52 Sound Level Meter | 00320618 | 1144540 | 14/05/2025 |
| | Rion NH-25 Preamplifier | 10626 | | |
| | Rion UC-59 Microphone | 05005 | | |
| | Rion NC-74 Acoustic Calibrator | 34984020 | 1131148 | 10/08/2024 |
| | Rion VM-56 Triaxial Groundborne Vibration Meter | 00680014 | TCRT23/1349 | 05/05/2025 |

The sound measurement equipment used during the survey was field calibrated at the start and end of the measurement period. A calibration laboratory has calibrated the field calibrator used within the twelve months preceding the measurements. A drift of less than 0.1 dB in the field calibration was found to have occurred on the sound level meters.

The weather conditions during the survey were generally conducive to environmental noise measurement; it being dry, with wind speeds typically below 5 $ms^{-1}$.

The microphones were fitted with a protective windshield for the measurements, which are described in Table 6, with an aerial photograph indicating their location shown in Figure 8.

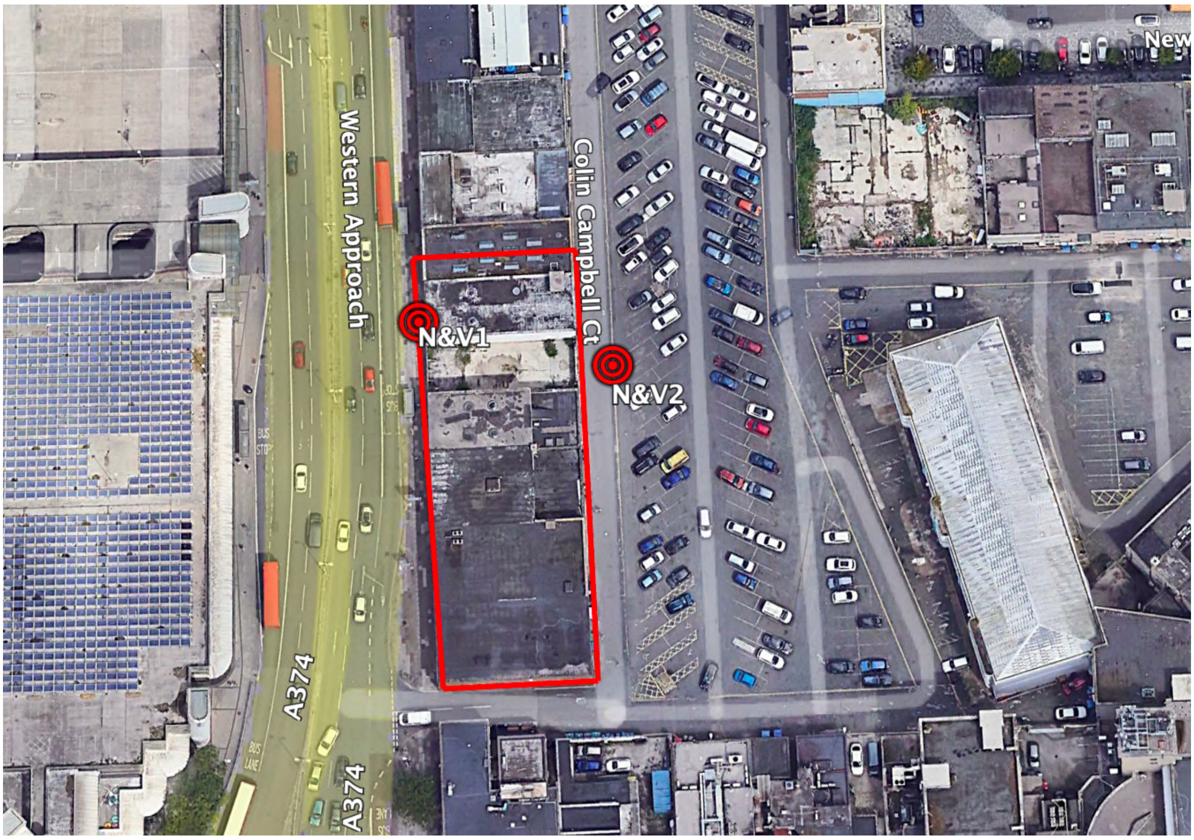
[3] British Standard 7445: 2003: Description and measurement of environmental noise. BSI

[4] British Standard 61672: 2013: Electroacoustics. Sound level meters. Part 1 Specifications. BSI.

TABLE 6: MEASUREMENT POSITION DESCRIPTION

| Measurement Position | Description |
|---|---|
| N&V 1 | Fully attended Noise and vibration measurement at a position representative of the western façade of the Proposed Development. The microphone was set up under free-field conditions at approximately 1.5m above ground. The vibration meter was set up with the X axis facing the road.<br>The sound environment was dominated by road traffic noise on Western Approach, including heavy vehicles<br>The sound environment at this location was dominated by road traffic noise from the A374 (Western Approach) to the west with contributions from building works to the east of the car park and also in the buildings opposite the A374 to the west. It was noted that a bus stop on the A374 was fairly regular along with building work lorries stopping in traffic along the road. |
| N&V 2 | Fully attended Noise and vibration measurement at a position representative of the eastern façade of the Proposed Development, within the existing car park. The microphone was set up under free-field conditions at approximately 1.5m above ground. The vibration meter was set up with the X axis facing the road.<br><br>The sound environment at this location was dominated by road traffic noise from the car park and the A374 (Western Approach) to the west with contributions from building works to the east of the car park and also in the buildings opposite the A374 to the west. |

FIGURE 8: NOISE & VIBRATION MEASUREMENT POSITIONS



## 5.2. Summary Results

The summarised results of the updated environmental sound measurements can be seen below in Table 7. Full results of this noise survey are presented in Appendix C.

TABLE 7: SOUND MEASUREMENT RESULTS

| Measurement Position | Period | Average $L_{Aeq,T}$ (dB) | Highest $L_{Aeq,1Hour}$ (dB) | Typical $L_{AFmax}$ (dB) | Typical $L_{AF90,T}$ (dB) |
|---|---|---|---|---|---|
| N&V 1 | 13:15 – 16:00 | 66 | 67 | 86 | 55 |
| N&V 2 | 11:30 – 12:30 | 58 | 58 | 79 | 50 |

As a summary, the highest vibration level measured at each position are presented below. Full results of the vibration survey are presented in Appendix C.

TABLE 8: VIBRATION MEASUREMENT RESULTS – HIGHEST ACCELERATION LEVEL

| Measurement Position | Period | X axis ($m/s^2$ rms) | Y axis ($m/s^2$ rms) | Z axis ($m/s^2$ rms) |
|---|---|---|---|---|
| N&V 1 | 13:16 to 16:09 (1-minute samples) | 0.00046 | 0.00019 | 0.00128 |
| N&V 2 | 11:31 to 12:31 (1-minute samples) | 0.00008 | 0.0001 | 0.00049 |

# 6. Internal Noise Levels from External Sources

## 6.1. Acoustic Criteria

The criteria for noise intrusion from external sources as set out in HTM-08-01, relevant to the spaces proposed at the Plymouth CDC, are presented in Table 9.

Table 9: Noise Intrusion Limits from External Sources

| Floor | Room Name | HTM-08-01 Classification | Criteria for noise intrusion from external sources $L_{Aeq,1hr}$ (dB) |
|---|---|---|---|
| GF | Ultrasound 1 | Treatment room | 40 $L_{Aeq,1hr}$ |
| GF | Ultrasound 2 | Treatment room | 40 $L_{Aeq,1hr}$ |
| GF | Ultrasound 3 | Treatment room | 40 $L_{Aeq,1hr}$ |
| GF | Ultrasound 4 | Treatment room | 40 $L_{Aeq,1hr}$ |
| GF | Phlebotomy/POCT | Treatment room | 40 $L_{Aeq,1hr}$ |
| GF | Domestic Services | Clean utility | - |
| GF | Independent Wheelchair WC | Toilets (no cubicles) - Public areas | 55 $L_{Aeq,1hr}$ |
| GF | Dirty Utility | Dirty utility-sluice | - |
| GF | Ambulance WC | Toilets (no cubicles) - Public areas | 55 $L_{Aeq,1hr}$ |
| GF | Sub-Wait | Waiting (small ≤20people) | 50 $L_{Aeq,1hr}$ |
| GF | MRI Wait | Waiting (small ≤20people) | 50 $L_{Aeq,1hr}$ |
| GF | Interview | Interview room | 40 $L_{Aeq,1hr}$ |
| GF | Changing Places | Toilets (no cubicles) - Public areas | 55 $L_{Aeq,1hr}$ |
| GF | MRI Scanner 1 | Examination room | 40 $L_{Aeq,1hr}$ |
| GF | Tech Room MRI 1 | Laboratories | 55 $L_{Aeq,1hr}$ |
| GF | Control Room MRI | Laboratories | 55 $L_{Aeq,1hr}$ |
| GF | MRI Scanner 2 | Examination room | 40 $L_{Aeq,1hr}$ |
| GF | Tech Room MRI 2 | Laboratories | 55 $L_{Aeq,1hr}$ |
| GF | Consultation 1 | Consulting room | 40 $L_{Aeq,1hr}$ |
| GF | Consultation 2 | Consulting room | 40 $L_{Aeq,1hr}$ |
| GF | Server Room | Clean utility | - |
| GF | Independent Wheelchair Change | Toilets (no cubicles) - Public areas | 55 $L_{Aeq,1hr}$ |
| GF | MRI Circulation | Corridor (no door) | 55 $L_{Aeq,1hr}$ |

| Floor | Room Name | HTM-08-01 Classification | Criteria for noise intrusion from external sources $L_{Aeq,1hr}$ (dB) |
|---|---|---|---|
| 1F | Lung Function 1 | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | Lung Function 2 | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | Sleep | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | Multi-Purpose 1 | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | Multipurpose 2 | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | Pacemaker 1 | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | Pacemaker 2 | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | First Floor Reception | Corridor (no door) | 55 $L_{Aeq,1hr}$ |
| 1F | PM Reporting | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 1F | PM Interview | Interview room | 40 $L_{Aeq,1hr}$ |
| 1F | Clean Utility | Clean utility | - |
| 1F | Echo 2 | Examination room | 40 $L_{Aeq,1hr}$ |
| 1F | Echo 1 | Examination room | 40 $L_{Aeq,1hr}$ |
| 1F | Echo Reporting | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 1F | ECG Bays | Consulting room | 40 $L_{Aeq,1hr}$ |
| 1F | CT Scanner 1 | Examination room | 40 $L_{Aeq,1hr}$ |
| 1F | CT Scanner 2 | Examination room | 40 $L_{Aeq,1hr}$ |
| 1F | X-Ray Room 1 | Examination room | 40 $L_{Aeq,1hr}$ |
| 1F | X-Ray Room 2 | Examination room | 40 $L_{Aeq,1hr}$ |
| 1F | Cannulation | Waiting (small ≤20people) | 50 $L_{Aeq,1hr}$ |
| 2F | Staff Rest | Rest room | 40 $L_{Aeq,1hr}$ |
| 2F | Interview/1 person | Interview room | 40 $L_{Aeq,1hr}$ |
| 2F | Meeting Room | Small meeting room (≤35m2) | 40 $L_{Aeq,1hr}$ |
| 2F | Interview Room | Interview room | 40 $L_{Aeq,1hr}$ |
| 2F | Central Store | Storeroom | - |
| 2F | Imaging Reporting | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 2F | Staff Change | Toilets (not cubicles) - Staff areas | 55 $L_{Aeq,1hr}$ |
| 2F | Audiology Room 1 | Examination room | 30 $L_{Aeq,1hr}$ |
| 2F | Audiology Room 2 | Examination room | 30 $L_{Aeq,1hr}$ |
| 2F | 1 Person Office | Single-person office | 40 $L_{Aeq,1hr}$ |

| Floor | Room Name | HTM-08-01 Classification | Criteria for noise intrusion from external sources $L_{Aeq,1hr}$ (dB) |
|---|---|---|---|
| 2F | Treatment Room 1 | Treatment room | 40 $L_{Aeq,1hr}$ |
| 2F | Store | Storeroom | - |
| 2F | Workshop | Small meeting room (≤35m2) | 40 $L_{Aeq,1hr}$ |
| 2F | Imagining Hot Desk | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 2F | Shared Admin | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 2F | PM Hot Desk | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 2F | Audiology Reporting | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |
| 2F | Audiology Room 3 | Examination room | 30 $L_{Aeq,1hr}$ |
| 2F | Treatment Room 2 | Treatment room | 40 $L_{Aeq,1hr}$ |
| 2F | Treatment Room 3 | Treatment room | 40 $L_{Aeq,1hr}$ |
| 2F | Treatment Room 4 | Treatment room | 40 $L_{Aeq,1hr}$ |
| 2F | Treatment Room 5 | Treatment room | 40 $L_{Aeq,1hr}$ |
| 2F | Treatment Room 6 | Treatment room | 40 $L_{Aeq,1hr}$ |
| 2F | Audiology Hot Desk | Multi-person office (2-4 people) | 40 $L_{Aeq,1hr}$ |

The acoustic mark-ups presented in Appendix E includes the internal noise limit from external sources for each relevant room.

It should be noted that the acoustic criteria for the audiology rooms in Table 9 are taken from BSA's Practice Guidance, based on a 10dB relaxation upon the levels advised in BS EN ISO 8253-2:2009, assuming that they are to be used for sound field audiometry testing.

## 6.2. Façade Performance Requirements

In order to achieve appropriate indoor noise levels presented in Table 9 the building itself needs to be considered with regard to the level of façade mitigation required. Based on the results of the environmental noise survey as presented in Section 4 and Section 5 and the latest layout proposals, an assessment of the proposed external building fabric has been undertaken.

The sound insulation requirements of the building envelope, namely the external walls, glazing and ventilation elements, to achieve the required indoor ambient noise levels presented in Table 9 are outlined below. It is assumed that the proposed rooms will be designed to control reverberation as specified in Section 8.

### 6.2.1. External Walls

The minimum sound insulation performance of the external walls are presented below.

TABLE 10: MINIMUM REQUIRED ACOUSTIC PERFORMANCE OF EXTERNAL WALLS

| External Wall | Sound Reduction Index (R) dB | | | | | |
|---|---|---|---|---|---|---|
| | Frequency, Hz | | | | | $R_w$ |
| | 125 | 250 | 500 | 1000 | 2000 | |
| All Façades | 26 | 37 | 44 | 50 | 55 | **46** |

The above sound reduction performance can be achieved by either cavity masonry walls or by lightweight façade systems. The following lightweight build-up, capable of achieving the above performance, is provided as an example only.

- External Cladding/Render;
- Thermal Insulation;
- 12mm sheathing board;
- Metal stud filled with 100mm Mineral Wool;
- 10mm cement particle board; and
- 15mm wallboard.

Other systems might be suitable, as long as they achieve the above sound insulation performance. In due course, all suppliers must produce a laboratory test report to support their material submittal.

### 6.2.2. Glazing

The minimum sound insulation performance of external glazed elements are presented below.

TABLE 11: MINIMUM REQUIRED ACOUSTIC PERFORMANCE OF EXTERNAL GLAZING

| Glazing System | Sound Reduction Index (R) dB | | | | | |
|---|---|---|---|---|---|---|
| | Frequency, Hz | | | | | $R_w$ |
| | 125 | 250 | 500 | 1000 | 2000 | |
| Western Façade | 26 | 22 | 28 | 38 | 41 | **33** |
| Other Façades | 22 | 20 | 26 | 36 | 39 | **31** |

| | | | | | | |
|---|---|---|---|---|---|---|
| Audiology Room on Eastern Facade | 29 | 27 | 35 | 37 | 36 | **36** |

As an example, the highest 36 dB $R_w$ performance can be achieved by a '8-12-10' double glazing system, comprising a 8mm pane of glass, 12mm air gap and a 10mm pane of glass. Similarly, the 33 dB $R_w$ performance can be achieved by a '4-12-8' glazing system and the 31 dB $R_w$ performance can be achieved by a '4-12-4' glazing system.

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

### 6.2.3. Ventilation Strategy

HTM 08-01: Acoustics does not provide definitive guidance relating to ventilation systems in healthcare environments. However, it does imply that either natural or mechanical ventilation systems can be used. To that end, the guidance suggests that either acoustically rated trickle ventilators or mechanical ventilation systems may be required on noisy sites and that, on the noisiest of sites, sealed facades may be required also.

In this instance, it is understood that the majority of spaces will be ventilated by means of full mechanical ventilation systems, with no need for façade ventilation openings or opening windows. However, the mechanical engineers have confirmed the design intent of using Hybrid Ventilation Units within some of the audiology rooms on the eastern facade, mounted locally to the external façade, as presented in the example below.

FIGURE 9: EXAMPLE OF HYBRID VENTILATION UNITS


The following minimum acoustic performance should be achieved by the ventilation elements, depending on the façade location, in order to mitigate external noise ingress and ensure that the relevant indoor ambient noise levels are achieved.

TABLE 12: MINIMUM REQUIRED ACOUSTIC PERFORMANCE OF VENTILATION SYSTEM

| Ventilation System | Element Normalised Level Difference ($D_{n,e}$) dB | | | | | |
|---|---|---|---|---|---|---|
| | Frequency, Hz | | | | | $D_{n,e,w}$ |
| | 125 | 250 | 500 | 1000 | 2000 | |
| Audiology Rooms not used for Testing | 35 | 38 | 26 | 29 | 36 | **31** |
| Audiology Rooms used for Sound Field Testing | 33 | 32 | 31 | 37 | 47 | **37** |

The arriving air path is likely to require the incorporation of acoustic attenuation to achieve the levels presented in Table 12. Alternatively, full mechanical ventilation systems should be used, with no direct openings to the room's façade.

One Hybrid Ventilation Unit has been assumed per room. Where more ventilators are used, the acoustic performance of the ventilators would need to be upgraded by 10*log(N); N being the number of ventilators per room.

### 6.2.4. Note on Overheating

Overheating is a growing concern but there are no specific requirements relating to overheating in HTM-08-01. Enhanced ventilation rates are often required to mitigate overheating and therefore it is possible that higher noise levels may be experienced in rooms during this ventilation condition if windows need to be open.

Ideally, the contractor should be looking to determine the typical worst-case duration that windows would need to be opened (if at all) to control thermal gains, then assess whether it is a problem. If, for example, the occupants would only need to open windows for short periods of time, exceeding indoor ambient noise levels should normally be acceptable. Otherwise, if the thermal gain analysis identifies that overheating is actually a problem, then a further acoustic assessment should be undertaken to evaluate noise impact during these periods. Alternatively, full mechanical ventilation with comfort cooling may be provided to avoid opening windows to prevent overheating.

# 7. Internal Sound Insulation

## 7.1. Airborne Sound Insulation Criteria

HTM-08-01 sets out criteria for airborne sound insulation between adjacent spaces based on the privacy requirements, noise generation and noise sensitivity of the spaces. These are reproduced in Table 13 below.

Table 13: Sound-Insulation Ratings (dB $D_{nT,w}$) to be Achieved on Site

| Privacy requirement for source room | Noise generation of the source room | Noise sensitivity of receiving room | | |
|---|---|---|---|---|
| | | Not sensitive | Medium sensitivity | Sensitive |
| **Confidential** | Very high | 47 | 52 | ★ |
| | High | 47 | 47 | 52 |
| | Typical | 47 | 47 | 47 |
| | Low | 42 | 42 | 47 |
| **Private** | Very high | 47 | 52 | ★ |
| | High | 42 | 47 | 52 |
| | Typical | 42 | 42 | 47 |
| | Low | 37 | 42 | 42 |
| **Moderate** | Very high | 47 | 52 | ★ |
| | High | 37 | 42 | 47 |
| | Typical | 37 | 37 | 42 |
| | Low | No rating | No rating | 37 |
| **Not private** | Very high | 47 | 52 | ★ |
| | High | No rating | 42 | 47 |
| | Typical | No rating | No rating | 42 |
| | Low | No rating | No rating | 37 |

**Notes:**
★ = These adjacencies should be avoided by layout planning. Where this is not possible, $D_{nT,w}$ 57 dB needs to be achieved as a minimum. In practice this is extremely difficult, as it would need very wide partitions and place onerous demands on the building structure to control flanking noise sufficiently.

Note that for:

- **Confidential** – raised speech would be audible but not intelligible, and normal speech would be inaudible;
- **Private** – normal speech would be audible but not intelligible;
- **Moderate** – normal speech would be audible and intelligible but not intrusive;
- **Not private** – normal speech would be clearly audible and intelligible;
- **Sensitive** – room cannot accommodate any noticeable noise from rooms next door;
- **Medium sensitivity** – room generally needs to be free from noise of other rooms; and
- **Not sensitive** – noise from other rooms does not affect the use of the receiving room.

Table 5 of HTM-80-01 also details a matrix showing sound insulation performance requirements ($D_{nT,w}$) for each combination of source room and receiving room types, which has form the basis of this assessment. This matrix is also presented in Table 14 overleaf.

Table 14: HTM-08-01 Matrix of Sound-Insulation Performance Requirements (dB $D_{NT,W}$)

| | Receiving room | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Clinical areas | | | | | | | | | | | | | | | | |
| Source room | Single-bed/on-call room | Multi-bed room | Children & older people (single bed) | Children & older people (multi-bed) | Consulting room | Examination room | Treatment room | Counselling/bereavement room | Interview room | Operating theatre suite | Nurseries | Birthing room | Laboratories | Dirty utility/sluice | Clean utility | Speech and language therapy | Snoezelen/multi-sensory room |
| **Clinical areas** | | | | | | | | | | | | | | | | | |
| Single-bed/on-call room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Multi-bed room | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Children & older people (single bed) | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 42 | 42 | 52 | 52 |
| Children & older people (multi-bed) | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | 37 | 37 | 47 | 47 |
| Consulting room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Examination room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Treatment room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Counselling/bereavement room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 47 | 47 | 52 | 52 |
| Interview room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Operating theatre suite | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | 42 | 42 | 47 | 47 |
| Nurseries | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | ★ | 52 | 52 | 52 | 47 | 47 | ★ | ★ |
| Birthing room | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | ★ | 52 | 52 | 52 | 47 | 47 | ★ | ★ |
| Laboratories | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 37 | 37 | 37 | 37 | 42 | 42 |
| Dirty utility/sluice | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | n/a | n/a | 47 | 47 |
| Clean utility | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 37 | n/a | n/a | n/a | n/a | n/a | 37 | 37 |
| Speech and language therapy | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 47 | 47 | 52 | 52 |
| Snoezelen/multi-sensory room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 47 | 47 | 52 | 52 |
| **Public areas** | | | | | | | | | | | | | | | | | |
| Multi-faith/chapel | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 42 | 42 | 52 | 52 |
| Corridor (no door) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | n/a | n/a | n/a | n/a | 42 | 42 |
| Atrium | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | n/a | n/a | 47 | 47 |
| Dining | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | n/a | n/a | 47 | 47 |
| Toilets (not cubicles) | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 37 | 37 | 37 | 37 | 42 | 42 |
| Waiting (large >20 people) | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | n/a | n/a | 47 | 47 |
| Waiting (small ≤20 people) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | 42 |
| **Staff areas** | | | | | | | | | | | | | | | | | |
| Toilets (not cubicles) | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 37 | 37 | 37 | 37 | 42 | 42 |
| Main kitchen | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | 52 | ★ | 52 | 52 | 52 | 47 | 47 | ★ | ★ |
| Ward kitchen, pantry | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | n/a | n/a | n/a | n/a | 42 | 42 |
| Storeroom | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 37 | n/a | n/a | n/a | n/a | n/a | 37 | 37 |
| Rest room | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | 37 | 37 | 47 | 47 |
| Locker/changing room | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 37 | 37 | 37 | 37 | 42 | 42 |
| Large training/seminar (>35 m²) | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 42 | 42 | 52 | 52 |
| Small training/seminar (≤35 m²) | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | 42 | 42 | 47 | 47 |
| Lecture theatre | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 42 | 42 | 52 | 52 |
| Library/archiving room | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 37 | n/a | n/a | n/a | n/a | n/a | 37 | 37 |
| Single-person office | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | 42 | 42 | 47 | 47 |
| Multi-person office (2–4 people) | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 37 | 37 | 37 | 37 | 42 | 42 |
| Open-plan office (≥5 people) | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | n/a | n/a | n/a | n/a | 42 | 42 |
| Boardroom | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 47 | 47 | 52 | 52 |
| Large meeting room (>35 m²) | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 47 | 47 | 42 | 42 | 52 | 52 |
| Small meeting room (≤35 m²) | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 42 | 42 | 42 | 42 | 47 | 47 |

| | Receiving room | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Public areas | | | | | | | Staff areas | | | | | | | | | | | | | | | |
| Source room | Multi-faith/chapel | Corridor (no door) | Atrium | Dining | Toilets (not cubicles) | Waiting (large >20 people) | Waiting (small ≤20 people) | Toilets (not cubicles) | Main kitchen | Ward kitchen, pantry | Storeroom | Rest room | Locker/changing room | Large training/seminar (>35 m²) | Small training/seminar (≤35 m²) | Lecture theatre | Library/archiving room | Single-person office | Multi-person office (2–4 people) | Open-plan office (≥5 people) | Boardroom | Large meeting room (>35 m²) | Small meeting room (≤35 m²) |
| **Clinical areas** | | | | | | | | | | | | | | | | | | | | | | | |
| Single-bed/on-call room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Multi-bed room | 42 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Children & older people (single bed) | 52 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Children & older people (multi-bed) | 47 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Consulting room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Examination room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Treatment room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Counselling/bereavement room | 52 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Interview room | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |
| Operating theatre suite | 47 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Nurseries | ★ | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 52 | 52 | ★ | ★ | 52 | 52 | 52 | 52 | 52 | 52 |
| Birthing room | ★ | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 52 | 52 | ★ | ★ | 52 | 52 | 52 | 52 | 52 | 52 |
| Laboratories | 42 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Dirty utility/sluice | 47 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Clean utility | 37 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 37 | 37 | n/a | n/a | n/a | n/a | n/a | n/a |
| Speech and language therapy | 52 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Snoezelen/multi-sensory room | 52 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| **Public areas** | | | | | | | | | | | | | | | | | | | | | | | |
| Multi-faith/chapel | 52 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Corridor (no door) | 42 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | 42 | n/a | n/a | n/a | n/a | n/a | n/a |
| Atrium | 47 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Dining | 47 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Toilets (not cubicles) | 42 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Waiting (large >20 people) | 47 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | n/a | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Waiting (small ≤20 people) | 42 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | 42 | n/a | n/a | n/a | n/a | n/a | n/a |
| **Staff areas** | | | | | | | | | | | | | | | | | | | | | | | |
| Toilets (not cubicles) | 42 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Main kitchen | ★ | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 47 | 52 | 52 | ★ | ★ | 52 | 52 | 52 | 52 | 52 | 52 |
| Ward kitchen, pantry | 42 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | 42 | n/a | n/a | n/a | n/a | n/a | n/a |
| Storeroom | 37 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 37 | 37 | n/a | n/a | n/a | n/a | n/a | n/a |
| Rest room | 47 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 37 | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Locker/changing room | 42 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Large training/seminar (>35 m²) | 52 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Small training/seminar (≤35 m²) | 47 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Lecture theatre | 52 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Library/archiving room | 37 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 37 | 37 | n/a | n/a | n/a | n/a | n/a | n/a |
| Single-person office | 47 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |
| Multi-person office (2–4 people) | 42 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 37 | 42 | 42 | 37 | 37 | 37 | 37 | 37 | 37 |
| Open-plan office (≥5 people) | 42 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a | 42 | 42 | n/a | n/a | n/a | n/a | n/a | n/a |
| Boardroom | 52 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Large meeting room (>35 m²) | 52 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 42 | 47 | 47 | 52 | 52 | 47 | 47 | 47 | 47 | 47 | 47 |
| Small meeting room (≤35 m²) | 47 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 42 | 47 | 47 | 42 | 42 | 42 | 42 | 42 | 42 |

For special rooms not included in the table above, such as MRI or CT Scanner rooms, sound insulation requirements have been based on the privacy requirements, noise generation and noise sensitivity of the spaces.

It is noted that the sound insulation requirement is given as a $D_{nT,w}$ which is an onsite performance value to be measured once the development is complete. For the purpose of specification this value is converted to an $R_w$ which is a standardised sound insulation parameter measured in a laboratory. The $R_w$ value is quoted by suppliers of partition systems.

Typically, the derived $R_w$ requirements for lightweight partitions should be around 8 dB higher than the in-site $D_{nT,w}$ values, in order to allow for the volume of the receiver room and the sound absorption in the receiving room, along with flanking transmission, assuming good junction detailing. As a reference only, the required in-situ sound insulation between consulting/treatment/examination rooms is 47 dB $D_{nT,w}$, requiring a partition with a laboratory performance in the order of 55 dB $R_w$.

HTM-08-01 also provides a more detailed method for deriving the $R_w$ laboratory partition value, based on the required in-situ sound insulation ($D_{nT,w}$), the separation area and the volume of the receiving room. The $R_w$ results for each relevant partition using this method are presented below.

Table 15: Required In-Situ $D_{nT,w}$ and Derived Partition Laboratory $R_w$ (dB)

| Floor | Room 1 | | Room 2 | | Acoustic Requirements | |
|---|---|---|---|---|---|---|
| | Room Name | HTM-08-01 Classification | Room Name | HTM-08-01 Classification | HTM-08- $D_{nT,w}$ | Partition $R_w$ |
| GF | Ultrasound 1 | Treatment room | Ultrasound 2 | Treatment room | 47 | 56 |
| GF | Ultrasound 2 | Treatment room | Ultrasound 3 | Treatment room | 47 | 56 |
| GF | Ultrasound 3 | Treatment room | Ultrasound 4 | Treatment room | 47 | 56 |
| GF | Ultrasound 4 | Treatment room | Phlebotomy/ poct | Treatment room | 47 | 55 |
| GF | Domestic Services | Clean utility | Independent Wheelchair WC | Toilets (no cubicles) - Public areas | 37 | 48 |
| GF | Dirty Utility | Dirty utility-sluice | Ambulance WC | Toilets (no cubicles) - Public areas | 37 | 50 |
| GF | Sub-Wait | Waiting (small ≤20people) | Interview | Interview room | 47 | 57 |
| GF | MRI Wait | Waiting (small ≤20people) | Interview | Interview room | 47 | 57 |
| GF | Interview | Interview room | Changing Places | Toilets (no cubicles) - Public areas | 47 | 56 |
| GF | Ambulance WC | Toilets (no cubicles) - Public areas | Ambulance WC | Toilets (no cubicles) - Public areas | 37 | 50 |
| GF | Server Room | - | Tech Room MRI 2 | - | 37 | 45 |
| GF | Server Room | - | Independent Wheelchair WC | Toilets (no cubicles) - Public areas | 37 | 48 |
| GF | MRI Scanner 1 | - | Tech Room MRI 1 | - | 52 | 62 |
| GF | MRI Scanner 2 | - | Tech Room MRI 2 | - | 52 | 60 |
| GF | Ultrasound 1 | Treatment room | Ultrasound 2 | Treatment room | 47 | 56 |
| 1F | Lung Function 1 | Consulting room | Lung Function 2 | Consulting room | 47 | 56 |
| 1F | Lung Function 2 | Consulting room | Sleep | Consulting room | 47 | 56 |
| 1F | Sleep | Consulting room | Multi-Purpose 1 | Consulting room | 47 | 56 |
| 1F | Multi-Purpose 1 | Consulting room | Pacemaker 2 | Consulting room | 47 | 56 |

| Floor | Room 1 | | Room 2 | | Acoustic Requirements | |
|---|---|---|---|---|---|---|
| | Room Name | HTM-08-01 Classification | Room Name | HTM-08-01 Classification | HTM-08- $D_{nT,w}$ | Partition $R_w$ |
| 1F | Multipurpose 2 | Consulting room | Pacemaker 1 | Consulting room | 47 | 56 |
| 1F | Clean Utility | Clean utility | PM Interview | Interview room | 47 | 57 |
| 1F | Echo 2 | Examination room | Echo 1 | Examination room | 47 | 56 |
| 1F | Echo Reporting | Multi-person office (2-4 people) | Echo 1 | Examination room | 47 | 56 |
| 1F | ECG Bays | Consulting room | Echo Reporting | Multi-person office (2-4 people) | 47 | 54 |
| 1F | CT Scanner 2 | - | X-Ray Room 1 | Examination room | 47 | 54 |
| 1F | ECG Bays | Consulting room | X-Ray Room 2 | Examination room | 47 | 54 |
| 2F | Staff Rest | Rest room | Interview/1 person | Interview room | 47 | 56 |
| 2F | Interview/1 person | Interview room | Meeting Room | Small meeting room (≤35m2) | 47 | 55 |
| 2F | Meeting Room | Small meeting room (≤35m2) | Meeting Room | Small meeting room (≤35m2) | 42 | 50 |
| 2F | Meeting Room | Small meeting room (≤35m2) | Interview Room | Interview room | 47 | 58 |
| 2F | Central Store | Storeroom | Staff Rest | Rest room | 37 | 45 |
| 2F | Central Store | Storeroom | Imaging Reporting | Multi-person office (2-4 people) | 37 | 47 |
| 2F | Audiology Room 1 | Examination room | Staff Change | Toilets (not cubicles) - Staff areas | 52 | 59 |
| 2F | Audiology Room 2 | Examination room | Staff Change | Toilets (not cubicles) - Staff areas | 52 | 59 |
| 2F | Audiology Room 1 | Examination room | Audiology Room 2 | Examination room | 52 | 61 |
| 2F | 1 Person Office | Single-person office | Treatment Room 1 | Treatment room | 47 | 54 |
| 2F | Store | Storeroom | Workshop | Small meeting room (≤35m2) | 42 | 49 |
| 2F | Imagining Hot Desk | Multi-person office (2-4 people) | Shared Admin | Multi-person office (2-4 people) | 37 | 45 |

| Floor | Room 1 | | Room 2 | | Acoustic Requirements | |
|---|---|---|---|---|---|---|
| | Room Name | HTM-08-01 Classification | Room Name | HTM-08-01 Classification | HTM-08- $D_{nT,w}$ | Partition $R_w$ |
| 2F | Shared Admin | Multi-person office (2-4 people) | PM Hot Desk | Multi-person office (2-4 people) | 37 | 45 |
| 2F | PM Hot Desk | Multi-person office (2-4 people) | Audiology Reporting | Multi-person office (2-4 people) | 37 | 45 |
| 2F | Audiology Reporting | Multi-person office (2-4 people) | Audiology Room 3 | Examination room | 52 | 60 |
| 2F | Audiology Room 3 | Examination room | Treatment Room 2 | Treatment room | 52 | 60 |
| 2F | Treatment Room 2 | Treatment room | Treatment Room 3 | Treatment room | 47 | 55 |
| 2F | Treatment Room 3 | Treatment room | Treatment Room 4 | Treatment room | 47 | 55 |
| 2F | Treatment Room 4 | Treatment room | Treatment Room 5 | Treatment room | 47 | 55 |
| 2F | Treatment Room 5 | Treatment room | Treatment Room 6 | Treatment room | 47 | 55 |
| 2F | Treatment Room 6 | Treatment room | Audiology Hot Desk | Multi-person office (2-4 people) | 47 | 56 |

## 7.2. Impact Sound Insulation Criteria

HTM-08-01 sets a maximum weighted standardised impact sound pressure level ($L'_{nT,w}$) of 65 dB as being reasonable for floors over noise-sensitive areas.

## 7.3. Separating Walls Proposals

At this stage, no design information has been provided relating to separating walls build-ups within the development. As such, in order to assist with the design development, Table 16 presents indicative notionally suitable construction options for achieving the various airborne sound insulation requirements identified in the acoustic mark-ups presented in Appendix E.

TABLE 16: INDICATIVE CONSTRUCTION OPTIONS FOR AIRBORNE SOUND INSULATION OF SEPARATING WALLS

| Airborne Sound Insulation Performance Requirements $RR_W$ (dB) | Indicative Construction Options | |
|---|---|---|
| | Lightweight | Masonry |
| 40 | 12.5mm plasterboard (8 kg/m$^2$),<br>70mm metal studs at 600mm c/c,<br>25mm Isover APR 1200 in the cavity,<br>12.5mm plasterboard (8 kg/m$^2$)<br><br>*Width: 97mm* | 100mm low density block (up to 1350 kg/m$^3$),<br>13mm plaster on one side<br><br>*Width: 113mm* |
| 45 | 2x12.5mm plasterboard (8 kg/m$^2$),<br>70mm metal studs at 600mm c/c,<br>2x12.5mm plasterboard (8 kg/m$^2$)<br><br>*Width: 122mm* | 100mm medium density block (min 1450 kg/m$^3$),<br>13mm plaster on one side<br><br>*Width: 113mm* |
| 50 | 2x15 mm plasterboard (9.8 kg/m$^2$),<br>70mm metal stud at 600mm c/c,<br>25mm Isover APR 1200 in the cavity,<br>2x15 mm plasterboard (9.8 kg/m$^2$)<br><br>*Width: 132mm* | 13mm plaster,<br>140mm medium density block (min 1450 kg/m$^3$),<br>13mm plaster<br><br>*Width: 166mm* |
| 55 | 2x15mm high density plasterboard (12.6 kg/m$^2$),<br>70 mm metal studs at 600mm c/c,<br>50mm Isover APR 1200 in the cavity,<br>2x15 mm high density plasterboard (12.6 kg/m$^2$)<br><br>*Width: 132mm* | 13mm plaster,<br>215mm medium density block (min 1450 kg/m$^3$),<br>13mm plaster<br><br>*Width: 241mm* |
| 60 | 2x15mm high density plasterboard (11.7 kg/m$^2$),<br>Twin independent 48mm metal "C" studs at 600mm c/c,<br>50mm Isover APR 1200 in the cavity,<br>2x15 mm high density plasterboard (11.7 kg/m$^2$)<br><br>*Width: 200mm* | 13mm plaster,<br>100mm block high density (min 2000 kg/m$^3$),<br>12.5mm high density plasterboard (10.6 kg/m$^2$) on metal frame,<br>50 mm cavity filled with Isover APR 1200<br><br>*Width: 176mm* |

Subject to development of appropriate junction details, quality of workmanship and appropriate detailing on-site, use of the above constructions should prove commensurate with achieving the project criteria.

As advised before, for the 'audiological testing' it is advised that purpose-built audiology cabins are installed within the Audiology Rooms, since that is the only pragmatic way to achieve the high acoustic requirements for professional audiology testing.

### 7.3.1. Corridor Walls and Doors

HTM08-01 does not stipulate targets for walls (containing doors) separating corridor/circulation spaces with rooms, in terms of $D_{nT,w}$. This is because the entrance door in these partitions limit the overall performance, regardless of the performance of the walls. As such, HTM08-01 advises that walls separating corridors from sensitive spaces must achieve a minimum composite rating of 10 dB higher than the specified for the doors, consequently 40 – 45 dB $R_w$. Accordingly, the acoustic mark-up drawings included in Appendix E reflect these requirements.

Table 17 below provides the normal performance requirements for doors (including glazed side panels) in different settings. Guidance is also provided relating to notionally suitable systems. Appendix E also provides a graphical display of the required door ratings throughout the scheme.

TABLE 17: INTERNAL DOOR PERFORMANCE REQUIREMENTS AND NOTIONALLY SUITABLE SYSTEMS

| Acoustic Performance Requirements, $R_w$ (dB) | Room Type | Notionally Suitable Systems |
|---|---|---|
| 30 | Consulting, Examination, Interview, Office | 44mm thick solid core door with acoustic seals around the whole perimeter (incl. threshold) |
| 35 | Audiology Room, Seminar Room, Plant Rooms | 52 mm thick solid core door with acoustic seals around the whole perimeter (incl. threshold) |

### 7.3.2. Audiology Rooms

The British Society of Audiology (BSA) Practice Guidance 'The Acoustics of Sound Field Audiometry in Clinical Audiological Applications' advises that "*The room should have low ambient noise. BS EN ISO 8253-2:2009 specifies maximum permissible ambient sound pressure levels for hearing threshold level measurements down to 0 dB HL which is usually achievable by the commission of a purpose-built audiology room. However, these levels can be difficult to achieve and, for practical purposes, it is reasonable to accept ambient sound pressure levels that are adequate for measuring hearing threshold level measurements down to 10 dB HL, still only achievable through specialist audiology room design.*"

Following discussions with KTA, WWA and UHP, it was agreed that the Trust's preferred option is to avoid purpose-built audiology booths. As such, this assessment has been revised to provide advice in order to achieve the recommended BSA specifications within the Audiology Room 1, 2 and 3, assuming that all of them can be used for Sound Field Audiology Testing.

A summary of the recommendations provided in the BSA Guidance, in terms of considerations when planning a testing facility, are presented below.

- The room should be of adequate size (preferred minimum dimensions for paediatric assessment 4m x 6m, plus a separate control room);
- The room should have low ambient noise;
- The room should have low reverberation times;
- There should be a defined layout of furniture, furnishings and equipment;
- There should be defined positions for people in the room during testing;
- Preferably, the room should have the audiometer and control equipment for the sound field stimuli in a separate and adjacent control room, with an observation window between the two rooms; and
- The loudspeakers should be at the head-height of the seated listener and directed towards the reference point. The distance from loudspeakers to the reference point should be at least 1 m.

### 7.3.3. Mark-up Comments

The acoustic mark-ups in Appendix E include a number of comments, that are summarized here for easy reference:

*Ground Floor*

- Glazed panels in partition separating the MRI Scanner Rooms and the MRI Control Room should provide a minimum airborne sound insulation of 45 dB $R_w$. As an example only, this can be achieved by acoustic double glazing comprising a 10mm glass pane, 20mm air cavity filled with argon and laminated 8.4mm glass pane (10-20-8.4A).
- If MRI Control Room needs privacy or moderate noise levels, then a 45 dB $R_w$ partition and 35 dB $R_w$ doorset should be provided to separate the space from the MRI Access Area.
- Rather than a sliding door, a 35 dB $R_w$ doorset is recommended between the MRI Circulation Area and the MRI Access Area.

*First Floor*

- Glazed panels in partition separating the CT Scanner Rooms and the CT Control Room should provide a minimum airborne sound insulation of 40 dB $R_w$. As an example only, this can be achieved by acoustic double glazing comprising a 8mm glass pane, 12mm air cavity and laminated 8.4mm glass pane (8-12-8.4A).
- Glazed panels in partition separating the X-Ray Rooms and the X-Ray Viewing should also provide a minimum airborne sound insulation of 40 dB $R_w$.

*Second Floor*

A movable/folding partition is proposed to divide the large Meeting Room into two smaller Meeting Rooms. The required laboratory sound reduction performance for this movable partition will be 50 dB Rw, if these spaces are to be used independently, which can be very onerous.

In reality, removable partitions systems will generally have significantly lower acoustic performances, except for some heavy and costly systems which are considered onerous. In addition, the effective acoustic separation between the spaces will be limited by flanking transmission, mainly through the floor/ceiling void if present. If a reasonable level of privacy is required between these spaces, acoustically rated floor and ceiling void barriers should be installed.

Alternatively, a lower sound insulation criteria for these spaces should be agreed between the client, BREEAM Assessor and the Design Team. A movable partition capable of providing an acoustic performance of 45 dB $R_w$ is considered a reasonable compromise between acoustic privacy, operability of the partition and costs.

## 7.4. Separating Floor Proposals

Floor systems separating two sensitive rooms across the scheme should achieve a minimum airborne sound insulation performance in the order of 55 dB $R_w$.

Floor system separating sensitive rooms on the Second Floor below the Third Floor Plant should achieve a minimum airborne sound insulation performance in the order of 60 dB $R_{w.}$ In the case of Audiology Rooms, the performance should be in the order of 70 dB $R_{w.}$

Floor system separating the CT Scanner Rooms on First Floor from sensitive uses on Second Floor should achieve a minimum airborne sound insulation performance in the order of 65 dB $R_w$.

Floor system separating the MRI Scanner Rooms from the CT Scanner Rooms above should achieve a minimum airborne sound insulation performance in the order of 70 dB $R_w$.

Floor system separating the Generator Room in the Ground Floor and the ECG Bays in the First Floor above should achieve a minimum airborne sound insulation performance in excess of 70 dB $R_w$.

In order to achieve the required in-situ weighted standardised impact sound pressure level ($L'_{nT,w}$) of 65 dB, all floor systems over noise-sensitive areas should provide a maximum laboratory impact sound insulation performance of 60 dB $L_{nw}$.

It is understood that the proposed floor system across the development will comprise 300mm floor slabs, a 1500mm ceiling void and ceiling, as shown below in Figure 10.

FIGURE 10: OUTLINED FLOOR AND CEILING BUILD-UP

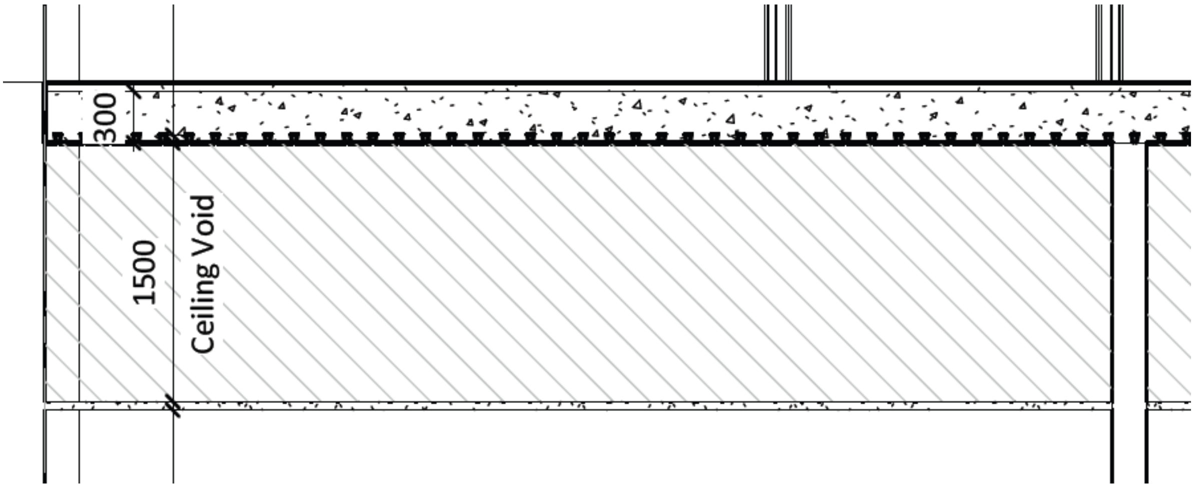
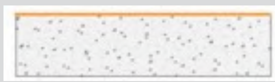
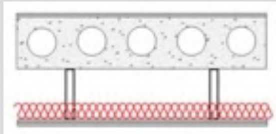
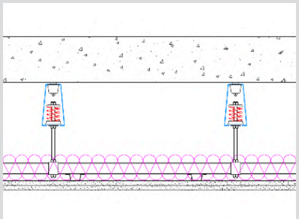



Table 18 below provides notionally suitable systems for achieving the airborne and impact sound insulation requirements across the scheme identified above.

TABLE 18: INDICATIVE CONSTRUCTION OPTIONS FOR AIRBORNE & IMPACT SOUND INSULATION OF FLOORS

| Area | Laboratory Airborne Sound Insulation Performance Requirements $R_w$ (dB) | Laboratory Impact Sound Insulation Performance Requirements $L_{nw}$ (dB) | Indicative Construction Options | |
|---|---|---|---|---|
| All Floors | 55-60 | 55-60 | 300mm Solid concrete floor consisting of reinforced solid cast in-situ concrete with or without shuttering, concrete beams with infill blocks and screed, hollow or solid concrete planks with screed, with soft covering.<br>Total slab mass in the order of 500 kg/m$^2$,<br>1500mm Ceiling void and 10-15mm ceiling tiles | <br><br> |

| Area | Laboratory Airborne Sound Insulation Performance Requirements $R_w$ (dB) | Laboratory Impact Sound Insulation Performance Requirements $L_{nw}$ (dB) | Indicative Construction Options | |
|---|---|---|---|---|
| MRI/CT Scanner Rooms | 65-70 | *45-50* | All above base floors with suspended 2 x 15mm dense plasterboard (i.e. SoundBloc) ceiling on a proprietary metal frame and 50mm Isover Acoustic Partition Roll (APR 1200) in the ceiling void (min. 100mm depth) |  |
| Genset Room, Audiology Rooms | > 70 | - | All above base floors with suspended ceiling comprising a metal frame supported on spring hangers with a natural frequency of 4Hz, 200mm cavity filled with at least 100mm mineral wool and 2x15mm high density plasterboard (13 kg/m$^2$) |  |

Floor finish on Level 01 and Level 02 above another sensitive space must have a resilient backing to provide a weighted reduction in impact sound pressure level of not less than 17 dB $\Delta L_w$. A resilient backing is not required in ground floor rooms, carpeted rooms or rooms which are not above another sensitive space.

Assuming all potential flanking paths are appropriately detailed and a high level of workmanship is employed during every stage of construction, the above construction would be expected to satisfy the relevant airborne and impact sound insulation design criteria and should, therefore, be considered notionally acceptable.

## 7.5. Flanking Sound Transmission Considerations

There is potential for flanking noise transmission across separating walls and floors at junction interfaces and services penetrations. To achieve the relevant performance requirements between two spaces, appropriate junction detailing is vital to ensure that the acoustic integrity of the separating walls and floors is not compromised. Beams and columns bridging acoustically rated separating constructions will also need attention. General guidance in control of sound flanking is provided below although analysis and advice on details is beyond this stage's scope. The following general guidance should be noted.

### 7.5.1. Junction of a Separating Wall with a Separating Floor

The separating walls should be brought down to the structural floor and extended up to the underside of the structural soffit, where appropriate head deflection detailing would need to be developed. Any gaps between the top and bottom edges of the partitions should be minimised and well-sealed with non-setting mastic.

For separating walls extended up to the underside of lightweight elements such as lightweight roofs, use of a sound insulating ceiling to the underside of the roof would be necessary.

It will be necessary to ensure that an appropriate perimeter flanking strip is installed at the junctions of a floating floor system with the separating/external walls to ensure that the floating floor does not have a rigid contact with surrounding structures and its resilience is not unduly compromised.

It is important to note that any gaps at the junction of the ceiling and the walls should be minimised as far as possible and any unavoidable gaps should be well filled with non-setting mastic.

### 7.5.2. Junction of an External Wall with a Separating Floor or Wall

There are likely to be a number of junction details with the external walls. Where a separating wall or floor structure abuts the inner leaf of the external walls there is the potential for flanking transmission, which may act to reduce the acoustic performance of the installed separating wall/floor system. The important principles to be followed in these areas are as follows:

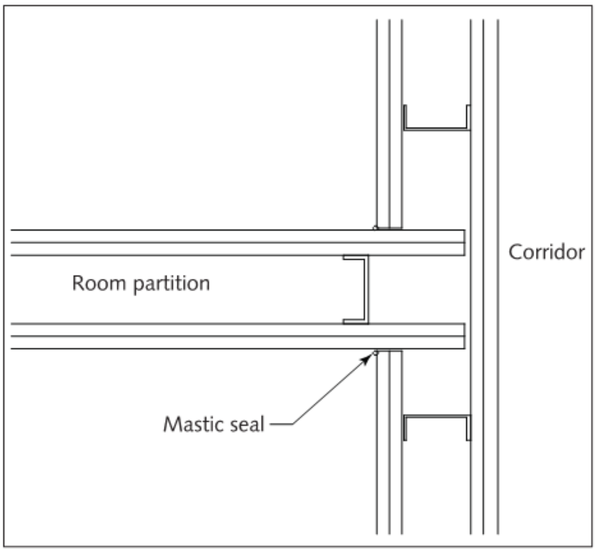
- The inner layers of the external walls should not be continuous across the separating walls and separating floors.
- The void (if any) within the external wall system at the line of the separating wall or separating floor should be closed with a flexible mineral wool closer.

Depending on the external wall construction it may not prove possible to break in the inner leaf of the external walls. As such, under these circumstances it is considered a minimum the installation of a plasterboard wall lining to the external wall areas. Any gaps at the head and base should be minimised, with any remaining gaps being well sealed with non-setting mastic.

### 7.5.3. Junction of a Separating Wall with a Corridor Wall

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

FIGURE 11: TYPICAL SCHEMATIC DETAIL AT JUNCTION OF ACOUSTIC PARTITIONS WITH CORRIDOR WALLS




### 7.5.4. Beams and Columns

Any steel or concrete beams or columns bridging acoustically rated separating constructions will require special attention. Wall boards should not be in direct contact with any beams or columns. The important principles to be followed for columns are as follows:

- Any columns that are on the line of the separating wall must be integrated so they do not act as a bridge through the wall for sound transmission. It is important to ensure that the gypsum lining is not fixed directly to the columns, and to provide some resilience between the column and the separating wall structure. This is usually achieved by providing 30 mm of dense mineral wool board around the column.
- Any steel columns should be boxed out with 2 layers of 15mm dense plasterboard and the void packed full with dense mineral wool;

The important principles to be followed for beams are as follows:

- Continuous beams across separating walls should be avoided where possible;
- Beams should be boxed out with two layers of 15mm dense plasterboard and the void packed full with dense mineral wool;
- The separating partitions should be carefully installed around the beams prior to boxing out, with any gaps packed with mineral wool and non-setting mastic.

### 7.5.5. Penetrations and Integration of Services

*Routing Services Through or Near Acoustically Sensitive Spaces*

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

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

If the proposals are likely to include the provision of MVHR and extract fan units within the ceiling voids, depending upon the specification of the units, it may be necessary to include acoustic shrouding to the main units, or for the units to be boxed out within the ceiling void in order to minimise noise transfer into the room served.

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

### *Service Distribution and Service Penetrations*

In practice, improper sealing is one of the most common and significant causes of failure to achieve the sound insulation performance requirement. Therefore, it is strongly recommended that where possible penetrations through acoustically rated partitions between acoustically sensitive areas should be avoided. Good practice dictates that where services are required to enter sensitive rooms from common areas, the services should be routed to enter above the room entrance doors. Where other penetrations of separating walls cannot be avoided, suitably robust detailing must be employed.

Penetrations which occur where ducts and pipes pass through acoustically rated partitions are to have flexible, airtight seals to prevent the transmission of vibration into the structure and to maintain the sound insulation performance of the sound insulating element. This is achieved by forming a penetration which leaves a gap of approximately 15 mm around the duct or pipe, packing the gap tightly with mineral fibre and caulking the perimeter from both sides, using non-hardening sealant.

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

The recommendations and requirements for acoustic sealing should be coordinated with the requirements for fire protection of penetrations and for the sealing of plenum voids. Indicative services penetration details can be found in Appendix D.

### *Cross Talk Attenuation*

Control of ‘crosstalk’ (noise from one room entering a duct and being transmitted through the duct to another room), will be needed where ducts connect “private”, “confidential” or “sensitive” rooms. Crosstalk attenuation may be provided by proprietary attenuators in the ducts or internally-lined acoustic flexible duct. Ducts serving adjacent acoustically sensitive rooms should be routed via the circulation spaces and not directly room-to-room, to reduce the requirements for crosstalk attenuation.

HTM-08-01 examples of a recommended and no recommended layouts for ductwork distribution and crosstalk attenuators are presented below.

FIGURE 12: TYPICAL ROOM LAYOUT WITH MAIN DUCT PENETRATING ACOUSTIC PARTITIONS

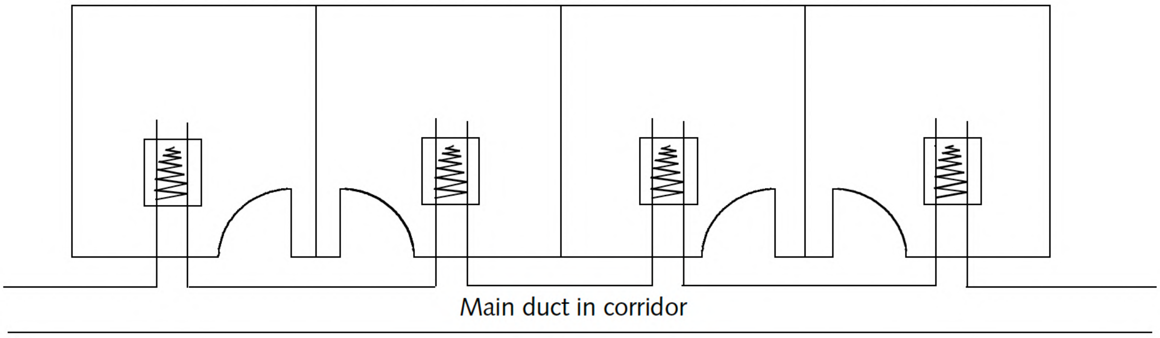



FIGURE 13: TYPICAL ROOM LAYOUT WITH ROOMS BOTH SIDES OF CORRIDOR DUCT

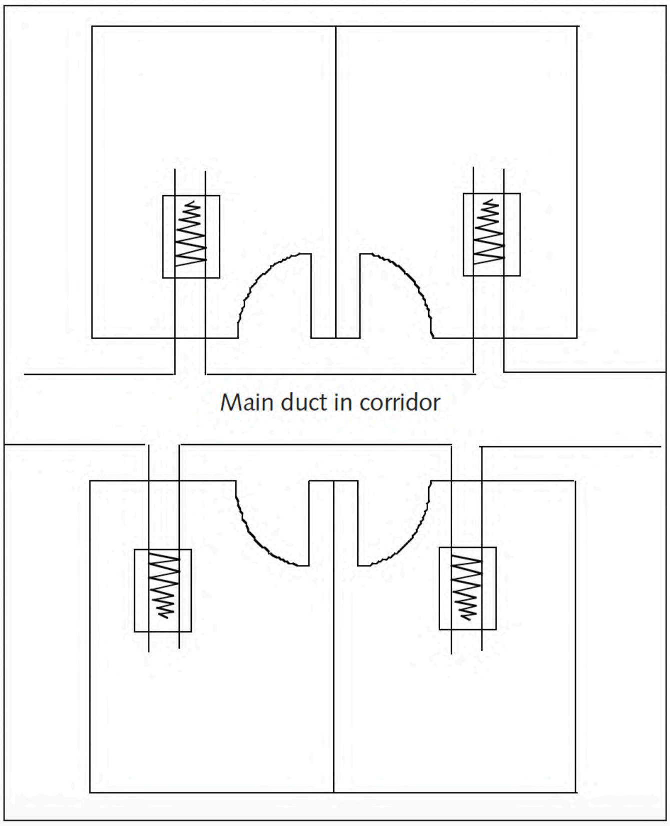
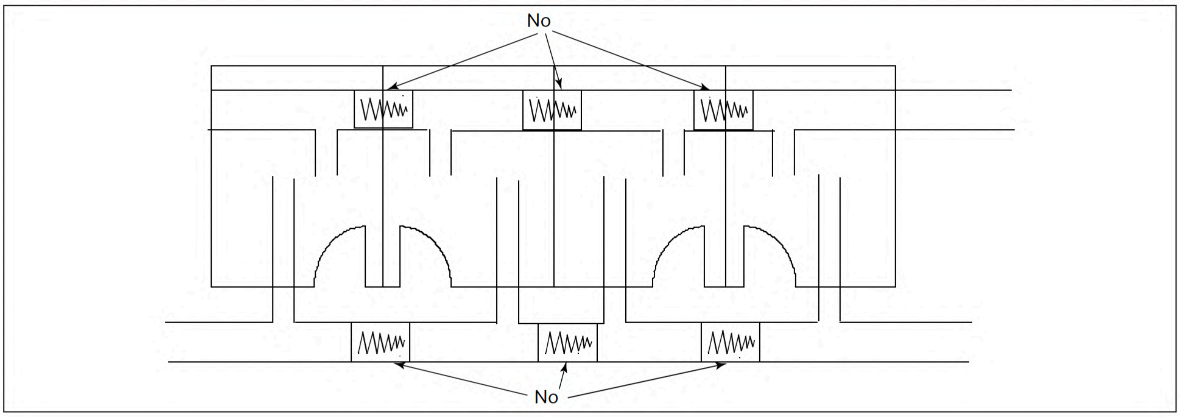


Figure 14: Layout Showing Attenuators in Series – Not Recommended




*Socket Penetrations*

Socket penetrations within separating walls should be avoided wherever possible. If socket penetrations are unavoidable on separating walls, back-to-back sockets should be avoided, with sockets staggered by at least one stud dimension.

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

- Option 1 – Plasterboard boxing

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

- Option 2 – Hilti Putty Pads

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

If back-to-back socket penetrations or service penetrations are unavoidable, then we would generally advise that a sacrificial lining is introduced on to one side of the separating wall, with a layer of 25mm mineral wool with the void.

*Integration of Light Fittings*

It is important that the plasterboard sound insulating ceilings are not penetrated for services such as light fittings etc, and that any items such as drop rods are acoustically sealed as they pass through the ceiling.

Puncturing the ceiling for light fittings may compromise its sound insulation performance. We would recommend for light fittings to be encased (boxed in) to maintain the acoustical integrity of the ceiling at areas where the sound insulation requirement is equal or above above 60 dB $R_{,w}$.

### *Pipework Runs*

#### Vertical Sacks

Where Soil Vent Pipework and/or Rain Water Pipework penetrates separating floors within the noise sensitive rooms, these pipes should be boxed in using 2 layers of 12.5mm plasterboard with a 25mm (un-faced) mineral wool quilt within the cavity in addition to a fire-stopping layer at floor level (penetration through this layer should be flexible).

#### Horizontal Pipe Runs

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

a) In the first instance, noise problems can often be avoided by zoning bends and horizontal runs away from sensitive rooms.
b) There is very little, if any, accurate research on the acoustic performance of pipes. However, the limited information available suggests that cast iron pipes or composite type pipes (e.g. Friaphon) have a better acoustic performance than standard PVC pipes. We would therefore advise the pipework for horizontal runs be of the cast iron or a composite (sound attenuated) type. Plumbing consideration permitting, any change in pipe type should occur at least one floor level above the vertical – horizontal transition.
c) The pipework should be wrapped with 50mm thickness mineral wool (10kg/m$^3$ minimum).
d) The pipework should then be independently boxed with two layers of 12.5mm SoundBloc, the standard ceiling introduced below.

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

#### Service Risers

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

## 8. Room Acoustics

HTM-08-01 does not impose a requirement to achieve a specific predetermined mid-frequency reverberation time within healthcare accommodation. However, it does indicate that as a minimum, rooms should be provided with the equivalent of Class C absorption (as defined in BS EN ISO 11654:1997) to a minimum of 80% of the floor area of the room, along with the absorption provided by other finishes in the space (such as wall and floor finishes).

This is applicable to all areas (including corridors), except acoustically unimportant rooms (for example storerooms etc.), where cleaning, infection-control, patient-safety, clinical and maintenance requirements allow. Washable, acoustically-absorbent materials will be required in some areas within the infection-control regime.

Our calculations show that the above outline recommendation from HTM-08-1 of Class C absorption to an 80% of the floor area will provide satisfactory reverberation control even on rooms with acoustically hard floor finishes, such as vinyl. For rooms with acoustically soft finishes such as carpet, the Class C absorption can be reduced to 40-50% of the floor area.

As an exception, in order to achieve better acoustic conditions for its intended use, it is recommended that the Meeting Room on the Second Floor is provided with a Class A absorption to at least 80% of the floor area if hard floor finishes are used, and 50% if carpet is used.

In addition, in order to reduce the reverberant noise build-up within the MRI Scanner Rooms, CT Scanner Rooms and Generator Room, it is recommended that a Class A absorbent ceiling is also installed underneath the sound insulated plasterboard ceiling also proposed in Section 7.4.

Specific to Audiology Rooms used for Sound Field Testing, BSA recommends that the room should have low reverberation times below 0.25s (HTM2045, 1996). In order to achieve this, the floor should be fitted with carpet and a Class A acoustic ceiling should be installed underneath the plasterboard ceiling. In addition, at least 10m$^2$ of Class A sound absorbent wall panels should be distributed on the walls.

# 9. VIBRATION

### 9.1.1. Continuous Vibration

HTM-08-01 sets that continuous vibration should be assessed in terms of the root mean square (RMS) value (averaged over one second) of the frequency-weighted acceleration on the floors of occupied areas. The base value of frequency-weighted acceleration is 0.005 $ms^{-2}$.

Multiplying factors relative to the specified base values are found by dividing the weighted RMS acceleration by the base value. Multiplying factors for different types of accommodation corresponding to a low probability of adverse comment are as follows:

TABLE 19: MULTIPLYING FACTORS FOR CONTINUOUS VIBRATION

| Type of accommodation | Multiplying factor (RMS/0.005 $ms^{-2}$) |
|---|---|
| Precision laboratory, audiometric testing booth | 1 |
| General laboratories, treatment areas | 4 |
| Offices, consulting rooms | 8 |

### 9.1.2. Intermittent Vibration

HTM-08-1 states that intermittent vibration may conservatively be assumed to be continuous.

Alternatively, if the duration and frequency of occurrence of events are known, the vibration dose value (VDV) may also be used. VDV values corresponding to a low probability of adverse comment for different types of accommodation are given below.

TABLE 20: VIBRATION DOSE VALUES ($MS^{-1.75}$) LIMITS FOR LOW PROBABILITY OF ADVERSE COMMENT

| Type of accommodation | Vibration Dose Values ($ms^{-1.75}$) |
|---|---|
| General laboratories, treatment areas | 0.4 $ms^{-1.75}$ |
| Offices, consulting rooms | 0.8 $ms^{-1.75}$ |

In the case of precision laboratories, it is not appropriate to make allowance for intermittent events, and the maximum frequency-weighted acceleration should be within the limits set for continuous vibration.

### 9.1.3. Vibration Control Strategy of M&E Plant

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

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

CHP units (if any), AHUs (if any), fans, pumps, and other rotating and reciprocating plant should be fitted with efficient anti-vibration mountings. Antivibration mount type and minimum static deflection should follow specifications in Table 4.56 'Vibration isolation selection chart' from CIBSE Guide B4, depending on the type of plant and floor span.

Plant mounted on anti-vibration mountings should be isolated by flexible connections from ducts, pipes and conduits. Ductwork and pipework in plantrooms, and ductwork and pipework in contact with structures bounding noise sensitive areas will need to be supported on anti-vibration hangers.

### 9.1.4. Vibration-sensitive equipment – MRI and CT Scanners

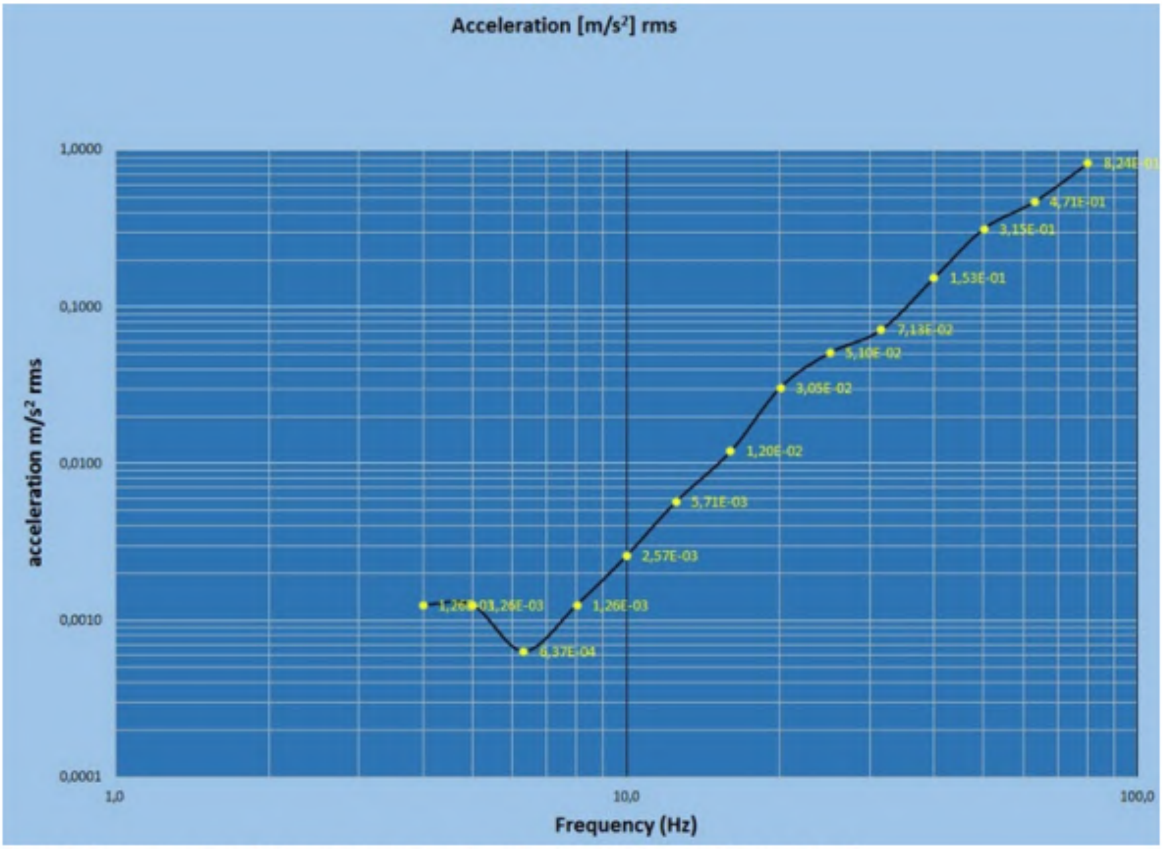
HTM-08-01 advises that some specialist medical equipment (for example scanners and some microscopes) is particularly sensitive to vibration, and that the suitability of a proposed site for such equipment should be specifically addressed, since meeting the vibration criteria above does not guarantee that such equipment will not be affected by vibration.

Specific to this development, floor vibration can affect the stability of the magnetic field of the MRI scanners and CT scanners, which leads to poor image quality.

There are no specific British or International Standards that set specify vibration limits for medical imaging equipment. It is recommended that limits are set with reference to vibration performance requirements supplied by the manufacturer of the equipment, with regards to the likely sources of vibration affecting the site, which might include footfalls, plant, nearby vehicular traffic or railways, loading, unloading.

As an example only, the following maximum allowed acceleration has been provided by Phillips for their Ambition 1.5T MRI.

FIGURE 15: MAXIMUM ALLOWED ACCELERATION FOR PHILLIPS AMBITION 1.5T MRI AS AN EXAMPLE




As an alternative to specific manufacturers' vibration limits, vibration criterion curves can be set in accordance with Chapter 48 of the 2015 ASHRAE handbook, which provide guidance for maximum vibration on the structural surface supporting the human body or the sensitive equipment, which is also reproduced in BS 5228-2:2009+A1:2014[5]

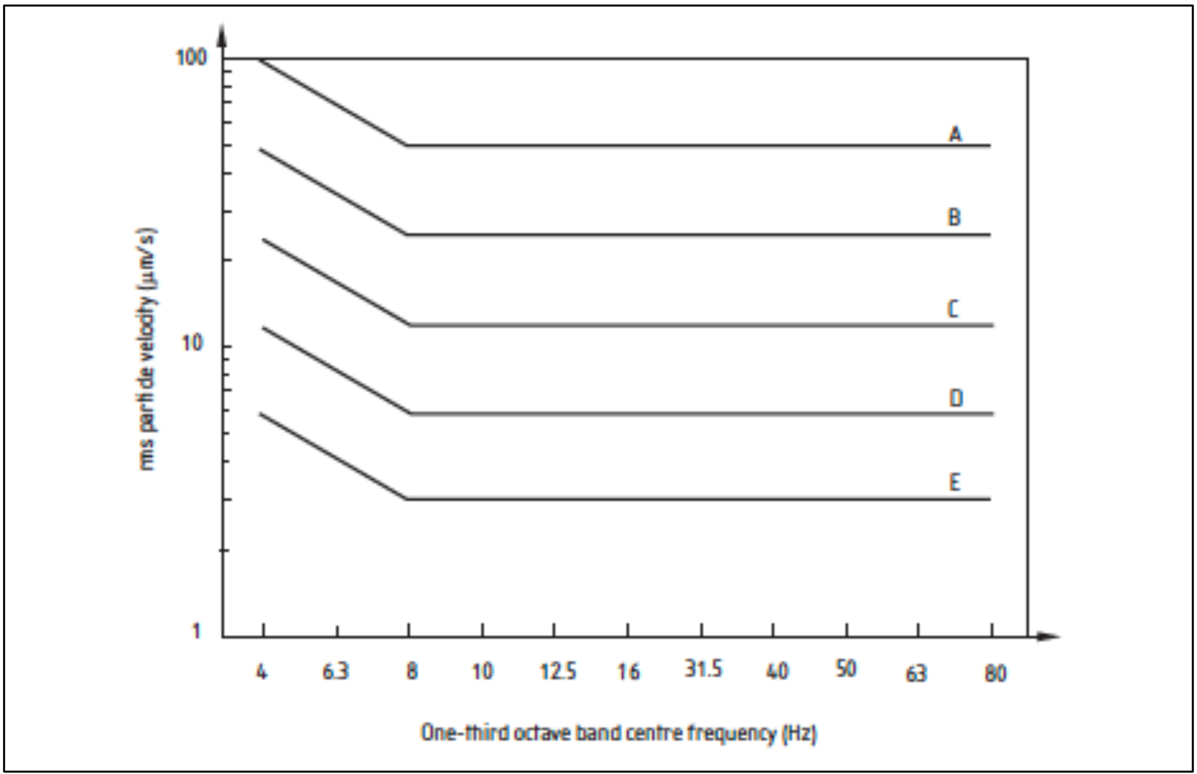
TABLE 21: HUMAN COMFORT AND EQUIPMENT VIBRATION CRITERIA - ASHRAE

| VC Curve | Facility, equipment or use | rms vibration velocity (μm/s) |
|---|---|---|
| VC-A | Bench microscopes at up to 400× magnification; optical and other precision balances; coordinate measuring machines; metrology laboratories; optical comparators.<br>Microelectronics manufacturing equipment – Class A: Inspection, probe test, and other manufacturing support equipment. | 50 |
| VC-B | Micro surgery, eye surgery, neurosurgery; bench microscopes at magnification greater than 400×; optical equipment on isolation tables.<br>Microelectronics manufacturing equipment – Class B: aligners, steppers, and other critical equipment for photolithography with line widths of 3 μm or more. | 25 |

[5] Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration, BSI 2014

| | | |
|---|---|---|
| VC-C | Electron microscopes at up to 30 000× magnification; microtomes; magnetic resonance imagers. Microelectronics manufacturing equipment – Class C: aligners, steppers, and other critical equipment for photolithography with line widths of 1 µm. | 12 |
| VC-D | Electron microscopes at greater than 30 000× magnification; mass spectrometers; cell implant equipment. Microelectronics manufacturing equipment – Class D: aligners, steppers, and other critical equipment for photolithography with line widths of 0.5 µm; includes electron-beam systems. | 6 |
| VC-E | Microelectronics manufacturing equipment – Class E: aligners, steppers, and other critical equipment for photolithography with line widths of 0.25 µm; includes electron-beam systems; un-isolated laser and optical research systems. | 3 |

Figure 16: Example of vibration criteria – VC Curves from ASHRAE and BS5228




Please note that the criterion in the ASHRAE and BS5228 Curves is given in terms of the rms velocity, while most MRI manufacturers state acceleration limits. Therefore, a conversion from acceleration to velocity if necessary to compare the two set of criteria.

The results of the site vibration survey presented in Table 25 and Table 26 in Appendix C show that the maximum 1-minute sample measured do not exceed the VC-C curve at N&V1 and VC-E at N&V2, which suggest that the site might be suitable for magnetic resonance imagers and other similar sensitive equipment. Regardless, it might be recommended that MRI scanners are supported on antivibration mounts to avoid potential vibration from building plant or footsteps, and also to attenuate vibration transmission from the scanner itself towards other sensitive areas of the building.

Table 25 and Table 26 in Appendix C present the tabulated measurement results for the maximum 1-minute sample measured at each 1/3 octave frequency band. It is the responsibility of the selected MRI and CT Scanner suppliers to confirm whether measured values meet the requirements of the specific equipment. Higher resolution vibration measurements in 100ms periods are also available if required by the supplier.

### 9.1.5. Generator Room

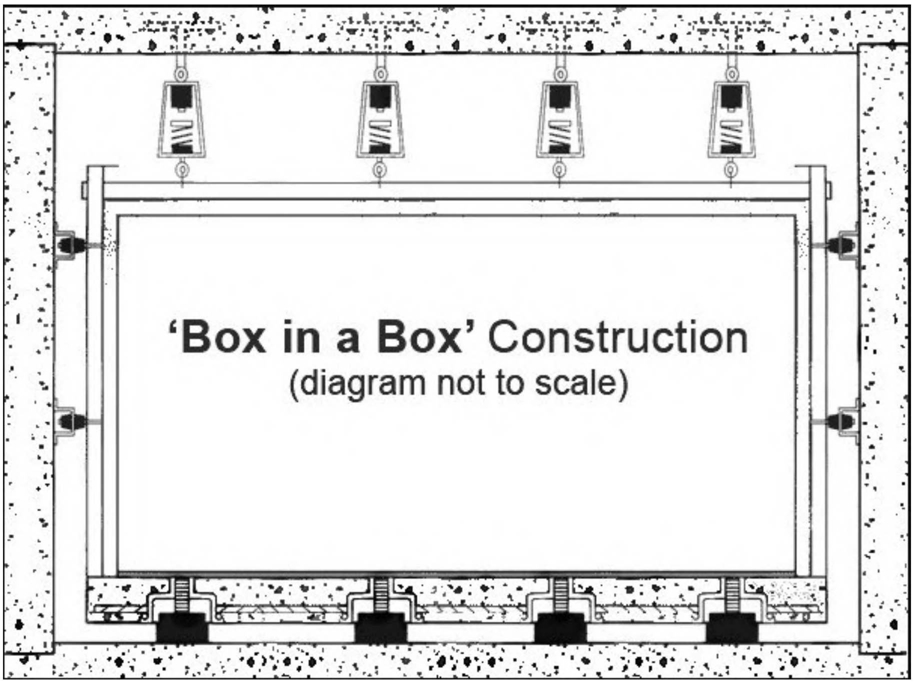
The proposed Generator Room at Ground Floor has the potential to generate high levels of vibration and noise, both airborne and structural. Although the generator is for emergency use only, it needs to run periodic tests, generating vibration levels that might compromise the use of high-sensitive vibration equipment such as the MRI Scanners and CT Scanners.

Although the location of the Generator Room has been optimised to avoid highly sensitive adjacent uses, structural noise and vibration from the Generator can be transmitted not only to the rooms adjacent and above, but to the rest of the building via structural elements, and therefore a high sound and vibration insulation is required.

In this case, a 'Box-in-a-box' system is proposed for the Generator Room, where the inner layers of the room are acoustically decoupled from the building structure.

The typical configuration of a 'Box in a Box' construction can be seen in Figure 17.

FIGURE 17: TYPICAL 'BOX IN A BOX' CONSTRUCTION



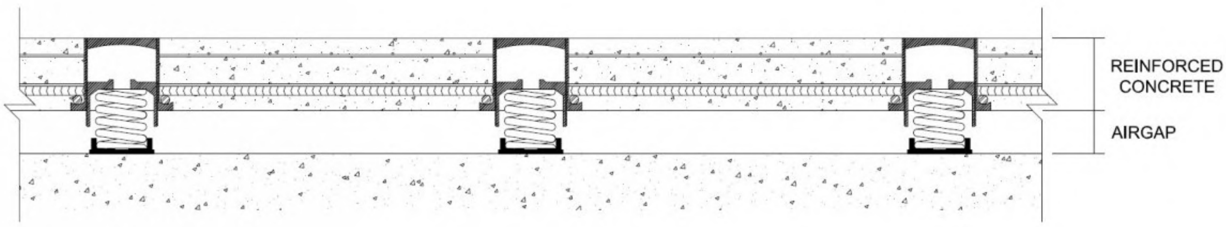
*Acoustic Floating Floor*

The floating floor system shall consist of a 100mm thick concrete slab isolated from and supported 50mm above the structural slab by metal spring isolators with neoprene pads within cast iron housings designed to jack up the floor after pouring on the sub-floor, based on a Mason UK Jack Up Floating Floor or equivalent system.

The floating floor slab shall be isolated from adjoining walls, columns and corners by means of perimeter isolation. Any floor drains, piping, conduit and duct penetrations must not short circuit the isolation system.

A detail of a typical jack up Floating Floor is presented below:

FIGURE 18: TYPICAL FLOATING FLOOR CONSTRUCTION




*Acoustic Ceiling*

The acoustic ceiling underneath the upper concrete slab should comprise the following:

- Metal frame supported on spring hangers with a natural frequency of 4Hz, such as Mason UK HDQF-X or equivalent;
- 200mm cavity filled with at least 100mm mineral wool;
- 2x15mm high density plasterboard (13 kg/m$^2$)

The acoustic ceiling boards and channels should not be in rigid contact with the structural walls.

*Acoustic Wall Lining*

Blockwork base walls should be lined with 2 layers of 15mm high density plasterboard (13 kg/m$^2$) on independent 70mm metal studs with 50mm Isover Steel Frame Infill Batts cavity insulation.

This internal wall lining should be installed on the floating floor system and be independent from the blockwork wall or supported using acoustic wall ties such as Mason UK DNSB or equivalent. The lining should be built up to the acoustic ceiling and not being rigidly connected to the upper slab.

*Acoustic Door*

A high-performance acoustic door should be installed to give access to the Generator Room. The doorset should include proprietary acoustic seals around the whole perimeter (incl. threshold). The minimum sound reduction performance of the doorset (including glazing if present) should be in the order of 45 dB $R_w$.

# 10. INTERNAL NOISE FROM MECHANICAL AND ELECTRICAL SERVICES

HTM-08-01 sets internal noise limits from mechanical and electrical service. The criteria refer to the total noise from mechanical and electrical services (including rainwater pipes draining under “moderate” rainfall conditions, noise from plantrooms and from plant areas in other parts of the building or site), excluding medical equipment. The noise rating (NR) should take account of the noise in the octave band range from 63 Hz to 4 kHz.

Plant should be selected by the building services engineers to meet the internal noise levels presented in Table 22, also presented in the mark-ups in Appendix E.

TABLE 22: CRITERIA FOR INTERNAL NOISE FROM MECHANICAL AND ELECTRICAL SERVICES

| Floor | Room Name | HTM-08-01 Classification | Criteria for noise from Mechanical and Electrical services (NR) |
|---|---|---|---|
| GF | Ultrasound 1 | Treatment room | NR35 |
| GF | Ultrasound 2 | Treatment room | NR35 |
| GF | Ultrasound 3 | Treatment room | NR35 |
| GF | Ultrasound 4 | Treatment room | NR35 |
| GF | Phlebotomy/POCT | Treatment room | NR35 |
| GF | Domestic Services | Clean utility | NR40 |
| GF | Independent Wheelchair WC | Toilets (no cubicles) - Public areas | NR45 |
| GF | Dirty Utility | Dirty utility-sluice | NR40 |
| GF | Ambulance WC | Toilets (no cubicles) - Public areas | NR45 |
| GF | Sub-Wait | Waiting (small ≤20people) | NR40 |
| GF | MRI Wait | Waiting (small ≤20people) | NR40 |
| GF | Interview | Interview room | NR35 |
| GF | Changing Places | Toilets (no cubicles) - Public areas | NR45 |
| GF | MRI Scanner 1 | Examination room | NR35 |
| GF | Tech Room MRI 1 | Laboratories | NR40 |
| GF | Control Room MRI | Laboratories | NR40 |
| GF | MRI Scanner 2 | Examination room | NR35 |
| GF | Tech Room MRI 2 | Laboratories | NR40 |
| GF | Consultation 1 | Consulting room | NR35 |
| GF | Consultation 2 | Consulting room | NR35 |

| Floor | Room Name | HTM-08-01 Classification | Criteria for noise from Mechanical and Electrical services (NR) |
|---|---|---|---|
| GF | Server Room | Clean utility | NR40 |
| GF | Independent Wheelchair Change | Toilets (no cubicles) - Public areas | NR45 |
| GF | MRI Circulation | Corridor (no door) | NR40 |
| 1F | Lung Function 1 | Consulting room | NR35 |
| 1F | Lung Function 2 | Consulting room | NR35 |
| 1F | Sleep | Consulting room | NR35 |
| 1F | Multi-Purpose 1 | Consulting room | NR35 |
| 1F | Multipurpose 2 | Consulting room | NR35 |
| 1F | Pacemaker 1 | Consulting room | NR35 |
| 1F | Pacemaker 2 | Consulting room | NR35 |
| 1F | First Floor Reception | Corridor (no door) | NR40 |
| 1F | PM Reporting | Multi-person office (2-4 people) | NR35 |
| 1F | PM Interview | Interview room | NR35 |
| 1F | Clean Utility | Clean utility | NR40 |
| 1F | Echo 2 | Examination room | NR35 |
| 1F | Echo 1 | Examination room | NR35 |
| 1F | Echo Reporting | Multi-person office (2-4 people) | NR35 |
| 1F | ECG Bays | Consulting room | NR35 |
| 1F | CT Scanner 1 | Examination room | NR35 |
| 1F | CT Scanner 2 | Examination room | NR35 |
| 1F | X-Ray Room 1 | Examination room | NR35 |
| 1F | X-Ray Room 2 | Examination room | NR35 |
| 1F | Cannulation | Waiting (small ≤20people) | NR40 |
| 2F | Staff Rest | Rest room | NR35 |
| 2F | Interview/1 person | Interview room | NR35 |
| 2F | Meeting Room | Small meeting room (≤35m2) | NR35 |
| 2F | Interview Room | Interview room | NR35 |
| 2F | Central Store | Storeroom | - |
| 2F | Imaging Reporting | Multi-person office (2-4 people) | NR35 |
| 2F | Staff Change | Toilets (not cubicles) - Staff areas | NR45 |

| Floor | Room Name | HTM-08-01 Classification | Criteria for noise from Mechanical and Electrical services (NR) |
|---|---|---|---|
| 2F | Audiology Room 1 | Examination room | NR25 |
| 2F | Audiology Room 2 | Examination room | NR25 |
| 2F | 1 Person Office | Single-person office | NR35 |
| 2F | Treatment Room 1 | Treatment room | NR35 |
| 2F | Store | Storeroom | - |
| 2F | Workshop | Small meeting room (≤35m2) | NR35 |
| 2F | Imagining Hot Desk | Multi-person office (2-4 people) | NR35 |
| 2F | Shared Admin | Multi-person office (2-4 people) | NR35 |
| 2F | PM Hot Desk | Multi-person office (2-4 people) | NR35 |
| 2F | Audiology Reporting | Multi-person office (2-4 people) | NR35 |
| 2F | Audiology Room 3 | Examination room | NR25 |
| 2F | Treatment Room 2 | Treatment room | NR35 |
| 2F | Treatment Room 3 | Treatment room | NR35 |
| 2F | Treatment Room 4 | Treatment room | NR35 |
| 2F | Treatment Room 5 | Treatment room | NR35 |
| 2F | Treatment Room 6 | Treatment room | NR35 |
| 2F | Audiology Hot Desk | Multi-person office (2-4 people) | NR35 |

The mechanical engineers confirmed that the design intention is to achieve an NR rating of 30 in those audiology rooms using Hybrid Ventilation Units. However, unless purpose-built audiometry booth are installed, the noise from the M&E services should be reduced to an NR25 on those audiology rooms used for sound field testing.

Noise from Mechanical and Electrical services in circulation spaces should not exceed NR40, and in laboratories with fume cupboards, NR60 should not be exceeded at 1m from fume cupboards with open sash.

Noise generated by services should be steady, with no periodic change in noise level or character. Continuous sound generated by services can provide useful masking noise for public areas. It is therefore not advisable to over-attenuate service-noise in these areas. The limits are defined in terms of $L_{90}$ and are to be achieved in the completed building (including normal furniture), although for design purposes it can be assumed that the $L_{eq}$ of plant noise is the same value as the $L_{90}$ for continuously operating plant.

# 11. Environmental Noise Impact at Off-Site NSRs

HTM-08-01 also sets that noise from healthcare premises should be controlled at properties outside the Site. The guidance does not provide specific limiting values but advises that these external criteria should be agreed with the Local Authority.

The standard methodology to assess the impact of sound from industrial and commercial sound in England is BS4142:2014+A1:2019. Where the rating sound level from the premises does not exceeds the prevailing background sound level at the receptor, it is assessed as an indication of 'Low Impact'. A more limiting criteria is required in order to achieve the BREEAM Pol05 acoustic credit. In this instance, rating sound level should not exceed 5dB below the measured background sound levels during the day and night-time periods.

The nearest Noise-Sensitive Receptors (NSRs) are deemed to be potential residential dwellings at the existing commercial building east of the site, as it is understood that the building might be converted to incorporate residential uses in the future.

At this stage of the design, the layouts and plant specifications are still under development, and therefore a noise limiting exercise has been undertaken.

The noise criteria set out in Table 23 are proposed, based on the results of the environmental sound survey undertaken at the Site and the target to achieve BREEAM Pol05 acoustic credit. These limits are based on achieving a rating sound level 5 dB below the typical measured background sound level at the nearest noise sensitive receptor, which would be an indication of 'Low Impact' when assessed in accordance with BS4142. These limits apply to the operating hours of the installation, which are understood to be during the daytime only. However, for information purposes, night-time noise limits are also included, in case some plant remain operational for longer periods.

Table 23: Proposed Plan Noise Rating Limits

| NSR | Operating Period | Measured Background Noise Level $_{LA90,T}$ (dB) | Proposed Plant "Rating Level" $L_{Ar,T}$ (dB) |
|---|---|---|---|
| Any | Daytime (07:00-23:00) | 51 | 46 |
| | Night-time (23:00-07:00) | 49 | 44 |

The above limits apply to the total sound emission level from all static plant and processes within the proposed Development. Individual plant items may need to be designed to a lower limit such that the overall total achieves the stated criteria above. Should the proposed plant items be found to be tonal, or impulsive in nature (so as to attract attention), a penalty correction would likely be applied to the above limits.

Screening of any external plant, as well as provision of sound attenuators to items of plant, may be necessary to control the transmission of sound and achieve the above criteria as well as to reduce the sound level produced by the plant to a reasonable extend around the footprint of the building itself. Environmental attenuators and possibly other means of sound mitigation such as acoustic louvres or acoustic screens may be required to control sound emanating from the plantrooms, air intake and discharge points or from externally mounted plant.

A more specific noise assessment, including 3D noise modelling if deemed appropriate, will be undertaken at RIBA Stage 4 as the M&E design progresses.

# 12. CONCLUSION

inacoustic has been commissioned to undertake an acoustic assessment for the proposed Community Diagnostics Centre (CDC) development at Colin Campbell Court, Plymouth City Centre, PL1 1TZ, to provide design advice at Spatial Coordination RIBA Stage 3.

This acoustic assessment reviews the proposed design layout and provide advice in order to achieve the requirements of HTM-08-01, as well as BREEAM Hea05 and Pol05. The assessment has been informed by a detailed environmental sound and vibration survey undertaken around the Site.

Acoustic design advice has been provided on the following issues:

- Internal noise levels from external sources;
- Internal sound insulation;
- Room acoustics;
- Vibration;
- Internal noise from mechanical and electrical services; and
- Environmental Noise Impact at off-site Noise-Sensitive Receptors.

The following acoustic works should be undertaken at RIBA Stage 4.

- Further development and final review of façade constructions;
- Final review of proposed separating wall and floor constructions;
- Final review of ceiling specifications and details;
- Review of critical junction and penetration details;
- Review of room absorption finishes; and
- Review of building services design proposals and advice on control measures.

# 13. APPENDICES

## 13.1. Appendix A – Definition of Terms

| | |
|---|---|
| Sound Pressure | Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure. |
| Sound Pressure Level (Sound Level) | The sound level is the sound pressure relative to a standard reference pressure of 20μPa ($20 \times 10^{-6}$ Pascals) on a decibel scale. |
| Decibel (dB) | A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 log10 ( s1 / s2 ). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20μPa. |
| A-weighting, dB(A) | The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies. |
| Noise Level Indices | Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out. |
| $L_{eq,T}$ | A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded. |
| $L_{max,T}$ | A noise level index defined as the maximum noise level during the period T. $L_{max}$ is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall $L_{eq}$ noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response. |
| $L_{90,T}$ | A noise level index. The noise level exceeded for 90% of the time over the period T. $L_{90}$ can be considered to be the "average minimum" noise level and is often used to describe the background noise. |
| $L_{10,T}$ | A noise level index. The noise level exceeded for 10% of the time over the period T. $L_{10}$ can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise. |
| Free-Field | Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m |
| Facade | At a distance of 1m in front of a large sound reflecting object such as a building façade. |
| Fast Time Weighting | An averaging time used in sound level meters. Defined in BS 5969. |

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

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

TABLE 24: TYPICAL SOUND LEVELS FOUND IN THE ENVIRONMENT

| Sound Level | Location |
|---|---|
| 0dB(A) | Threshold of hearing |
| 20 to 30dB(A) | Quiet bedroom at night |
| 30 to 40dB(A) | Living room during the day |
| 40 to 50dB(A) | Typical office |
| 50 to 60dB(A) | Inside a car |
| 60 to 70dB(A) | Typical high street |
| 70 to 90dB(A) | Inside factory |
| 100 to 110dB(A) | Burglar alarm at 1m away |
| 110 to 130dB(A) | Jet aircraft on take off |
| 140dB(A) | Threshold of Pain |

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

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

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

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

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

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

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

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

## 13.2. Appendix B – Sound Measurement Results

FIGURE 19: MEASURED TIME HISTORY – MP1

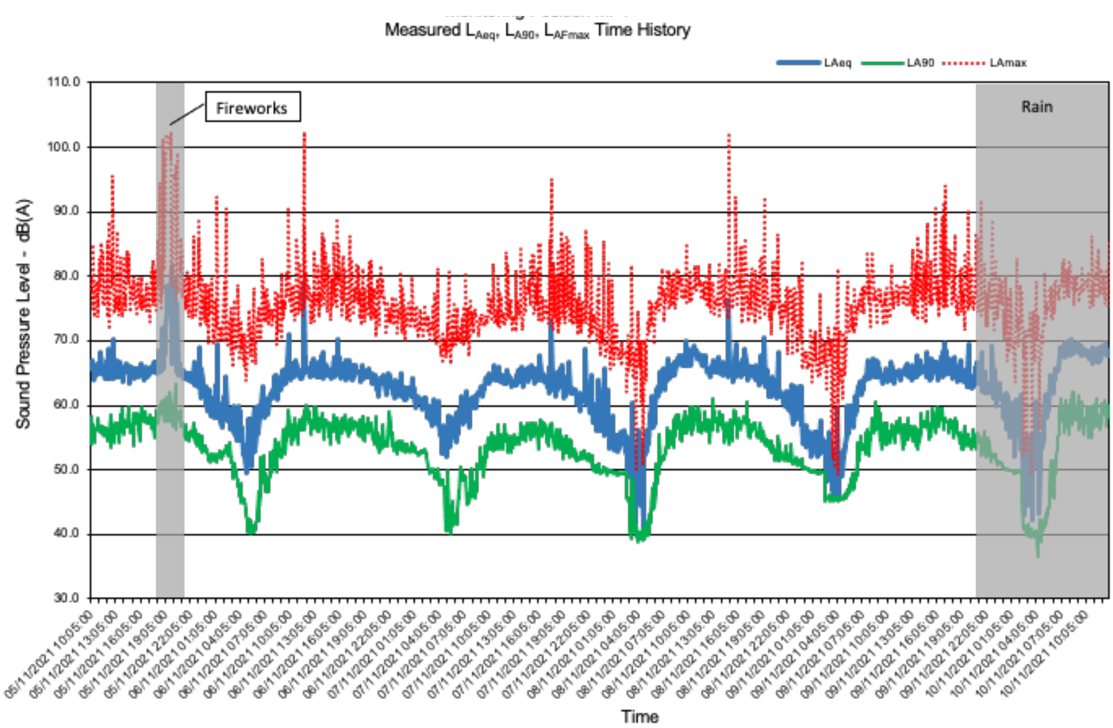
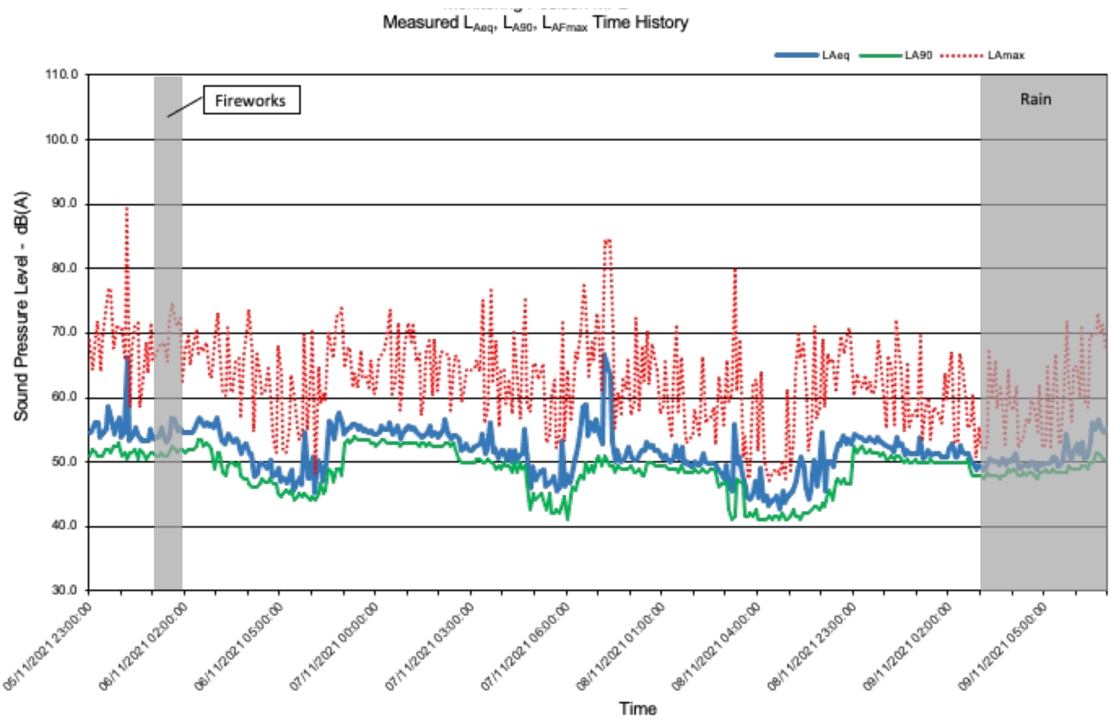


FIGURE 20: MEASURED TIME HISTORY – MP2



## 13.3. Appendix C – Vibration Survey and Updated Noise Survey

### 13.3.1. Updated Noise Survey

Figure 21: Measured Time History – N&V1

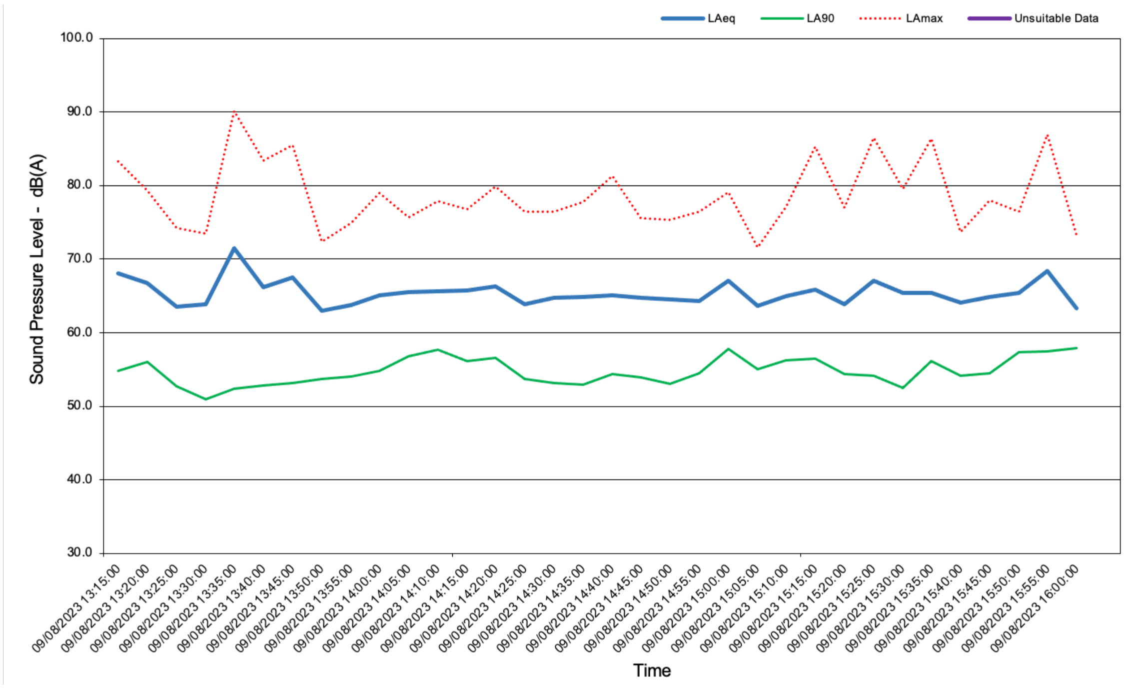
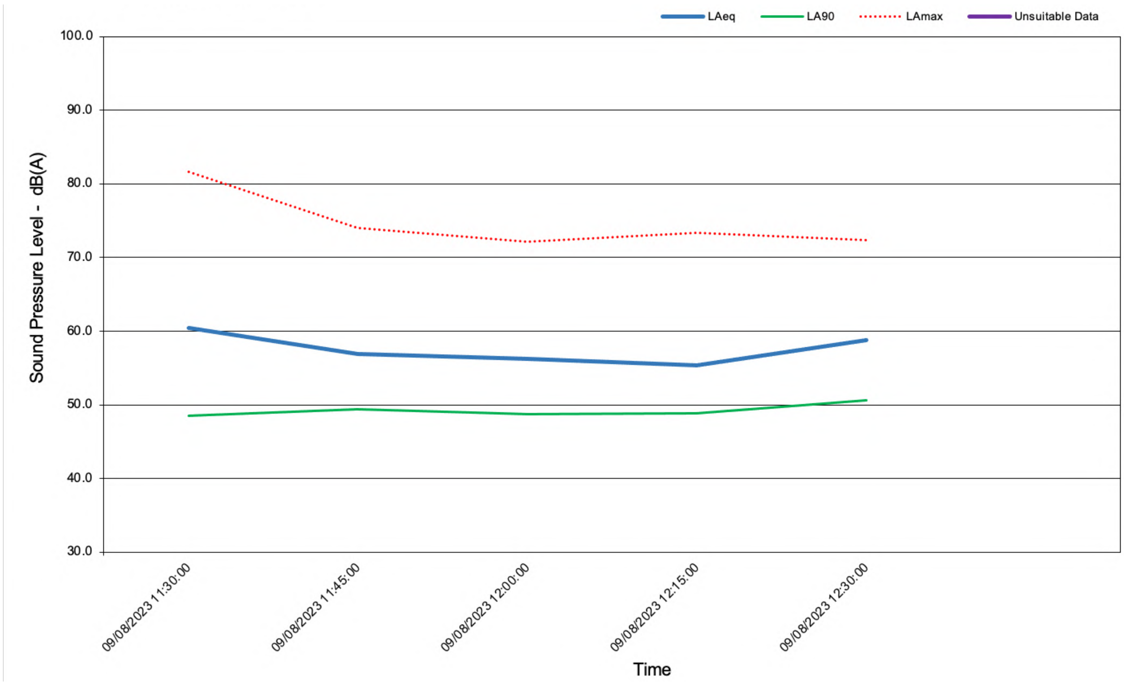



Figure 22: Measured Time History – N&V2



### 13.3.2. Measured Vibration Levels

TABLE 25: MEASURED VIBRATION ACCELERATION AT POSITION N&V1 – HIGHEST 1 MINUTE-SAMPLE

| Frequency (Hz) | X axis (m/s$^2$ rms) | Y axis (m/s$^2$ rms) | Z axis (m/s$^2$ rms) |
|---|---|---|---|
| 1 Hz | 0.00014 | 0.00005 | 0.00006 |
| 1.25 Hz | 0.00011 | 0.00004 | 0.00009 |
| 1.6 Hz | 0.00012 | 0.00003 | 0.00013 |
| 2 Hz | 0.00013 | 0.00004 | 0.00017 |
| 2.5 Hz | 0.00019 | 0.00006 | 0.00021 |
| 3.15 Hz | 0.00014 | 0.00004 | 0.00025 |
| 4 Hz | 0.00021 | 0.00006 | 0.00031 |
| 5 Hz | 0.00016 | 0.00004 | 0.00033 |
| 6.3 Hz | 0.00018 | 0.00004 | 0.00022 |
| 8 Hz | 0.00022 | 0.00007 | 0.00032 |
| 10 Hz | 0.00025 | 0.00007 | 0.00036 |
| 12.5 Hz | 0.00027 | 0.00015 | 0.00034 |
| 16 Hz | 0.00052 | 0.00036 | 0.00031 |
| 20 Hz | 0.00049 | 0.00039 | 0.00059 |
| 25 Hz | 0.00075 | 0.00056 | 0.00098 |
| 31.5 Hz | 0.00078 | 0.00129 | 0.00139 |
| 40 Hz | 0.00083 | 0.00134 | 0.00146 |
| 50 Hz | 0.00105 | 0.00068 | 0.00103 |
| 63 Hz | 0.00126 | 0.00064 | 0.00082 |
| 80 Hz | 0.00234 | 0.00114 | 0.0015 |
| 100 Hz | 0.01184 | 0.00808 | 0.00292 |
| 125 Hz | 0.01363 | 0.00826 | 0.00231 |
| 160 Hz | 0.00214 | 0.00136 | 0.00208 |
| 200 Hz | 0.00053 | 0.00073 | 0.00128 |
| 250 Hz | 0.00012 | 0.00022 | 0.00093 |
| 315 Hz | 0.0001 | 0.00022 | 0.00151 |

TABLE 26: MEASURED VIBRATION ACCELERATION AT POSITION N&V2 - – HIGHEST 1 MINUTE-SAMPLE

| Frequency (Hz) | X axis (m/s$^2$ rms) | Y axis (m/s$^2$ rms) | Z axis (m/s$^2$ rms) |
|---|---|---|---|
| 1 Hz | 0.00003 | 0.00003 | 0.00001 |
| 1.25 Hz | 0.00002 | 0.00002 | 0.00001 |
| 1.6 Hz | 0.00002 | 0.00002 | 0.00001 |
| 2 Hz | 0.00002 | 0.00002 | 0.00001 |
| 2.5 Hz | 0.00001 | 0.00001 | 0.00001 |
| 3.15 Hz | 0.00001 | 0.00002 | 0.00002 |
| 4 Hz | 0.00001 | 0.00001 | 0.00002 |
| 5 Hz | 0.00002 | 0.00002 | 0.00002 |
| 6.3 Hz | 0.00003 | 0.00002 | 0.00002 |
| 8 Hz | 0.00008 | 0.00005 | 0.00002 |
| 10 Hz | 0.00008 | 0.00006 | 0.00002 |
| 12.5 Hz | 0.00011 | 0.00009 | 0.00005 |
| 16 Hz | 0.00013 | 0.00012 | 0.00015 |

| | | | |
|---|---|---|---|
| 20 Hz | 0.00013 | 0.00014 | 0.00037 |
| 25 Hz | 0.0002 | 0.00023 | 0.00051 |
| 31.5 Hz | 0.00017 | 0.00015 | 0.00035 |
| 40 Hz | 0.0002 | 0.00017 | 0.00033 |
| 50 Hz | 0.00019 | 0.00019 | 0.00025 |
| 63 Hz | 0.00018 | 0.00018 | 0.00024 |
| 80 Hz | 0.00018 | 0.00017 | 0.00027 |
| 100 Hz | 0.00048 | 0.00063 | 0.0002 |
| 125 Hz | 0.0027 | 0.00382 | 0.00019 |
| 160 Hz | 0.00049 | 0.00054 | 0.0002 |
| 200 Hz | 0.0001 | 0.00018 | 0.00033 |
| 250 Hz | 0.00005 | 0.00007 | 0.00023 |
| 315 Hz | 0.00004 | 0.00004 | 0.00024 |

FIGURE 23: CALCULATED VC CURVE AT POSITION N&V1 – HIGHEST 1 MINUTE-SAMPLE

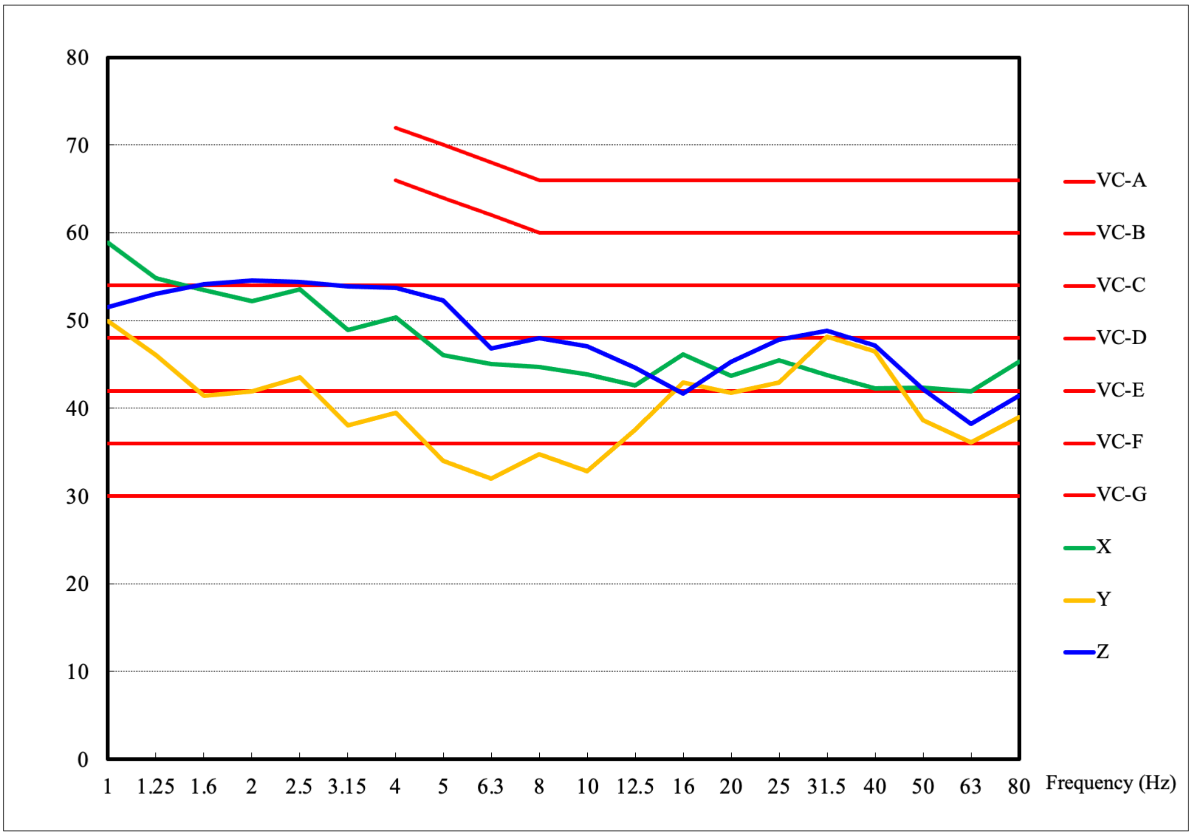
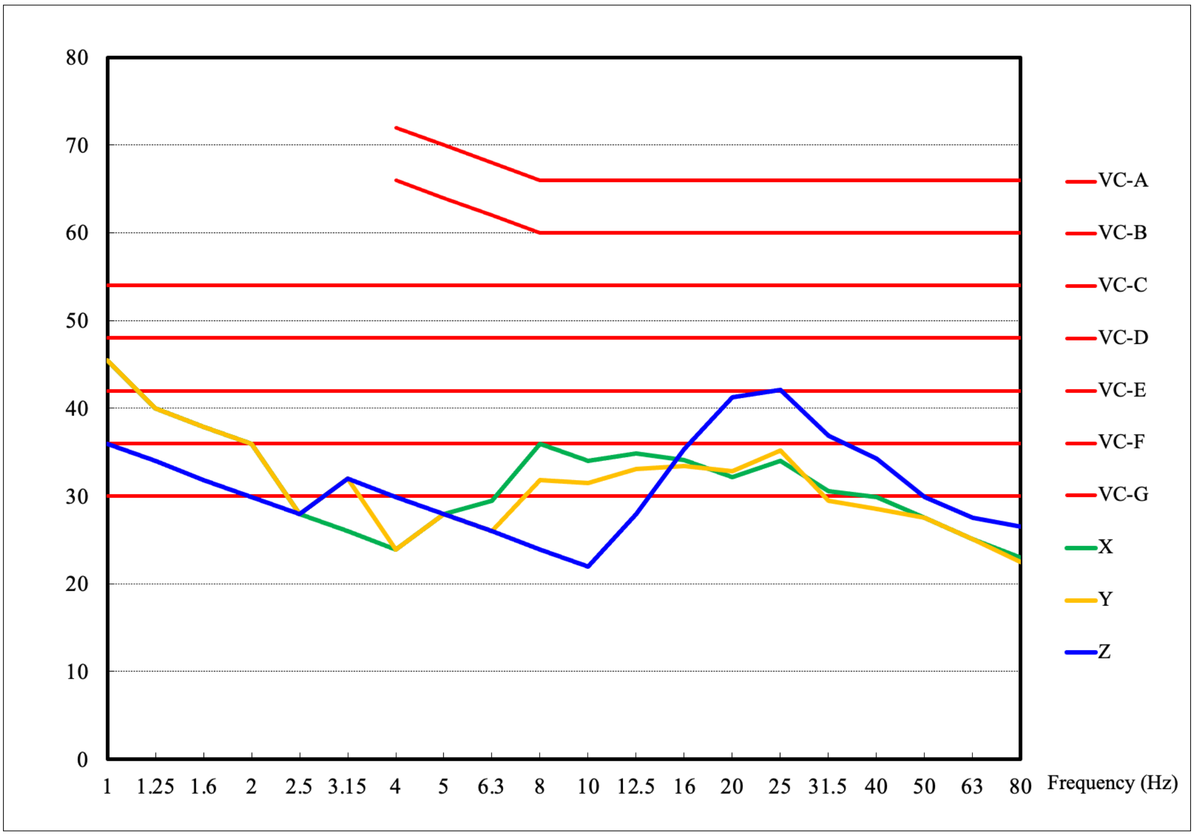


Figure 24: Calculated VC Curve at Position N&V2 – Highest 1 minute-sample



## 13.4. Appendix D - Standard Services Penetration Details

Services that penetrate acoustically rated separating walls or floors or are located within separating walls or floors must be detailed appropriately to ensure that the acoustic performance of the separating construction is not impaired.

The following indicative standard details show general principles that should be adopted when detailing service penetrations in order to maintain the acoustic integrity of the separating structure.

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

FIGURE 25: ELECTRICAL SOCKETS IN SEPARATING WALL

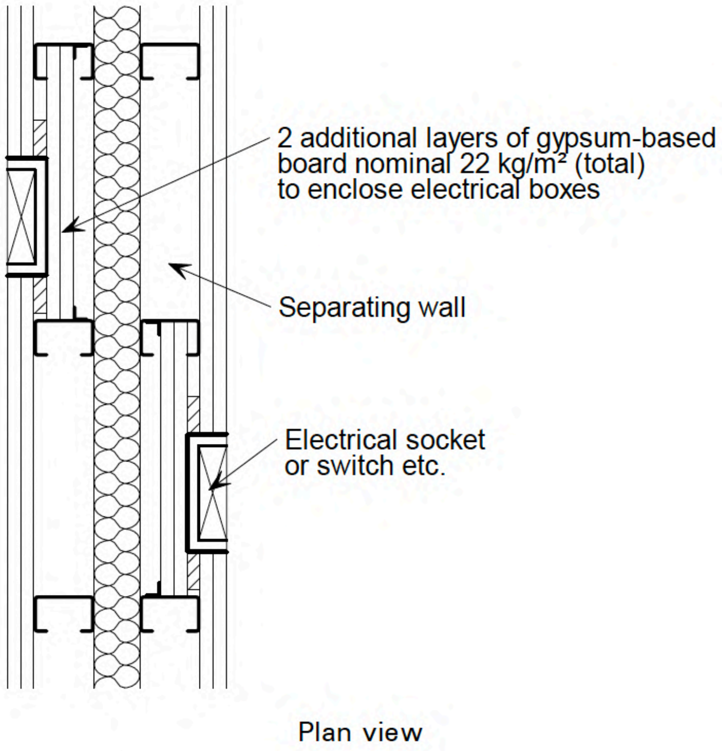


FIGURE 26: PIPED SERVICES IN A SEPARATING WALL

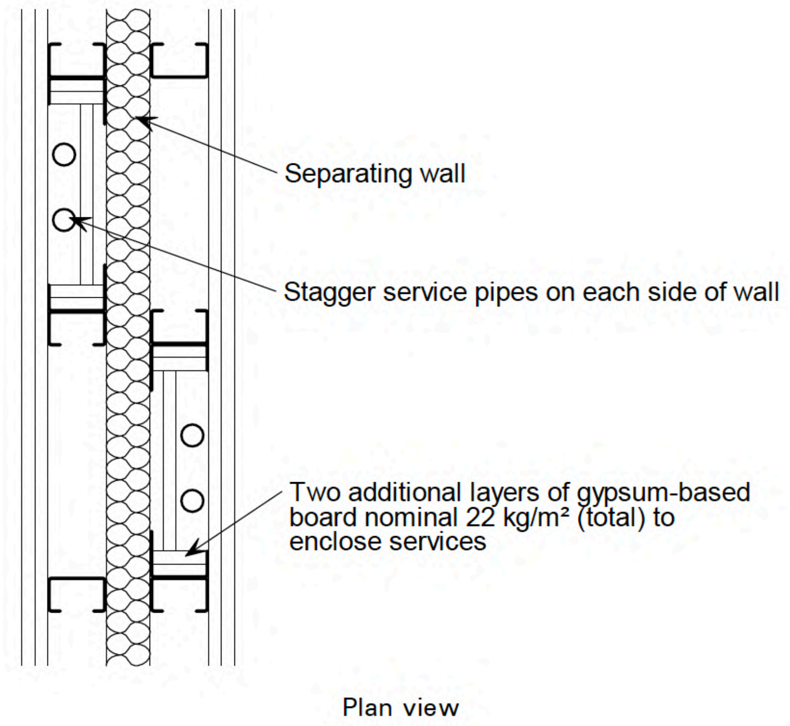



FIGURE 27: SERVICES WITHIN A SERVICE VOID

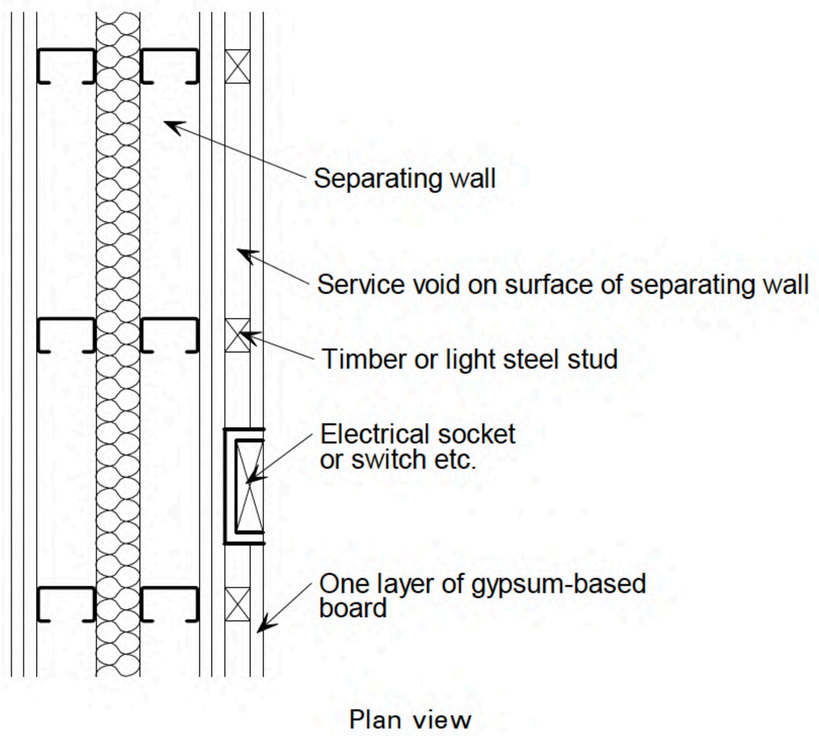
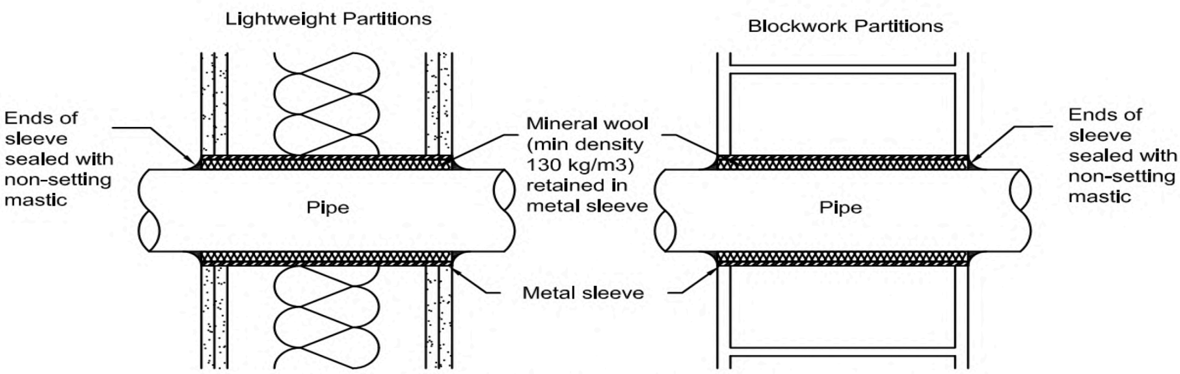
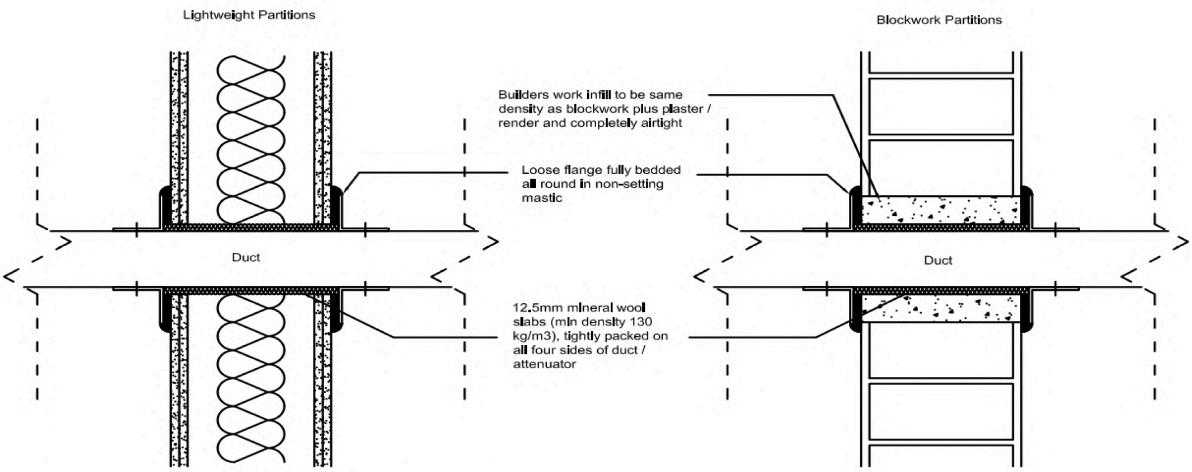


Figure 28: Pipe Penetrating a Separating Wall



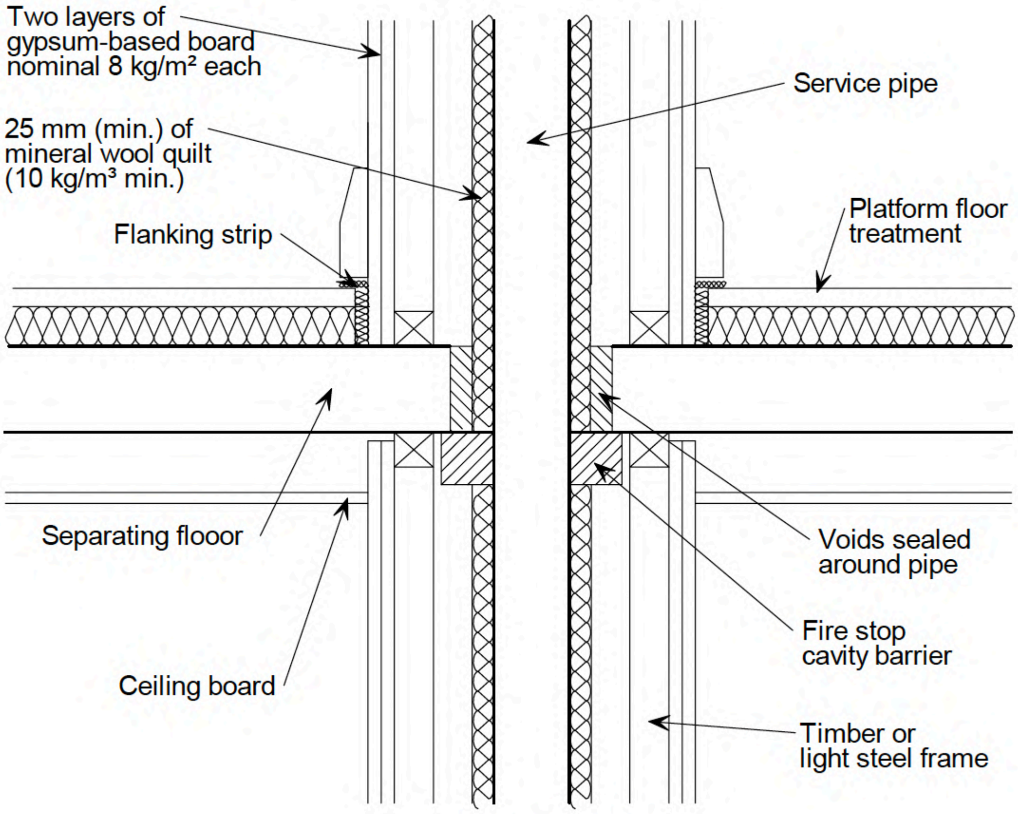

N.B. Large diameter hollow pipes (e.g. RWPs or SVPs) must also be lagged for the full service run. The specification of lagging will vary depending on the sound insulation performance required. In addition, if any pipe penetrations pass directly into a room (e.g. not into a ceiling / floor void), the pipe must be lined with 25mm mineral wool and boxed out with 2 x 12.5mm layers of plasterboard for the entire service run on both sides of the wall through which the pipe passes.

Figure 29: Duct Penetrating a Separating Wall




N.B. If duct penetrations pass directly into a room (e.g. not into a ceiling / floor void), the duct will need to be lined with 25mm mineral wool and boxed out with 2 x 12.5mm layers of plasterboard for the entire service run on both sides of the wall through which the duct passes.

FIGURE 30: SERVICES PENETRATING A SEPARATING FLOOR




Section view

## 13.5. Appendix E – Acoustic Mark-ups

FIGURE 31: GROUND FLOOR – ACOUSTIC MARK-UPS

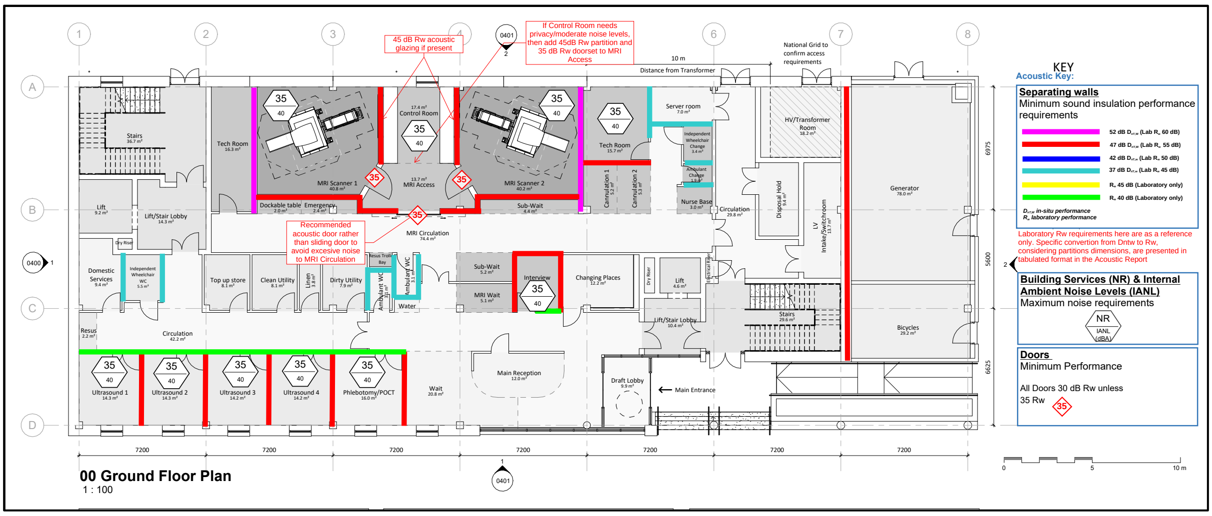



FIGURE 32: FIRST FLOOR – ACOUSTIC MARK-UPS

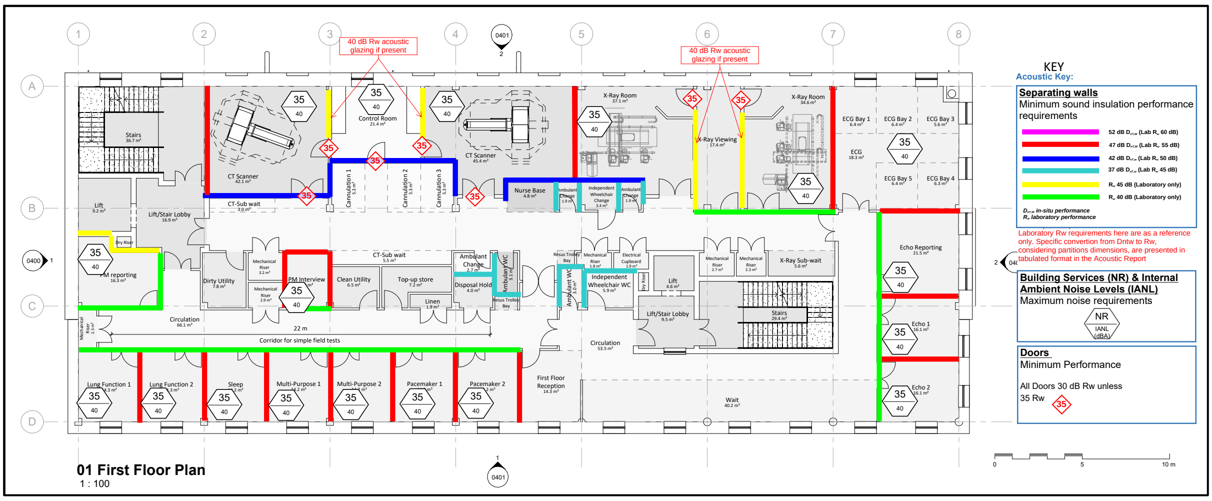


Figure 33: Second Floor – Acoustic Mark-ups