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Kildonan Street, Coatbridge

RIBA Stage 3 Acoustic Design Report

North Lanarkshire Council

1 August 2023

2023/JULY/02

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Document history

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Project	Kildonan Street, Coatbridge
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1. Introduction

1.1. Project Background

North Lanarkshire Council proposes a material change of use of the Municipal Building in Kildonan Street, Coatbridge from office space into residential social rent and office spaces that the Council will maintain and manage.

The main building is Category B listed and consists of one large, amalgamated block comprising three wings: the North Wing to Kildonan Street, the West Wing to Dunbeth Road, and the Police Wing to Muiryhall Street as shown in Figure 1-1. The remainder of the site consists of carparking and a courtyard. Additionally, some areas within the main building are intended to be commercial touchdown office spaces.

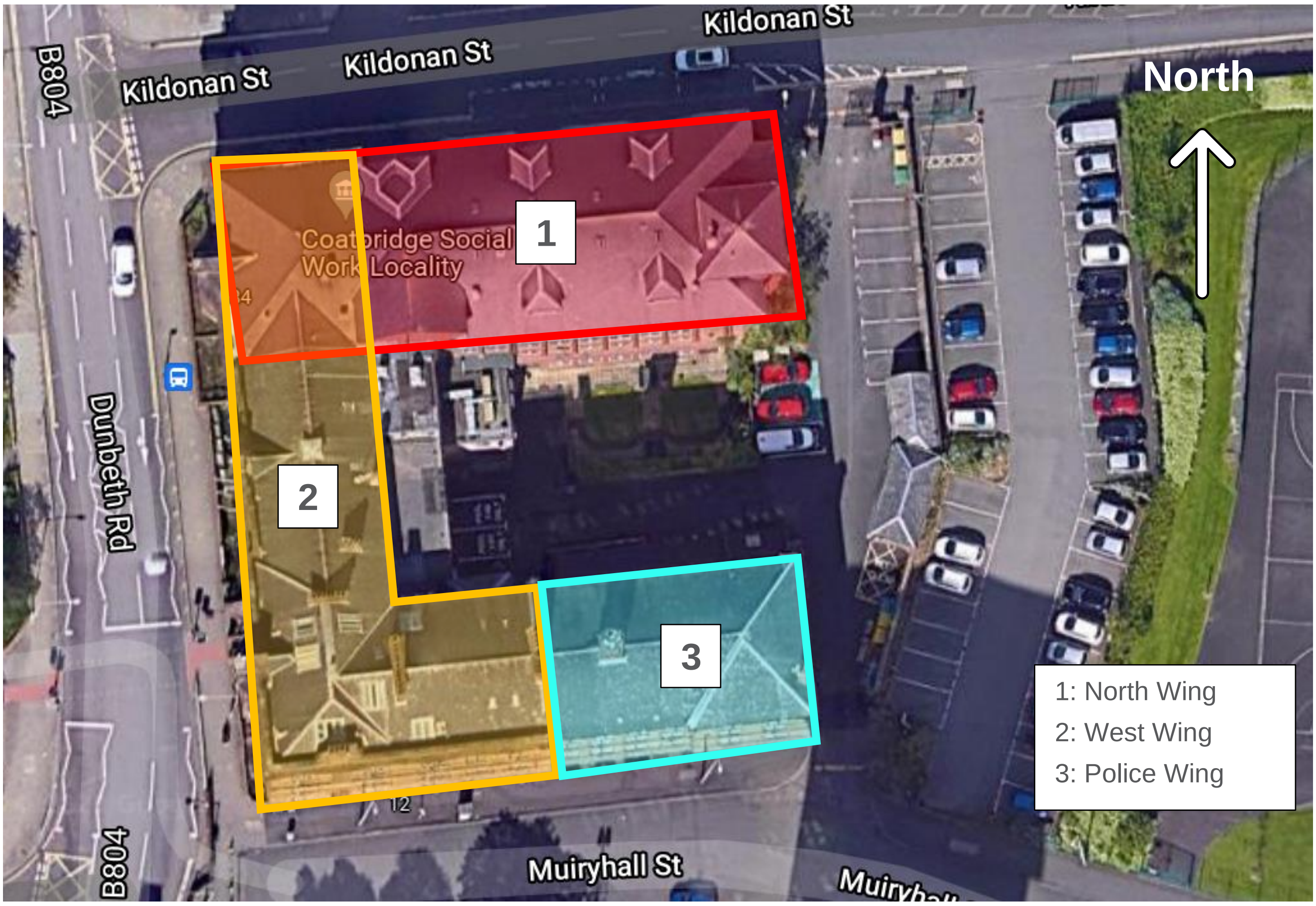

Figure 1-1 - Project aerial view (source: Google Maps)

1.2. Purpose & Scope

Atkins Ltd have been appointed to provide design advice pertaining to acoustics, throughout the RIBA Stages 2 to 5. This report provides RIBA Stage 3 acoustic design advice and includes the following sections:

- Section 1: project overview.
- Section 2: summary of the assessment criteria.
- Section 3: summary of acoustic survey.
- Section 4: external noise impact and indoor ambient noise levels.
- Section 5: internal sound insulation strategy and advice on methods of meeting the requirements.
- Section 6: reverberation time assessment and advice on control strategy.
- Section 7: mechanical building services noise assessments and advice on noise control.
- Section 8: report summary and a list of next steps.

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

2. Acoustic Requirements

The acoustic requirements for the development, with reference to the relevant planning policies, standards and guidance are described in Appendix B. These requirements are summarised below.

2.1. Scottish Statutory Requirements

The Scottish Building Standards technical handbooks provide guidance on achieving the standards set in the Building (Scotland) Regulations 2004. According to the Building Standard document 5. Noise[1], the sound insulation requirements listed below are, in general, mandatory. However, in this case they could be treated as aspirational since Historic and Listed buildings will, prior to conversion, display unique characteristics as far as sound insulation is concerned. The original building design and construction will influence the level of sound insulation achievable for the separating walls and separating floors. For this reason, specific prescriptive guidance on such buildings is not appropriate. The Local Planning Authority (LPA onward) may, at their discretion, agree measures that respect the character of the building.

2.1.1. Sound insulation of separating walls and floors

Sound insulation should be provided where any separating wall or separating floor is formed between areas in different occupation. The required performance levels for conversions of traditional buildings are:

- Minimum 53 dB $D_{nT,w}$ airborne sound insulation and
- Maximum 58 dB $L'_{nT,w}$ impact sound transmission.

It is understood from the building control officer that the development largely falls under conversion, in relation to the Building Regulations. However, new building regulation would technically apply to the new build elements: commercial annex and Police Wing. In this case, the required performance levels for commercial annex and Police Wing are:

- Minimum 56 dB $D_{nT,w}$ airborne sound insulation and
- Maximum 56 dB $L'_{nT,w}$ impact sound transmission.

The above performance levels should be confirmed by post-completion testing.

It should be noted that the airborne insulation results represent a level difference, hence higher ($D_{nT,w}$) figures represent better performance. While impact transmission ($L'_{nT,w}$) results represent the transmitted noise level, hence smaller figures constitute better performance.

2.1.2. Sound insulation of internal walls and intermediate floors

The internal walls and intermediate floors should achieve the following airborne sound insulation performance:

- Minimum 40 dB Rw for internal walls and
- Minimum 43 dB Rw for intermediate floors.

However, according to the Standard, many of the existing wall and floor constructions within a traditional building, will be constructed from materials generally not still in use, for example lath and plaster. In such cases the sound insulation level will not be known, therefore, it is not reasonably practicable for the existing walls or floors to meet the above performance levels.

2.1.3. Sound absorption in common residential areas

Reverberation time in residential common areas should be controlled to minimise the noise arising from activity in these areas. The following criteria are suggested, based on England's Approved Document E:

- For entrance halls, provide a minimum of 0.20 m^2 total absorption area per cubic metre of the volume.
- For corridors or hallways, provide a minimum of 0.25 m^2 total absorption area per cubic metre of the volume.

[1] Building Standards technical handbook 2017: domestic buildings - 5. Noise

2.2. Ambient Noise Level Criteria

The following ambient noise criteria are considered appropriate for the development, based on guidance included in BS 8233:2014. The following criteria refer to outdoor noise ingress and building services' noise combined.

- Daytime internal $L_{Aeq,16\ hour}$ to all habitable rooms no greater than 35 dB (Hours: 07:00-23:00).
- Night-time internal $L_{Aeq,8\ hour}$ to all bedrooms no greater than 30 dB (Hours: 23:00-07:00).
- Night-time internal $L_{Amax,F}$ to all bedrooms no greater than 45 dB[2].
- $L_{Aeq,\ 30\ min}$ from 45 to 50 dB in touchdown office spaces.

It is understood that all dwellings will be provided with a Mechanical Ventilation with Heat Recovery (MVHR onwards) unit. If higher than standard ventilation rates are required (for instance during overheating conditions), it would be considered reasonable to allow higher levels[3] of noise than the criteria presented above.

2.3. Sound Absorption in Office Spaces

Reverberation time in offices should be controlled for clear communication of speech between users in these spaces. To control activity and building services noise build-up, and to provide an appropriate acoustic environment for the intended use of these spaces. The reverberation time criterion for the offices is:

- ≤ 0.8 s T_{mf}

Considering that the ceilings of some offices are restricted to change as the building is a Category B listed building. They should be kept and protected as they are, sound absorbing materials may be installed on the walls.

2.4. Noise From Building Services

2.4.1. Outdoor Mechanical Plant Noise Limit

Based on consultation with the Local Planning Authority (LPA), it is proposed that operational noise levels from any new fixed plant or building services equipment associated with the development shall:

- not exceed the prevailing background sound level, dB L_{A90}, 1 m outside the window of the closest residential properties at any time.

The noise from building services plant at the façade of the proposed habitable rooms should not exceed:

- 50 dB $L_{Aeq,1hr}$

2.4.2. Indoor Mechanical Plant Noise Limit

Table 2-1 shows the IANL (internal ambient noise level) and building services noise limits in offices. The IANL limits refer to cumulative noise which includes contributions from all external sources outside the library premises. The NR limits are for the building services noise only.

A one-hour period is considered suitable to reflect typical expected occupancy patterns in the proposed spaces.

Table 2-1 - Internal ambient noise level limits

Space	IANL limits, $L_{Aeq,1hr}$ (dB)	NR limits (building services), dB
Offices and meeting rooms	40	35

2.5. Multi-Use Gaming Area (MUGA) noise

Based on relevant guidance by Sports England, it is proposed that limits to noise from the neighbouring MUGA (located within the Coatbridge High School grounds) should be as follows:

- 35 dB $L_{Aeq,1hr}$ inside dwellings.

[2] Indoor sound pressure levels from individual noise events should not exceed approximately 45 dB L_{Amax} more than 10-15 times per night.
[3] The BS 8233 criteria may be relaxed, depending on how frequently the overheating condition occurs based on the Acoustics Ventilation and Overheating Guide (Association of Noise Consultants, 2020).

3. Baseline Conditions

Baseline noise levels affecting the proposed development have been measured and modelled. The background sound levels at a position considered representative for the nearest noise sensitive receptors were measured. The details of the measurement and acoustic model has been described in RIBA Stage 2 design report[4]. Sound insulation tests of some of the typical walls and floors have been carried out to investigate the potential sound insulation performance of the retaining building elements. The details of the sound testing have also been described in RIBA Stage 2 design report. The summary of the noise measurements, acoustic modelling and sound tests are presented in this section.

3.1. Environmental Noise Survey

The main sources of noise at the site was traffic noise from Dunbeth Road and Kildonan Street. During the short term attended noise measurements around all sides of the main building, traffic was almost continuous and clearly audible. In the carpark area, noise from student discussions was audible. In the courtyard area, noise from existing plant was prevalent and tonal.

3.1.1. Survey methodology and locations

The aim of the survey was to establish the existing ambient and background noise levels at key locations around the site. The survey positions are shown in Figure 3-1. The survey consisted of a combination of attended and unattended measurements of different durations at these positions:

Position 1: A continuous unattended measurement between 16:49 on Wednesday 15/12/2021 and 11:30 on Friday 17/12/2021. Measurements from this position represent typical noise climate outside the northern façade of the main building facing Kildonan Street.

Position 2: A continuous unattended measurement between 16:37 on Wednesday 15/12/2021 and 12:03 on Friday 17/12/2021. Measurements from this position represent typical noise climate outside the western façade of the main building facing Dunbeth Rd.

Position 3: A continuous unattended measurement between 16:11 on Wednesday 15/12/2021 and 11:41 on Friday 17/12/2021. Measurements from this position represent typical noise climate outside the south façade of the main building facing Muiryhall St.

Position 4: Measurements from this position represent typical noise from the MUGA. Three attended measurements were carried out on 17/12/2021 as described below:

- A 15-minute measurement at 09:44. Noise from Kildonan St was prevalent.
- A 15-minute measurement at 10:18. Noise from Kildonan St was prevalent.
- A 10-minute measurement at 10:33, during the school interval. Conversations from students were audible, but not clear/intelligible.

Position 5: Measurements from this position represent typical noise within the main building courtyard. The noise was mainly influenced by existing plant located in the courtyard. Two continuous attended measurements were carried out on 17/12/2021 as described below:

- A 15-minute measurement at 10:01.
- A 15-minute measurement at 11:05.

The attended measurements were undertaken at a height of approximately 1.5 m above ground, under free-field conditions. The unattended measurements were façade measurements with microphone positions approximately 1m from the façades and at a height of approx. 6m from the ground (2nd floor level).

[4] Kildonan Street, Coatbridge, RIBA Stage 2 Acoustic Report, 12 January 2022

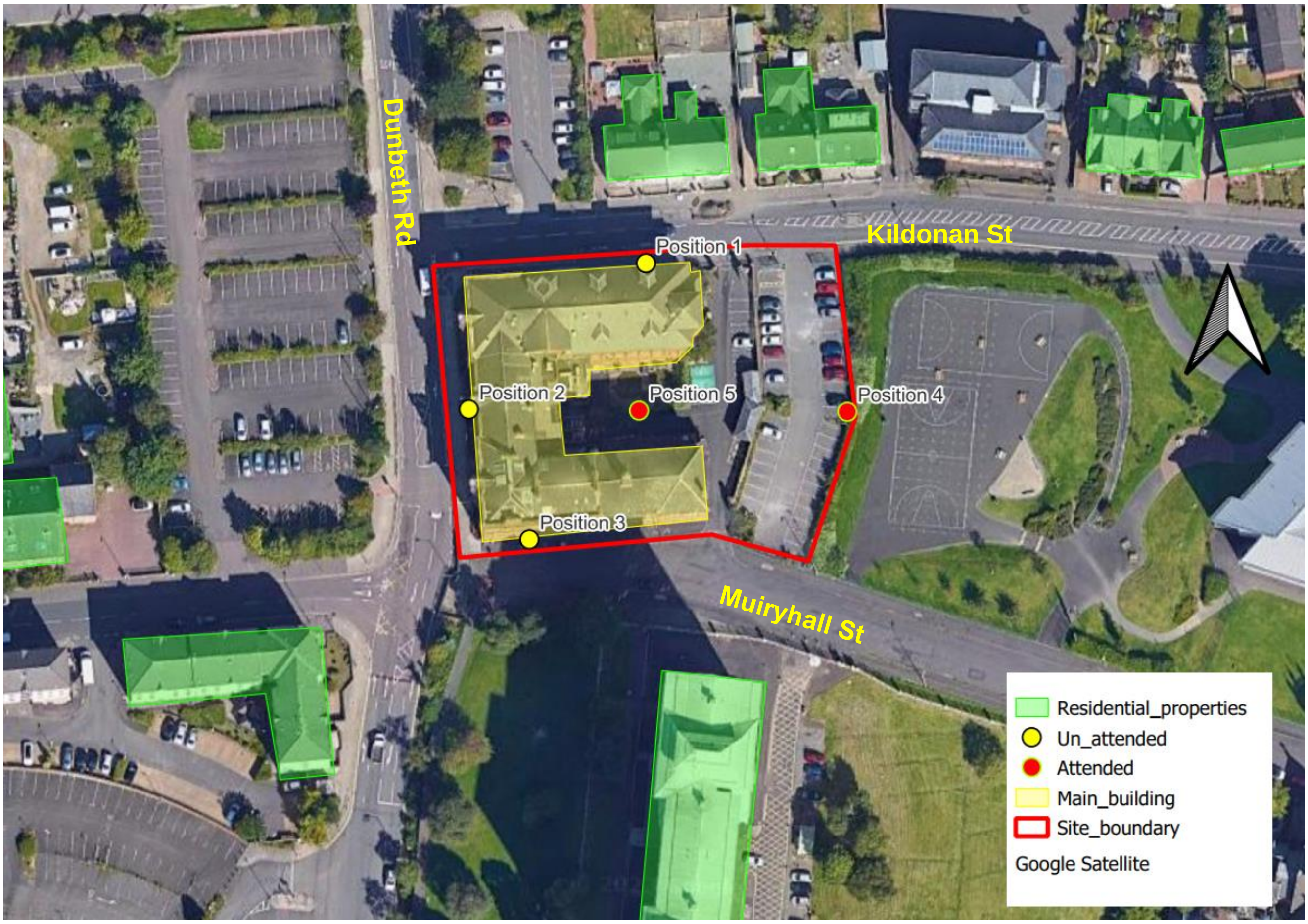

Figure 3-1 - Noise survey positions

3.1.2. Survey equipment

All measurements were undertaken using Class 1[5] sound level meters. The microphones were fitted with a windshield. Sound level meters were field calibrated both before and on completion of the survey. No significant drift in calibration levels was observed for any of the sound level meters used.

3.1.3. Weather conditions

Weather during the measurements was generally cloudy with temperatures of up to 11°C during daytime and going down to about 6°C during night-time. No rain was observed. Wind velocities did not exceed the microphone windshield limit of 5m/s (11mph) during the measurements.

A full history of the measured $L_{Aeq,15min}$, $L_{A90,15min}$ and $L_{Amax,15min}$ levels is presented in graphs Appendix D. A summary of the key measurements is provided in the tables further below. For the unattended positions, ambient noise levels L_{Aeq} are the equivalent continuous sound levels for the stated measurement periods during daytime (0700-2300 and night-time (2300-0700). Background noise levels L_{A90} are given as the mode 1-hour value recorded during each day and as the mode 15-minute value recorded during each night. L_{AFmax} is the maximum 15-minute noise level that is not exceeded more than 10 times during a single night.

The presented ambient and maximum noise levels can be used to guide the façade design of the main building. Background noise levels provide reference for assessing noise impact from any new plant/building services equipment at the closest noise sensitive receptors.

[5] Conforming to the specifications for sound level meters of Class 1 as defined in BS EN 61672-1:2013

Table 3-1 - Summary of noise survey results at the building façades (free field)

Position	Period	Hours	Noise level		
			L_{Aeq} (dB)	L_{A90} (dB)	L_{AFmax} (dB)
1	Daytime	15 minutes (highest level)	68	-	-
	Daytime	0700-2300	66	60	-
	Night-time	2300-0700	55	32	75
2	Daytime	15 minutes (highest level)	70	-	-
	Daytime	0700-2300	66	59	-
	Night-time	2300-0700	57	37	76
3	Daytime	15 minutes (highest level)	65	-	-
	Daytime	0700-2300	63	58	-
	Night-time	2300-0700	56	38	72

Table 3-2 - Summary of noise survey results: Position 4 (free field conditions)

Period	Date	Hours	Noise level		
			L_{Aeq} (dB)	L_{A90} (dB)	L_{AFmax} (dB)
Daytime	Friday, 17/12/2021	0945-1000	54	46	69
Daytime	Friday, 17/12/2021	1018-1033	53	44	65
Daytime (school interval)	Friday, 17/12/2021	1033-1043	56	50	71
Daytime	Friday, 17/12/2021	1048-1103	51	47	61

Table 3-3 - Summary of noise survey results: Position 5 (free field conditions)

Period	Date	Hours	Noise level		
			L_{Aeq} (dB)	L_{A90} (dB)	L_{Amax} (dB)
Daytime	Friday, 17/12/2021	0945-1000	50	45	60
Daytime	Friday, 17/12/2021	1018-1033	51	47	61

3.2. Noise Model

To have a better understanding of the noise climate around the site, a noise modelling exercise was carried out using the industry standard software NoiseMap. Based on data from Positions 1 and 2, the digital terrain model and the existing buildings, Kildonan St and Dunbeth road were modelled as linear noise sources. In the absence of traffic data, reasonable assumptions about the traffic and the HGV percentage in the traffic flow were made so that the modelled noise levels would match the measured noise levels in positions 1 & 2. Façade noise levels[6] were predicted for 103 receiver positions around the main building; in different locations and heights that correspond to the number of storeys in each location. Results of this modelling exercise are shown in Appendix C.

3.3. Sound Insulation Performance of Internal Building Fabric

A series of sound insulation tests (SITs) were carried out inside the main building. Airborne and impact sound insulation tests were carried out on floor/ceiling constructions. Airborne sound insulation tests were carried out on separating walls that are to be retained (identified by comparing the existing plans and the proposed plans). The measurements were carried out in accordance with BS EN ISO 16283-1:2014 (Airborne SITs) and ISO 16283-2:2020 (Impact SITs). The single number ratings were acquired based on the methodologies outlined in ISO 717-1:2020 & ISO 717-2:2020 for airborne sound insulation and impact sound transmission, respectively. The SIT results are shown below.

Table 3-4 - Floor sound insulation tests

Test ID	Building elements	Source room	Receiving room	Reference figure	Airborne, dB $D_{nT,w}$	Impact, dB $L'_{nT,w}$
1	Floor	First floor room	Ground floor room	Figure 8-7	60	41
2	Floor	First floor room	Ground floor room	Figure 8-8	55	41

Table 3-5 - Wall sound insulation tests

Test ID	Building elements	Source room	Receiving room	Reference figure	Airborne, dB $D_{nT,w}$
1	Wall	Room 1	Room 2	Figure 8-9	68
2	Wall	Room 3	Room 4	Figure 8-10	52
3	Wall	Room 5	Room 6	Figure 8-11	57
4	Wall	Room 7	Room 8	Figure 8-12	48
5	Wall	Room 9	Room 10	Figure 8-13	44

[6] It should be noted that the predicted noise levels are indicative. Future noise levels will be subject to a variety of factors such as changes in traffic flow, percentage of HGVs in the traffic flow, etc.

4. Internal Ambient Noise Levels

This section discusses the methods to attain the desired internal ambient noise levels, focusing solely on external noise sources. It is important to note that the noise generated by building services will also play a role in the overall internal ambient noise levels.

4.1. Road Traffic Noise Impact on Apartments

Table 4-1 and Table 4-2 show the existing external ambient noise levels and suggests glazing requirement to meet the IANL criteria from Section 2.2. All the rooms will be mechanically ventilated via MVHR units, and the calculations were carried out in closed window condition. Windows may be openable for purge ventilation, but it should be noted that when opened, the IANLs will be compromised. The sound insulation performance of the external walls is likely to be much higher than the windows. Therefore, the contribution of the noise ingress from external walls has been neglected in this analysis. The calculations are based on the most affected rooms which have the greatest window area over room volume ratio.

Table 4-1 - Indicative glazing performance requirement (part A)

Location	Ref. Measurement Position	External noise levels*	Indicative glazing configuration	Calculated indoor noise levels
Northern facade of North Wing (overlooking Kildonan St)	1	Daytime**: Ambient noise levels: $L_{Aeq,16hr}$ = 66 dB Night-time** Ambient noise levels: $L_{Aeq,8hr}$ = 55 dB Maximum noise levels: L_{Amax} = 75 dB	Living Room: Glazing: ≥ 31 dB R_w	Daytime: 32 dB $L_{Aeq,16hr}$
			Bedroom: Glazing: ≥ 35 dB R_w	Daytime: 31 dB $L_{Aeq,16hr}$ Night time: 22 dB $L_{Aeq,8hr}$ 42 dB L_{AFmax}
Western facade of West Wing (overlooking Dunbeth Rd)	2	Daytime: Ambient noise levels: $L_{Aeq,16hr}$ = 66 dB Night-time Ambient noise levels: $L_{Aeq,8hr}$ = 57 dB Maximum noise levels: L_{Amax} = 76 dB	Living Room: Glazing: ≥ 31 dB R_w	Daytime: 32 dB $L_{Aeq,16hr}$
			Bedroom: Glazing: ≥ 35 dB R_w	Daytime: 31 dB $L_{Aeq,16hr}$ Night time: 25 dB $L_{Aeq,8hr}$ 41 dB L_{AFmax}
Southern facade of Police Wing (overlooking Muiryhall St)	3	Daytime: Ambient noise levels: $L_{Aeq,16hr}$ = 63 dB	Living Room: Glazing: ≥ 31 dB R_w	Daytime: 30 dB $L_{Aeq,T}$
		Night-time Ambient noise levels: $L_{Aeq,8hr}$ = 56 dB Maximum noise levels: L_{Amax} = 72 dB	Bedroom: Glazing: ≥ 35 dB R_w	Daytime: 28 dB $L_{Aeq,16hr}$ Night time: 22 dB $L_{Aeq,8hr}$ 39 dB L_{AFmax}

* Single number A-weighted noise levels whose spectra were used in the calculations.
** Daytime hours from 07:00 to 23:00 and night-time hours from 23:00 to 07:00.

Table 4-2 - Indicative glazing configurations (part B)

Location	Ref. Measurement Position	External noise levels	Proposed façade constructions	Calculated indoor noise levels
Courtyard	5***	Daytime: Ambient noise levels: $L_{Aeq,16hr}$ = 54 dB	Living Room: Glazing: ≥ 31 dB R_w	Daytime: 19 dB $L_{Aeq,16hr}$
		Night-time Ambient noise levels: $L_{Aeq,8hr}$ = 45 dB Maximum noise levels: L_{Amax} = 63 dB	Bedroom: Glazing: ≥ 31 dB R_w	Daytime: 20 dB $L_{Aeq,16hr}$ Night time: 11 dB $L_{Aeq,8hr}$ 31 dB L_{AFmax}

***Noise was mostly influenced by Kildonan St and was noticed to generally be approx. 20 dB lower than what was measured on the Northern facade. A facade reflection correction factor of +3 dB has been added.

Achieving the IANLs is expected to be possible with typical façade constructions and glazing. All the windows will be new triple glazed windows. The window manufacturers should provide certificates or testing reports to demonstrate the compliance of the acoustic requirements. The façade markup drawing is shown in Appendix F.

4.2. Overheating

Since overheating assessment has not been carried out, it is unknown if the proposed development will have risks of overheating. Partially open windows may be acoustically feasible for rooms facing towards the Courtyard in case of overheating. However open windows are not feasible for other rooms in case of overheating.

4.3. MUGA Noise Impact on Apartments

The noise measurement at Position 4, taken during the school interval, includes the noise from using the MUGA (Multi-Use Games Area). This measurement is used to calculate the potential noise levels from the MUGA in the apartment. The calculations are based on the most affected rooms, which have the greatest window area over room volume ratio. Table 4-3 shows the MUGA noise levels and suggests glazing requirement to meet the IANL criteria.

Table 4-3 - indoor noise level calculation - MUGA

Location	Ref. Measurement Position	External noise levels	Proposed façade constructions	Calculated indoor noise level
All bedrooms, and living rooms	4	Daytime: Ambient noise levels: $L_{Aeq,1hr}$ = 56 dB Maximum noise levels: L_{Amax} = 71 dB	Bedroom: Glazing: ≥ 25 dB R_w	30 dB $L_{Aeq,1hr}$ 45 dB L_{AFmax}

4.4. Road Traffic Noise Impact on Offices

The internal ambient noise levels for the offices are determined using the highest 15-minute noise level. A reverberation time of 0.8 seconds is assumed for these calculations. The focus is on the most affected rooms, which have the least window area over room volume ratio. Table 4-4 shows the highest 15-minute noise levels and suggests glazing requirement to meet the IANL criteria.

Table 4-4 - indoor noise level calculation for offices – road traffic

Location	Ref. Measurement Position	External noise levels	Proposed façade constructions	Calculated indoor noise level
All offices	2	Daytime: Ambient noise levels: $L_{Aeq,15min}$ = 70 dB	Bedroom: Glazing: ≥ 32 dB R_w	35 dB $L_{Aeq,T}$

4.5. Lift Noise and Vibration

Vibration or re-radiated noise shall be limited and minimised. Lift noise when measured in the lift lobby at 1.5m from the floor and 1.2m from the door face should generally not exceed 55 dB L_{Amax} at any time during the lift cycle, when measured with a precision grade sound level meter set to “fast” meter response. Vibration caused by using the lift should be no greater than 0.3 mm/s within the most affected habitable rooms.

5. Internal Sound Insulation

The sound insulation ratings for separating walls, and doors, required to satisfy the internal sound insulation requirements specified in Section 2.1, are shown in Appendix N. The ratings have been specified assuming appropriate junction detailing, and acoustic treatment of services penetrations will be implemented.

5.1. Walls

5.1.1. Police Wing New Built Walls

The construction of the separating walls has been discussed with the architect and coordinated in the architectural drawing. The construction details are shown in Table G-1 in Appendix G.

5.1.2. North Wing and West Wing existing walls

Some of the walls will be retained and form separating partitions for apartments. Based on the sound insulation tests, independent lining is required for walls where sound insulation enhancement is needed to achieve the assessment criteria, which have been marked on the architectural drawing as shown in 0.

5.1.3. Internal walls

The internal walls should achieve a laboratory testing performance rather than in-situ test performance. Three potential construction options have been proposed to the architect which are sufficient for the sound insulation requirement as shown in Table G-1 in Appendix G.

5.2. Floors

Insulation against impact noise can be improved by adding a soft covering such as a carpet or foam-backed vinyl. However, these floor covering should not be included as part of the construction used to achieve the design levels in stated in section 2.1.1. Therefore, all the floors should have a resilient layer additional to the floor finish. The resilient layer should meet the following specification:

- Any resilient layer with a weighted reduction in impact sound pressure level (ΔL_w) of not less than 23 dB when measured in accordance with the latest relevant standards.

5.2.1. Police Wing floor

The proposed floor details have been reviewed and advice to improve the sound insulation performance has been provided to the architect. The details are shown in Table G-2.

5.2.2. North Wing floor

The sound insulation test conducted between the ground floor and first floor indicates that the existing floor in the North Wing meets the sound insulation requirements. Given that the test was performed on carpet, using a carpet floor finish is likely to satisfy the performance requirement. The architect's proposal to add a 100mm floor composition on top of the existing floor, however, cannot be reviewed at the time of report production. To meet the impact sound requirement, the floor composition should incorporate a resilient layer. Before proceeding to the next stage, an acoustician should review the floor details.

5.2.3. West Wing floor

Sound insulation tests indicate that the existing floor at the West Wing complies with the sound insulation requirements. The apartment floor details are not available at the time of writing this report. The floor details should be reviewed by the acoustician before next stage. Offices are proposed for the West Wing. It is understood that the following offices are proposed to have timber floor:

- Meeting Rooms on the ground floor; and
- Commercial Space (138m^2) and Commercial Space (82m^2) on the first floor.

Commercial Space (82 m^2) and Commercial Space (125 m^2) on the first floor are directly above apartments on the ground floor. A hard floor finish can increase the impact sound levels in the room below. Therefore, carpet floor finish is required for the Commercial Spaces on first floor. Other floor details are unknown at the time of writing this report, and they should be reviewed before the next stage.

5.3. Doors

The sound reduction index of the entrance doors for the apartments should be at least 30 dB R_w. The sound insulation requirement for the doors of the commercial spaces are indicated in the markup drawing as shown in Appendix N.

5.3.1. Flanking General Principles

There is no hard and fast rule associated with flanking as each scenario can differ. It follows that very careful design of junction details and quality workmanship will be required to control flanking noise to the required levels. Each scenario should be reviewed on a case-by-case basis.

Some general principles and good practises that are recommended to be followed in the design and construction of internal partitions, floors and ceilings to avoid excessive flanking transmission are set out below and should be detailed in the architectural wall details drawing at the next stage and checked by the acoustician.

- To achieve an appropriate level of sound insulation performance, partitions requiring $R_w \geq 50$ dB must be constructed from slab to soffit (i.e. full height) and should be well sealed at all peripheral junctions with flexible acoustic sealant.
- Any partitions with requirements of $R_w \leq 50$ dB may be constructed from on top of the raised access floor to underside of soffit with a well-installed floor void barrier.
- Head gaps (if required) should be kept as small as possible (maximum 10 mm) and be packed with a high-density acoustic insulating product.
- The risk of excessive flanking noise transmission at junctions with curtain walling is particularly high. Transom/mullions should not be continuous between areas and an acoustic break should be incorporated. Where possible, the plasterboard of the partition should over sail the mullion up to the glazing. If this is not possible, the mullions (if hollow) should be filled with sand or a similar product.
- Drywall partitions should not be continuous between sensitive spaces.
- Service penetrations in the partitions should be avoided. Where service penetrations in partitions are unavoidable, it should be ensured that all are pattressed and a good and effective seal is made with a flexible acoustic sealant. Any ductwork connecting sensitive spaces may require crosstalk attenuation.
- Any service penetrations will weaken the performance of the wall, including partial penetrations from power sockets. Wall sockets should not be installed back-to-back, but in separate panels at a minimum 600 mm apart. The wall sockets should be installed with additional acoustic boxes or sound absorbers behind to help alleviate the effect of the penetration. An example of a product to use would be *Hilti Putty Pads* or similar approved product.
- An acoustically rated door set greater than R_w 35 dB is a specialist item. Door sets rated at R_w 35 dB will need to be constructed in the following way:
  - The manufacturer or supplier of acoustic doors shall guarantee the specified SRI, in an installed condition on site. In the case of failure to meet the specification because of faulty design, the manufacturer or supplier will be held liable for remedial or replacement costs including consequential liability.
  - The acoustic doors shall be of hardwood or steel, and be complete with all seals and frames, and with furniture as specified.
  - The door shall be provided with double neoprene/rubber compression, or knife-edge, seals to the head and jambs.
  - Wiper seals will not be permitted at thresholds, doors should be fitted with drop seals that provide a full and effective seal.
  - The door fastener or lock should be designed to ensure that the seals operate over the whole periphery of the door.

It is noted that good workmanship is important to maximise the effectiveness of above flanking noise control methods.

6. Sound Absorbing Treatment

To achieve the specified reverberation times, sound absorption will be required in the offices and communal areas of the residential apartments. Proposed solutions include sound absorbing ceilings and absorbing walls panels.

The majority of the office walls are masonry, which has a hard surface, and its sound absorbing performance is negligible. Timber floors will be used for the offices at the ground level and the first level. Floors of other offices will be carpet. Two sound absorbing options are provided based on carpet floor and timber floor to give the design team more flexibility for the internal design. However, carpet floors are acoustically preferred for all commercial spaces.

The offices at first floor have very large volumes because of the high ceiling. The ceiling height of other offices is within the normal range between 3m and 4m. Therefore, the sound absorbing treatments are discussed separately.

Example absorbing materials are shown in Appendix H.

6.1. Offices at the First Floor

The room information and required amount of absorbing material is shown in Table 6-1.

Table 6-1 - Sound absorption specification for offices at first floor

Level	Room description	Floor finish	Reverberation control measures	Predicted T_{mf} (seconds)	Criteria T_{mf} (seconds)
First level	Commercial Space (138 m^2)	Option 1: Carpet	Min. 150 m^2 Class A*(1) wall panels	0.9*(3)	≤ 0.8
		Option2: Timber	Min. 150 m^2 Class A wall panels, and 38 m^2 additional Class A materials*(2).	0.9	≤ 0.8
	Commercial Space (125 m^2)	Option 1: Carpet	Min. 52 m^2 Class A wall panels and min. 48 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 52 m^2 Class A wall panels and min. 83 m^2 additional Class A materials	0.7	≤ 0.8
	Commercial Space (82 m^2)	Option 1: Carpet	Min. 54 m^2 Class A wall panels and min. 11 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 54 m^2 Class A wall panels and min. 34 m^2 additional Class A materials	0.7	≤ 0.8

*(1) Sound absorption measured in accordance with BS EN ISO 354:2003 and rated in accordance with BS EN ISO 11654: 1997

*(2) the Class A materials can be ceiling, rafts and wall panels.

*(3) due to the large volume and restrictions to the ceiling and walls, the desired reverberation time target is not possible to be achieved.

6.2. Offices at Other Floors

For the other offices, the required sound absorbing materials are shown in Table 6-2. To avoid standing waves and flutter echoes between parallel walls, wall panels are required in the offices, generally at head height. The recommended locations of the wall panels are shown in Appendix I.

Table 6-2 - Sound absorption specification for offices at other floors

Level	Room description	Floor finish	Reverberation control measures	Predicted T_{mf}	Criteria T_{mf} (seconds)
Lower ground floor	Office Zone A (19m^2)	Option 1: Carpet	Min. 2 m^2 Class A wall panels and 8 m^2 additional Class A materials*(2)	0.7	≤ 0.8
		Option2: Timber	Min. 2 m^2 Class A wall panels and 13 m^2 additional Class A materials	0.7	≤ 0.8
	Collaboration Zone A (25 m^2)	Option 1: Carpet	Min. 4 m^2 Class A wall panels and 9 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 4 m^2 Class A wall panels and 16 m^2 additional Class A materials	0.7	≤ 0.8
Ground floor	Meeting Room (31 m^2)	Option 1: Carpet	Min. 4 m^2 Class A wall panels and 21 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 4 m^2 Class A wall panels and 30 m^2 additional Class A materials	0.7	≤ 0.8
	Meeting Room (42 m^2)	Option 1: Carpet	Min. 5 m^2 Class A wall panels and 28 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 5 m^2 Class A wall panels and 40 m^2 additional Class A materials	0.7	≤ 0.8
Third floor	Meeting Room (44 m^2)	Option 1: Carpet	Min. 9 m^2 Class A wall panels and 32 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 9 m^2 Class A wall panels and 44 m^2 additional Class A materials	0.7	≤ 0.8
	Meeting Room (29 m^2)	Option 1: Carpet	Min. 6 m^2 Class A wall panels and 22 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 6 m^2 Class A wall panels and 30 m^2 additional Class A materials	0.7	≤ 0.8
	Meeting Room (20 m^2)	Option 1: Carpet	Min. 5 m^2 Class A wall panels and 14 m^2 additional Class A materials	0.7	≤ 0.8
		Option2: Timber	Min. 5 m^2 Class A wall panels and 20 m^2 additional Class A materials	0.7	≤ 0.8

*(1) Sound absorption measured in accordance with BS EN ISO 354:2003 and rated in accordance with BS EN ISO 11654: 1997

*(2) the Class A materials can be ceiling, rafts and wall panels.

6.3. Corridors and Lobbies

Class C absorbing ceilings should be installed to circulation areas, such as corridors and lobbies.

7. Mechanical Building Services Noise

The noise data of the mechanical plant and its impact are discussed in this section. Since the mechanical drawings and noise data were not available when this report was written, plant noise level limits are set to achieve the external noise requirement. Internal noise requirements will be addressed by using attenuators.

7.1. Proposal

7.1.1. Ventilation

The offices will be mechanically ventilated via AHU unit located on the roof. The residential apartments will be ventilated via Mechanical Ventilation with Heat Recovery (MVHR) units located locally in MVHR store of the apartments.

Mechanical services proposals currently include the following main plant items:

- One AHU (air handling unit) for the offices,
- One MVHR for each apartment, and
- One toilet extract fan for the offices.

Equipment selections have been provided by the mechanical design team. The selected plant items and the associated noise data are listed in Appendix J.

The AHU for the offices has the potential to operate 24 hours a day.

7.1.2. Cooling / heating

Cooling / heating for the commercial spaces will be provided by Fan Coil Units (FCU) located above the false ceiling. Two FCUs will be installed for each commercial space. The arrangement schedule of the FCUs is shown in Table J-5.

Heating for the apartments will be provided by Ground Source Heat Pump (GSHP) with a shoebox heat pump within each apartment.

7.2. Noise Control Measures

Internal building services noise should be controlled to satisfy noise criteria as proposed in Section 2.4. To satisfy the external and internal noise criteria, noise control measures will be needed.

7.2.1. Attenuators

Attenuators should be located at least three equivalent duct diameters from a fan, elbow, branch, take off or other duct element with potential of generating air turbulence, if possible. Locating a sound attenuator closer than three equivalent duct diameters can result in a significant increase of both the pressure loss and the regenerated noise. If unavoidable, advice of the specialist attenuator supplier should be sought.

The contractor should verify if the final attenuator selections satisfy the pressure drop and insertion loss requirements from the mechanical specification and do not introduce excessive regenerated noise. CIBSE B4 gives guidance on the relation between air flow velocity and the flow generated noise as shown in Appendix M.

7.2.1.1. AHU atmosphere side

The atmosphere side attenuators have been integrated in the AHU design, which will reduce the noise impact on the proposed development and other noise sensitive receptors. It is calculated that the proposed outdoor mechanical plant has low impact on the nearby noise sensitive receptors with the integrated attenuators.

7.2.1.2. AHU room side

Room side attenuators will be required to satisfy the noise criteria. The required insertion loss of the attenuators is shown in Table J-7 in Appendix J.

7.2.1.3. MVHR attenuators

The required insertion loss for the MVHR attenuators is shown in Table J-9 in Appendix J.

7.2.1.4. Toilet extract fan

The extract fan manufacturer proposed an attenuator AVT6-MSS-X (as shown in Table J-10) which is calculated to be sufficient to comply with the noise assessment criteria.

7.2.1.5. Cross-talk

The cross-talk attenuators should be installed to achieve at least 10 dB below the design ambient noise levels when talking in "loud voice"[7] in the source room. In this case, the speech from adjacent rooms may be masked and unlikely intelligible. The required insertion loss of the cross-talk attenuators are shown in Table J-8 in Appendix J.

7.2.2. Anti-Vibration Measures

Noise and vibration from mechanical equipment can travel through the building structure and affect adjacent spaces. Therefore, all vibration/rotating machinery should be isolated from the structure with appropriate types of isolators.

Appendix K illustrates the typical vibration isolation required for mechanical and electrical equipment (reproduced from the Chartered Institute of Building Services Engineers (CIBSE) Guide B4). This is intended to serve as a guide at this stage and assist with preliminary selection of suitable isolators. The final selections of suitable vibration isolation will be the responsibility of the contractor. All ceiling mounted mechanical plant should be mounted on spring anti-vibration hangers.

7.2.3. Services Penetrations

Services penetrations through walls should be kept at a minimum. All penetrations should be acoustically treated to ensure they do not affect the acoustic integrity of the separating structure. Typical services penetration detailing is shown in Appendix L.

7.3. Internal Building Services Noise Assessment

All rooms will be mechanically ventilated. Based on the proposed room side attenuators for the AHUs and MVHR units, the internal noise levels are calculated to be below the assessment limits. The calculated indoor noise levels with and without the attenuators are shown in Table 7-1.

Table 7-1 – Indoor noise levels from building service plant

Source	Receiving room	Indoor noise level, NR	
		Without room side attenuator	With proposed room side attenuator
AHU supply	Ground floor office	53	27
AHU return	Ground floor office	32	27
MVHR supply	Habitable room	40	28
MVHR return	Habitable room	25	n/a
Fan coil units	Ground floor office	38	n/a

The sound power level of the shoebox heat pump is 47 dB(A). With the sound attenuation provided by the door from the MVHR store, the noise level from the heat pump is likely to be negligible in the living room and bedrooms.

The noise from the fan coil units exceeds the assessment criteria by a few decibels in the commercial spaces. Therefore, quieter units or low operating capacity would be required.

7.4. Mechanical Plant Noise Impact Assessment

The outdoor mechanical plant noise levels at the identified receptors were predicted following the sound propagation principles of the standard ISO 9613-2, implemented within the environmental sound prediction software SoundPLAN (Version 8.2). The mechanical plant units are modelled as point sources.

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[7] CIBSE Guide, B4 Noise and Vibration Section 4.7

The highest predicted rating sound levels at the noise sensitive receptors are 18 dB $L_{Aeq,T}$, which is below the representative background sound level. This complies with the planning requirement and is an indication of low impact.

The details of the assessment are shown in Appendix J.

The calculated noise impact from the AHU at the proposed apartment is 30 dB $L_{Aeq,T}$ which is below the set limit of 50 dB $L_{Aeq,T}$.

8. Summary

Atkins has been commissioned to carry out acoustic design work for the refurbishment of the Municipal Building located at Kildonan Street, Coatbridge ML5 3LF.

This report summarised the acoustic design and assessments carried out during RIBA Stage 3 of the project.

Results of a noise survey carried out on site have been presented. The results were used to establish typical noise levels outside the proposed building and representative background sound levels at the closest noise sensitive receptors.

The internal noise criteria have been set. Glazing performance requirements have been provided with markup drawings to achieve the desired indoor noise levels. The noise from building services noise will contribute to the indoor noise levels, however, the overall indoor noise level requirements are likely achievable with appropriate noise mitigation for the mechanical noise.

Assessment of internal sound insulation has been carried out. Criteria for sound insulation between adjacent rooms have been set in accordance with the industry guidance. Mark-ups of minimum sound insulation ratings have been provided. Outline flanking noise control measures have been provided.

Reverberation time criteria have been set. A scheme of controlling reverberation has been proposed to fit the desired use of the space. Due to the restrictions of the requirement for listed buildings, absorbing wall panels have been proposed in the report. For the commercial spaces at first floor, the desired reverberation time may not be achievable due to the large volume and significant ceiling height.

External and internal criteria for noise from the proposed mechanical building services have been set based on the requirements of the local planning policy and the industry standards. With the integrated attenuators for the air handling unit and toilet extract fan, the rating level of the noise from those units at the most affected noise sensitive receptor is below the background sound level. This is an indication of low impact according to BS 4142 and complies with the planning requirement. The mechanical plant noise level at the façade of the proposed apartment is below the set limit. Room side attenuators for the air handling unit and mechanical ventilation with heat recovery units will be required and the performance requirements of these attenuators have been specified in the report. The noise from the fan coil units (serving the commercial areas) slightly exceeds the assessment criteria. Quieter units or low operating capacity would be required.

At the next stage, the key acoustic design tasks for the contractor will be as follows:

- The contractor should carry out a detailed design of separating constructions and flanking elements with consideration of criteria and recommendations included in this report.
- Detailing of the proposed reverberation control scheme.
- Review of proposed building services noise control measures based on a finalised building services design, with adjustments to the noise control scheme if required.
- Selections of suitable anti-vibration mounts and plant supports.
- Acoustic detailing of services penetrations.

Appendices

Appendix A. Glossary of Acoustic Terms

Table A-1 - List of acoustic terms used in the report

<table>
<tr><th>Acoustic term</th><th>Explanation</th></tr>
<tr><td>A-weighting</td><td>The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.</td></tr>
<tr><td>dB</td><td>Decibel. The unit of sound level.</td></tr>
<tr><td>dBA or dB(A)</td><td>The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear</td></tr>
<tr><td>Sound Absorption Class</td><td>Property of a building element used for reverberation time control, determined in accordance with BS EN ISO 11654:1997 based on the random incidence weighted sound absorption coefficient (α_w) of the element. The table below shows the weighted sound absorption coefficients that must be achieved by an element to achieve a given sound absorption class.
<table>
<tr><th>Sound absorber acoustic rating</th><th>Weighted sound absorption coefficient, α_w</th></tr>
<tr><td>Class A</td><td>0.90; 0.95; 1.00</td></tr>
<tr><td>Class B</td><td>0.80; 0.85</td></tr>
<tr><td>Class C</td><td>0.60; 0.65; 0.70; 0.75</td></tr>
<tr><td>Class D</td><td>0.30; 0.35; 0.40; 0.45; 0.50; 0.55</td></tr>
<tr><td>Class E</td><td>0.25; 0.20; 0.15</td></tr>
</table></td></tr>
<tr><td>$D_{nT,w}$</td><td>Weighted standardised level difference: a measure of sound insulation performance of a partition on site, which is referenced to a standard reverberation time of 0.5 seconds</td></tr>
<tr><td>$D_{nf,w}$</td><td>Weighted normalised flanking level difference: Laboratory measurement of the flanking sound transmission only i.e. without direct sound transmission through the element.</td></tr>
<tr><td>$L_{Aeq,T}$</td><td>The equivalent continuous A-weighted sound pressure level. This is commonly referred to as the average sound level. The suffix “T” represents the time interval over which the sound level is determined, e.g. “15min” represents a period of 15 minutes.</td></tr>
<tr><td>$L_{A90,T}$</td><td>The A-weighted sound level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background sound level. The suffix “T” represents the time interval over which the sound level is determined, e.g. “15 min” represents a period of 15 minutes.</td></tr>
<tr><td>$L_{Afmax,T}$</td><td>The A-weighted maximum sound level. The highest level that occurs over a time interval “T”, with a specified time weighting. Typically used time weightings are fast “F” (with 125 ms duration used to establish the sound level) and slow “S” (1 s duration), resulting in $L_{Afmax,T}$ and $L_{Asmax,T}$ measurements respectively</td></tr>
<tr><td>$L_{As,T}$</td><td>The specific sound level; the equivalent continuous A-weighted sound pressure level of a specific sound source. The suffix “T” represents the time interval over which the sound level is determined, e.g. “15 min” represents a period of 15 minutes.</td></tr>
<tr><td>$L_{Ar,T}$</td><td>The rating level; the equivalent continuous A-weighted sound pressure level of a specific sound source, adjusted to account for characteristic features of the sound such as tonality or impulsivity. The suffix “T” represents the time interval over which the sound level is determined, e.g. “15 min” represents a period of 15 minutes.</td></tr>
<tr><td>$L'_{nT,w}$</td><td>The weighted standardised impact sound pressure level. It is the sound level in the receiving room when the floor/ceiling system is excited by a standard tapping machine, which is a measure of the effectiveness of the separating elements in attenuating structure borne noise such as footfall. The lower the $L'_{nT,w}$, the higher the sound insulation performance of the system.</td></tr>
</table>

Acoustic term	Explanation
NR	Noise Rating value, which is a single-number rating assigned to a given sound level frequency spectrum. The NR values are commonly used to describe noise from mechanical ventilation systems in buildings.
Reverberation time	Time required for the sound pressure in a room to drop by 60 dB after the sound has stopped. It indicates the duration of sound decay in a room. Large rooms with hard sound-reflecting surfaces (e.g. brick walls) have longer reverberation time than small rooms with sound-absorbing materials (e.g. soft furniture or curtains). Reverberation time in a room can be reduced by introducing sound-absorbing materials such as carpets or upholstered furniture, or specific acoustic treatment such as sound-absorbing ceilings or acoustic wall panels.
R_w	Weighted sound reduction index, which is a measure of the effectiveness of a building element in attenuating airborne sound transmission. It is a single-number rating determined based on testing the building element in an acoustic laboratory in accordance with the relevant standards. The higher the R_w, the better the sound attenuation performance of the building element.
Sound Insulation	When sound hits a surface, some of the sound energy is transmitted through the material. “Sound insulation” refers to effectiveness of a building element to attenuate sound propagating through it.
T_{mf}	Reverberation time average over the mid-octave frequencies 500Hz, 1kHz and 2kHz.

Appendix B. Noise Policy, Guidance and Design Criteria

Environmental Protection Act 1990, Part III

Section 79 of the Environmental Protection Act 1990 (as amended) declares a number of items as statutory nuisances. Under the provisions of the Environmental Protection Act, the local authority is required to periodically inspect its area to detect any nuisance and, where a complaint of a statutory nuisance is made by a person living within its area, to take such steps as are reasonably practicable to investigate the complaint.

National Planning Practice Guidance (NPPG): 2014

In March 2014, the government published Planning Practice Guidance (an on-line resource) to supplement the NPPF. The guidance incorporates a dedicated document in respect of noise (ID:30) updated in March 2014 which advises how the planning system should manage potential noise impacts in new development.

Paragraph 1 of the NPPG states that 'noise needs to be considered when new developments may create additional noise'. The NPPG also identifies instances where potential noise impacts could be a concern through the noise exposure hierarchy. The guidance acknowledges that impacts depend of the type of development being considered and the character of the proposed location.

The guidance also advises in paragraph 8 that there are four broad types of noise mitigation. These relate to engineering, layout, the use of conditions/obligations and mitigating the impact on areas likely to be affected.

BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings

This Standard considers, amongst other matters, the internal acoustic environment within various rooms under different uses to ensure it is appropriate to their function. For many common situations, such as suitable sleeping and resting conditions, this Standard proposes noise levels that normally satisfy these criteria for most people. For these spaces, it is desirable that the internal ambient noise levels do not exceed the guideline values in Table B-1, which assume normal diurnal fluctuations in external noise.

Table B-1 - BS 8233 recommended indoor ambient noise levels

	$L_{Aeq,16h}$ (07:00 to 23:00)	$L_{Aeq,8h}$ (23:00 to 07:00)
Living room	35 dB	-
Dining room/area	40 dB	-
Bedroom	35 dB	30 dB

It is also stated that regular noise events, such as scheduled aircraft or passing trains, can cause sleep disturbance, and that a guideline value in terms of SEL or L_{Amax} may be set dependent on the character and number of events per night.

The main factors affecting whether these internal design noise levels can be achieved are the level of noise outside the building and the sound insulation of the building envelope (windows, roof, walls, doors and ventilation systems). In practice, the sound insulation of the building envelope is only as good as its weakest element; in most cases this is taken to be an open window when determining the suitability of a site for development. However, alternative acoustic ventilation strategies can be considered where external noise levels are too high to meet internal design targets with windows open.

For traditional external areas that are used for amenity space, such as gardens and patios etc it is desirable that the steady noise level does not exceed 50 dB $L_{Aeq,T}$ and 55 dB $L_{Aeq,T}$ should be regarded as an upper limit (T is the time period over which the averaging is carried out). Other locations, such as balconies, roof gardens and terraces are also important in residential buildings where normal external amenity space is limited or not available, i.e. in flats, apartment blocks etc. Small balconies intended for uses such as drying clothes or growing pot plants should not be subject to noise limits. However for larger balconies, roof gardens and terraces, which might be intended to be used for relaxation, achieving the level of 55 dB $L_{Aeq,T}$ or less should occur in some areas of the space.

The standard also recognises that:

“these guideline values are not achievable in all circumstances where development might be desirable. […] In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited”.

In some cases, such as open-plan offices and restaurants, a moderate noise level might provide masking for acoustic privacy in shared spaces without causing disturbance, so upper and lower noise levels should be considered, e.g. $L_{Aeq,\ 30\ min}$ from 45 to 50 dB for an open office.

Calculation of Road Traffic Noise (1988)

The Calculation of Road Traffic Noise (CRTN) is a technical memorandum that describes procedures for road traffic noise measurements and calculations using the $L_{A10,18h}$ noise index. CRTN is suitable for environmental assessments of schemes where road traffic noise may have an impact.

Using the prediction methodology detailed in CRTN, the Basic Noise Level can be calculated for an 18-hour period (06:00 to 24:00) at 10 m from the kerb of a road link using the following information:

- Annual Average Weekly Traffic flow (18-hour traffic flows);
- Average traffic speed; and
- Traffic composition, namely the proportion of heavy goods vehicles comprising the traffic flow.

The Basic Noise Level is then corrected for road gradient, distance to the noise sensitive receptors, angle of view, and the presence of screening, to arrive at a final noise level for each NSR of interest.

Noise from Mechanical Plant

The noise impact on existing dwellings as a result of any building services associated with the proposed development should be controlled.

The assessment of impacts from such fixed items of plant at any neighbouring residential buildings can be undertaken based on guidance contained in BS 4142:2014.

According to this standard, the rating level of the noise from the item of plant is determined and compared to the existing measured L_{A90} background noise level for that period. It states:

“*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.*”

It also notes that:

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

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

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.”

MUGA Noise – Artificial Grass Pitch (AGP) Acoustics – Planning Implications (2015)

The most relevant guidance relating to the assessment of noise from proposed MUGA and 3G pitch is Artificial Grass Pitch (AGP) Acoustics – Planning Implications (2015) published by Sports England. This document provides details of the acoustic implications associated with AGPs, typical source noise levels and design advice.

The document provides a “typical free-field noise level from an AGP (at 10 m from the side-line halfway marking) – 58 dB $L_{Aeq,1\ hour}$” and states that “the most significant noise source from typical AGP sports sessions is voice”.

The guidance refers to the World Health Organisation (WHO) noise limits. These limits are defined for steady sound sources without a specific character, such as road traffic. The Sports England guide suggest that these limits can also be applied to AGP noise, with a noise assessment period of 1 hour to reflect the typical duration of use (i.e. classes). The above limits should therefore be observed in terms of the $L_{Aeq,1hour}$ values.

Based on the guidance outlined above, noise criteria of 55 dB $L_{Aeq,1hour}$ and 35 dB $L_{Aeq,1hour}$ have been considered for sports noise in neighbouring, external living areas (gardens) and inside the dwellings, respectively.

Building Standards technical handbook 2017: domestic buildings – 5. Noise

The Building Standards technical handbooks provide guidance on achieving the standards set in the Building (Scotland) Regulations 2004 and are available in two volumes, domestic buildings and non-domestic buildings.

The following design performance levels are given for the control of sound through separating walls and separating floors. The levels have been developed from research covering sound and perceived sound in dwellings. They have been identified as levels, based on normal domestic activities that have been shown to produce few noise complaints. All work should be designed to the levels in the following table:

Table B-2 - Design performance levels in dB

Design performance	New build and conversions not including traditional buildings	Conversions of traditional buildings
Minimum airborne sound insulation	56 $D_{nT,w}$	53 $D_{nT,w}$
Maximum impact sound transmission	56 $L'_{nT,w}$	58 $L'_{nT,w}$

The design performance levels for internal walls and intermediate floors covered by this standard should achieve minimum airborne sound insulation levels indicated in the following table.

Table B-3 - Design performance levels

Design performance	Minimum airborne insulation level
Internal walls	40 dB R_w
Intermediate floors	43 dB R_w

Many of the existing wall and floor constructions within a traditional building, will be constructed from materials generally not still in use, for example lathe and plaster. In such cases the sound insulation level will not be known, therefore it is not reasonably practicable for the existing walls or floors to meet the performance levels in the above table.

Local Planning Authority

Consultations with the Local Planning Authority (North Lanarkshire Council) have been undertaken by the architectural team, highlighting the following Planning requirements:

- To assess impact of existing/future noise on the proposed residential and commercial units using a CRTN (Calculation of Road Traffic Noise) methodology.
- To consider the impact of proposed plant on the proposed residential and commercial units.

It should be noted that for detailed CRTN calculations, the existing/future traffic flow data for the adjacent roads would be required. It is understood that this data is not available. It is therefore proposed that the impact of ambient noise on the proposed development would be determined by a combination of environmental noise measurements at the site and road noise modelling using the noise data collected on site in general accordance with CRTN. It understood that assessment of the operational noise impact from the proposed development on the neighbouring noise sensitive receptors (including plant noise) is not required for Planning, however environmental noise limits based on the background noise are being proposed.

Further consultations with Moira Cartwright (Environmental Health Officer), have been undertaken by Atkins ANV, where the following were agreed (email dated 7/12/2021):

The impact of noise on the development would be determined by a combination of environmental noise measurements at the site and road noise modelling using the data collected on site. Our plan is to install 3 noise loggers on the facades of the building overlooking Kildonan Street, Muiryhall Street & Dunbeth Road and also carry out a number of manned measurements in other key locations.

The parameters to be measured are L_{Aeq}, L_{Amax} & L_{A90}. The former two will be used to design the building's façade to comply with the criteria given in World Health Organisation Guidelines for Community Noise and BS 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings. The latter (L_{A90}) will be used to establish an environmental noise limit. However, it is understood that assessment of the operational noise impact from the proposed development on the neighbouring noise sensitive receptors (including plant noise) is not required for Planning.

Resistance to sound: Approved Document E

The Scottish Building Standards technical handbooks do not make a reference to sound absorption in common spaces. Therefore, the relevant part from England's Approved Document E is suggested to be adopted; to set suitable performance criteria:

- 7.17 For entrance halls, provide a minimum of 0.20m² total absorption area per cubic metre of the volume. The additional absorptive material should be distributed over the available surfaces.
- 7.18 For corridors or hallways, provide a minimum of 0.25m² total absorption area per cubic metre of the volume. The additional absorptive material should be distributed over one or more of the surfaces.

BS ISO 22955:2021 – Acoustic quality of open office spaces

This document provides technical guidance to achieve acoustic quality of open office spaces to support dialogue and formal commitment between the various stakeholders involved in the planning, design, construction, or layout of open-plan workspaces: end customers, project owners, prescribers, consultants, etc. It is applicable to all open-plan offices in which the following activities are performed:

— Space type 1: activity not known yet – vacant floor plate;

— Space type 2: activity mainly focusing on outside of the room communication (by telephone/audio/video);

— Space type 3: activity mainly based on collaboration between people at the nearest workstations;

— Space type 4: activity based on a small amount of collaborative work;

— Space type 5: activity that can involve receiving public;

— Space type 6: combining activities within the same space.

Touchdown office spaces can best be associated with Space Type 6. This type of space is laid out to accommodate a variety of activities within the same space. Activities can include:

— Focused individual work in a designated focus area for greater noise control;

— Individual task-based work at a workstation, in an area with small amounts of collaboration, talking, discussion;

— Collaboration, either focused or creative, in a one-to-one situation, informal meeting area or chat booth;

— Telephone/communication with people who are not adjacent;

— Informal working, which may involve collaboration or individual work, in an area that does not have noise control etiquette;

— Non-work activity, which may include refreshment, recuperation, physical and wellbeing;

— Formal meeting spaces which are not provided with acoustic privacy from the remaining spaces;

— Formal meeting spaces which are provided with acoustic privacy from the remaining spaces, usually with full height partitions and a door;

— Social and welfare.

The acoustic treatment of a room involves covering its surfaces (ceiling, floor and walls) with absorptive acoustic material to limit sound reflection. The following are proposed:

Ceiling treatment

The ceiling is the most important reflecting surface in open plan offices; it should be as absorptive as possible. A full coverage of the ceiling should be preferred. A high weighted absorption coefficient is close to 1. Weighted Absorption coefficient needs to be calculated according to ISO 11654.

Wall treatment

The proportion of wall surfaces compared to the ceiling is low in an open-plan space. However, use of wall absorbers can limit reflections for workstations close to walls and especially at corners in the open-plan space. Such absorbers can be useful for curtailing flutter echo between parallel walls. This is also a good way to reduce reverberation, if diffusion is low (little furniture). If there is a risk of absorptive material damage, stress-resistant treatments should be favoured and should be positioned above potential impact level. Wall coverings should be installed at approximately 1.2 m above the floor: the height of a seated person's ears.

Floor treatment

Floor covering absorption performance is limited, so its contribution to general absorption inside the room is not usually significant. Special coverings with acoustics layers in the floor cover can support mid and high frequency absorption. Perforated cavity flooring systems can deliver broad band absorption. The main benefit of proper floor covering selection for acoustic treatment is less impact noises associated with movement of people and furniture. In the case of the use of access flooring, a special attention should be brought to the use of structure insulation to prevent impact noise and limit resonance of footsteps throughout the office.

Appendix C. Acoustic Modelling

D.1. Locations of modelled receivers

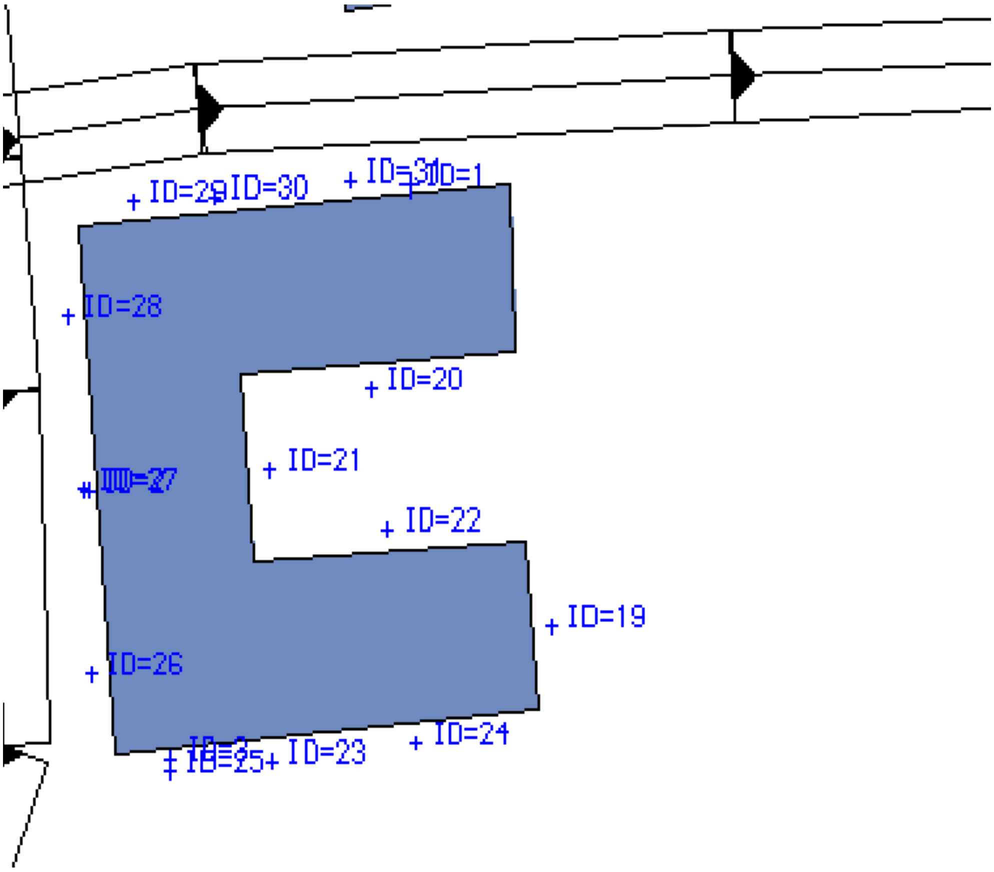

Figure C-1 - Locations of modelled receivers (In plan)

C.1. Predicted Noise Levels in Different Locations and Heights

Table C-1 - Predicted noise levels (IDs 1-16)

Receiver Number	Receiver Name	Floor	$L_{Aeq, night}$ (dBA)	$L_{Aeq, day}$ (dBA)
1	prediction N	N/A	60.7	68.9
2	prediction W	N/A	60.7	68.9
3	prediction S	N/A	54.7	62.6

Table C-2 - Predicted noise levels (IDs 17-26)

Receiver Number	Receiver Name	Floor	$L_{Aeq, night}$ (dBA)	$L_{Aeq, day}$ (dBA)
18	Main Building E1	0	52.1	59.8
18	Main Building E1	1	54.1	61.9
18	Main Building E1	2	54.7	62.6
18	Main Building E1	3	54.6	62.4
18	Main Building E1	4	54.6	62.4
19	Main Building E2	0	41.3	48.4
19	Main Building E2	1	43.5	50.7
19	Main Building E2	2	44.7	52

19	Main Building E2	3	45.7	53.1
19	Main Building E2	4	46.8	54.2
20	Main Building I3	0	31.7	38.2
20	Main Building I3	1	32.8	39.4
20	Main Building I3	2	34.1	40.8
20	Main Building I3	3	35.9	42.7
20	Main Building I3	4	38.1	45
21	Main Building I2	0	32.2	38.8
21	Main Building I2	1	34	40.7
21	Main Building I2	2	36.5	43.4
22	Main Building I1	0	33.3	39.9
22	Main Building I1	1	34.5	41.2
22	Main Building I1	2	35.7	42.5
22	Main Building I1	3	37.1	43.9
22	Main Building I1	4	38.8	45.7
23	Main Building S2	0	48.7	56.2
23	Main Building S2	1	51.1	58.8
23	Main Building S2	2	52.4	60.1
23	Main Building S2	3	53	60.8
23	Main Building S2	4	53.1	60.9
24	Main Building S1	0	45.1	52.4
24	Main Building S1	1	47.3	54.7
24	Main Building S1	2	48.7	56.2
24	Main Building S1	3	49.9	57.5
24	Main Building S1	4	50.5	58.1
25	Main Building S3	0	53.3	61.1
25	Main Building S3	1	55.6	63.6
25	Main Building S3	2	55.6	63.6

Table C-3 - Predicted noise levels (IDs 27-31)

Receiver Number	Receiver Name	Floor	$L_{Aeq, night}$ (dBA)	$L_{Aeq, day}$ (dBA)
26	Main Building W3	0	59.8	67.9
26	Main Building W3	1	60.6	68.8
26	Main Building W3	2	59.7	67.9
27	Main Building W2	0	59.9	68
27	Main Building W2	1	60.5	68.7
27	Main Building W2	2	59.6	67.8
28	Main Building W1	0	60.2	68.4
28	Main Building W1	1	61	69.3
28	Main Building W1	2	60	68.2
29	Main Building N3	0	60.3	68.5
29	Main Building N3	1	61.3	69.6
29	Main Building N3	2	60.5	68.7
30	Main Building N2	0	60	68.1
30	Main Building N2	1	60.9	69.1

30	Main Building N2	2	60.6	68.8
30	Main Building N2	3	60.1	68.3
30	Main Building N2	4	59.6	67.8
31	Main Building N1	0	60.1	68.3
31	Main Building N1	1	61	69.3
31	Main Building N1	2	60.5	68.7
31	Main Building N1	3	60	68.2
31	Main Building N1	4	59.5	67.7

Appendix D. Noise Survey

D.1. Survey Photos

Figure D-1 - Monitoring Position 1, facing North

Figure D-2 - Monitoring Position 2, facing West

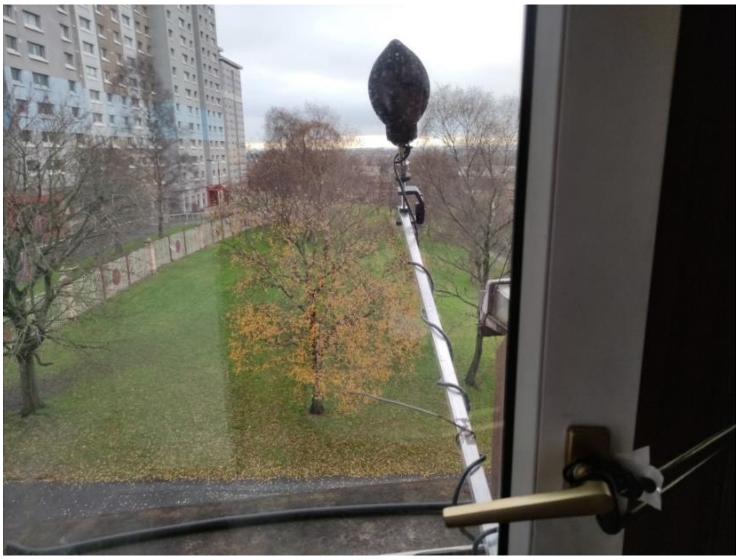

Figure D-3 - Monitoring Position 3, facing South

Figure D-4 - Monitoring Position 4, facing East (Townhouses location)

Figure D-5 - Monitoring Position 5, main building courtyard

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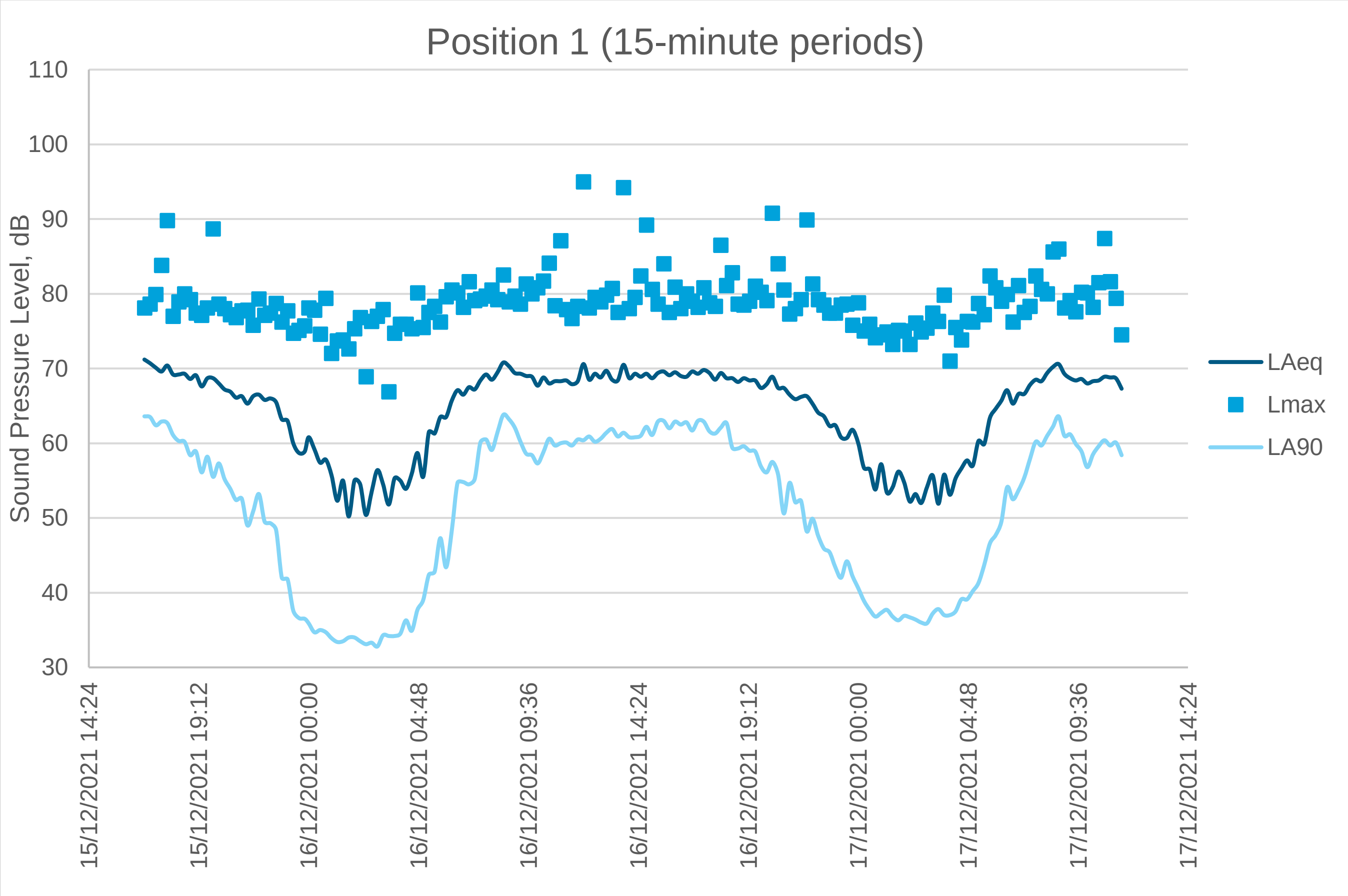
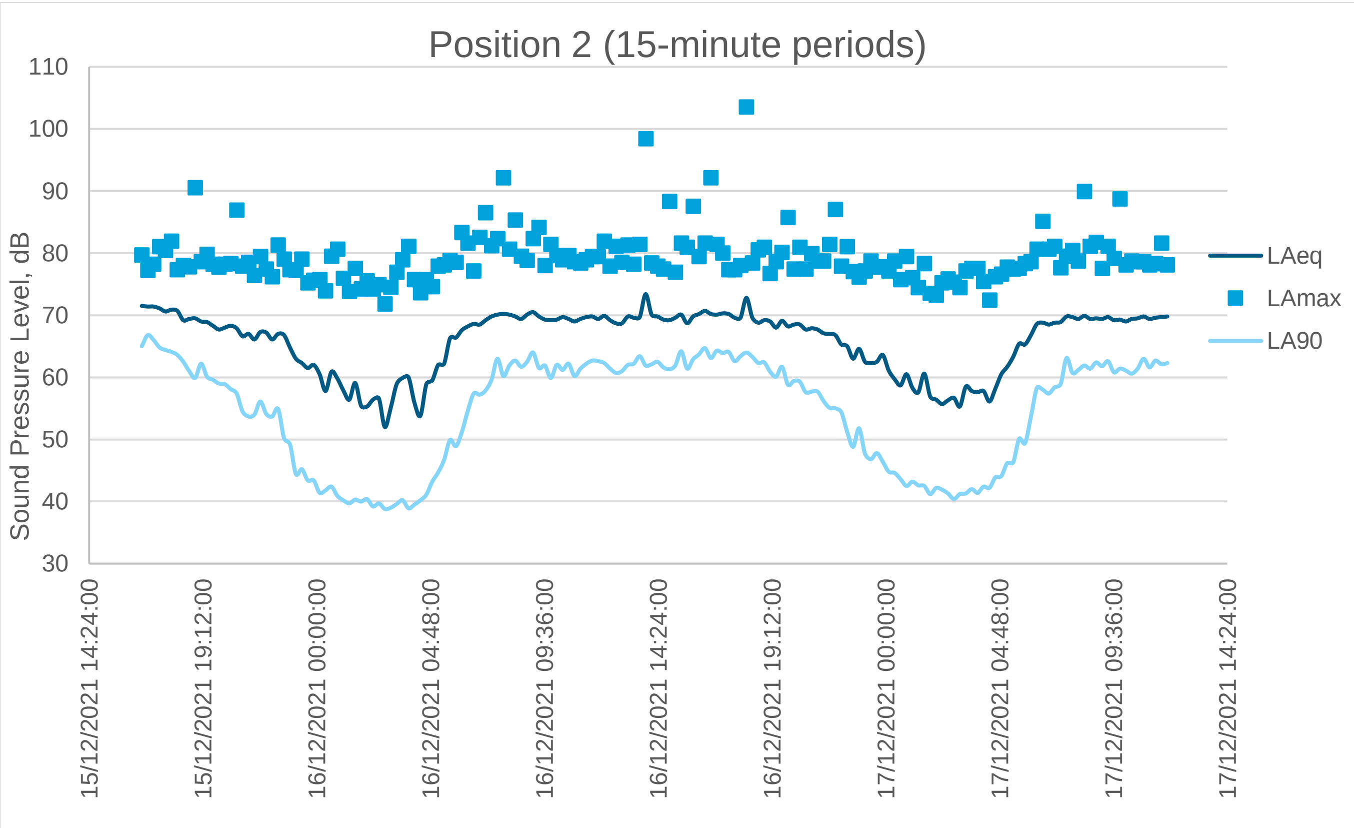
D.2. Equipment Details

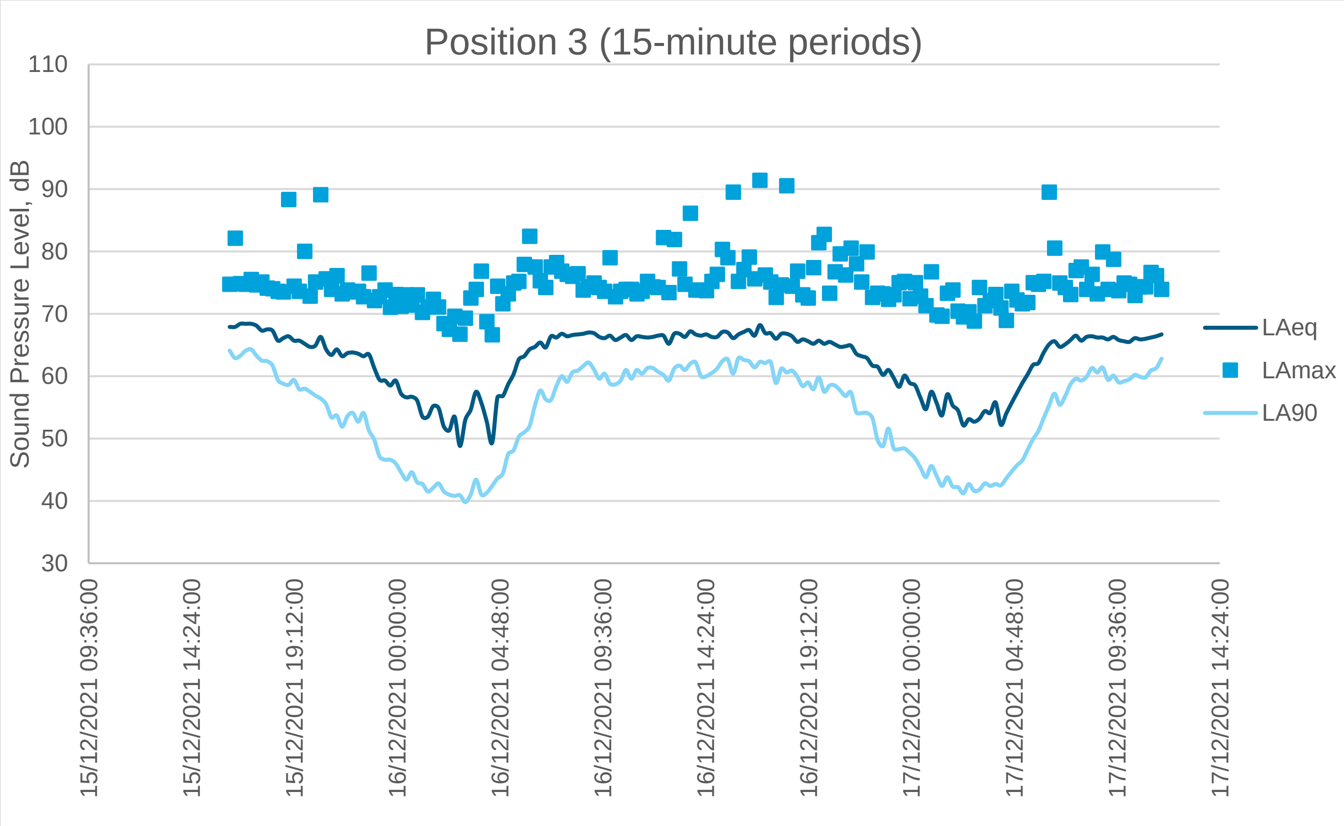
Table D-1 - Sound level meters

	Type	Manufacturer	Model	Serial	Last Laboratory Calibration
SLM for Sound Insulation tests, Measurement Positions 4 & 5	Frequency Meter	Norsonic	140	1407471	26/11/2021
	Microphone	Norsonic	1225	358137	26/11/2021
	Preamplifier	Norsonic	1209	22335	26/11/2021
	Associated Calibrator	Norsonic	1251	29152	26/11/2021
Position 1	Frequency Meter	01dB	FUSION	11201	17/11/2020
	Microphone	GRAS	40CE	233351	17/11/2020
	Ext Pre Amplifier	01dB	Pre No22	1605099	17/11/2020
	Int Pre Amplifier	01dB	FUSION	11201	17/11/2020
	Associated Calibrator	01dB	CAL21	34565048	23/11/2021
Position 2	Frequency Meter	Rion	NL-52	00620857	14/10/2021
	Microphone	Rion	UC-59	03693	14/10/2021
	Pre Amplifier	Rion	NH-25	20917	14/10/2021
	Associated Calibrator	Rion	NC-74	35125804	13/10/2021
Position 3	Frequency Meter	Rion	NL-52	00620854	30/09/2020
	Microphone	Rion	UC-59	3690	30/09/2020
	Pre Amplifier	Rion	NH-25	20914	30/09/2020
	Associated Calibrator	Rion	NC-74	35125802	27/04/2021

D.3. Time History Charts of Measured Noise Data at Positions 1,2 & 3







D.4. Measured Noise Data at Positions 4 & 5

Table D-2 - Noise levels measured at positions 4 & 5 (17/12/21)

Position ID	Start time	Duration	dB $L_{Aeq,T}$	dB $L_{Amax,F}$	dB $L_{A90,T}$	Adjacent School Interval
Position 4	09:44	15min	49.7	60	45.3	N
	10:18	15min	53.1	65.1	44.4	N
	10:33	10min	56	71.4	50.4	Y
	10:48	15min	54.5	72.3	46.5	N
Position 5	10:01	15min	49.7	60	45.3	N
	11:05	15min	50.8	61	46.5	N

Appendix E. Sound Insulation Test Markup

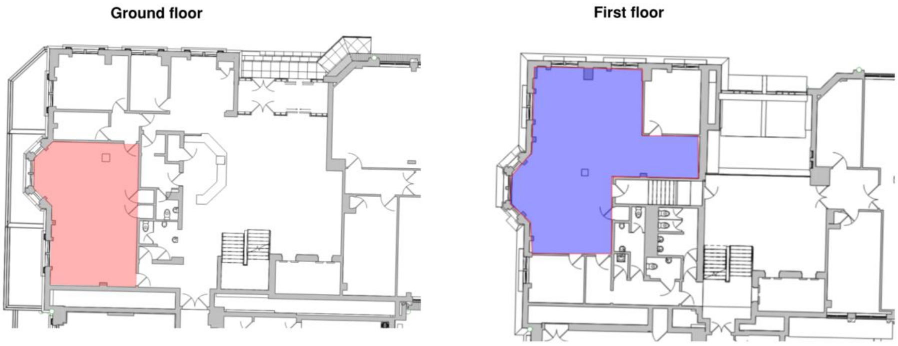


Figure 8-7 - Floor sound insulation test, no. 1

Figure 8-8 - Floor sound insulation test, no. 2

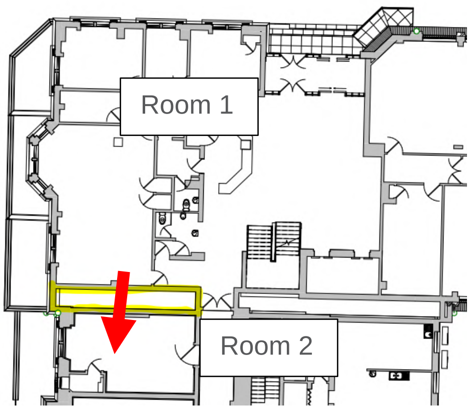


Figure 8-9 - Wall sound insulation test, no.1

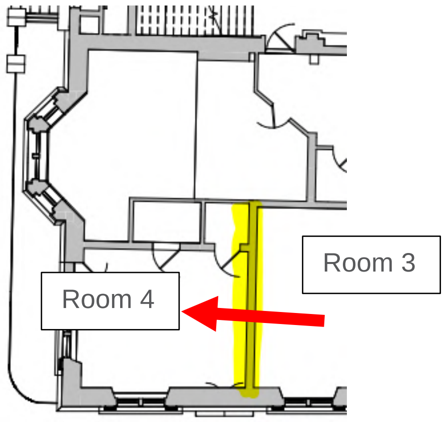


Figure 8-10 - Wall sound insulation test, no.2

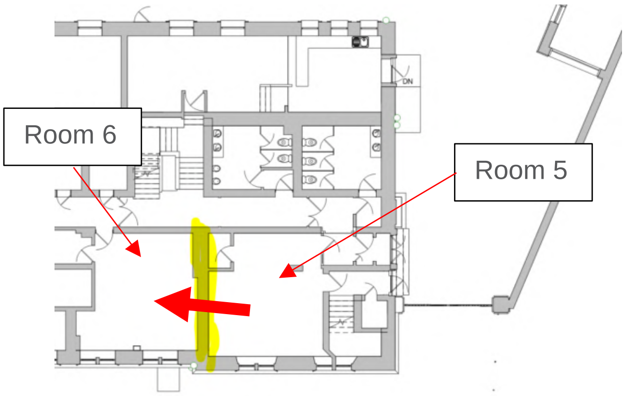


Figure 8-11 - Wall sound insulation test, no.3

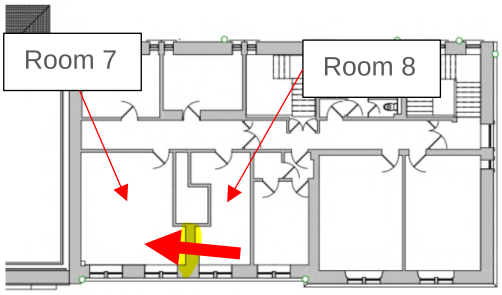


Figure 8-12 - Wall sound insulation test, no.4

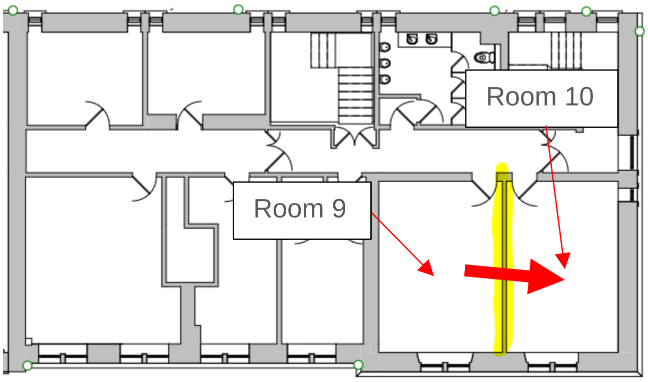


Figure 8-13 - Wall sound insulation test, no.5

Appendix F. Façade Markup Drawing

Appendix G. Example Constructions

The example construction details to achieve the required acoustic ratings are shown in Table G-1 and Table G-2. The acoustic ratings are shown in the markup drawings in a separate document.

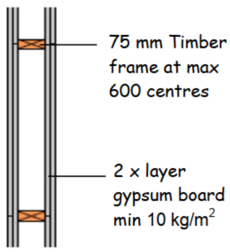
Table G-1 - Example construction details for walls

Acoustic rating	Example construction
≥ 40 dB R_w	The following examples are taken from the Scottish Government guidance: Example construction and generic internal constructions. Other construction details are also possible to achieve 40 dB R_w. The gypsum board can be 12.5 mm Gyproc WallBoard

Option 1

Type 1 Timber frame

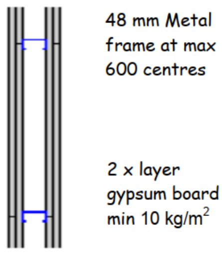
- 2 layers of gypsum based board, each layer with a total minimum mass per unit area 10 kg/m^2.
- Timber frame with minimum 75 mm studs at maximum 600 mm centres.
- All joints staggered and sealed.



Option 2

Type 2 Metal frame

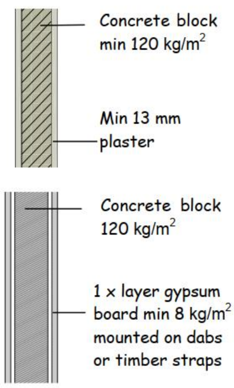
- 2 layers of gypsum based board, each layer with a total minimum mass per unit area 10 kg/m^2.
- Metal frame with minimum 48 mm metal studs at maximum 600 mm centres.
- All joints staggered and sealed.



Option 3

Type 3 Solid wall - concrete block

- Minimum 13 mm plaster coat or gypsum based board minimum mass per unit area 8 kg/m^2, mounted on dabs or timber straps, on both sides.
- Concrete block minimum mass per unit area, excluding finish 120 kg/m^2.
- All mortar joints fully filled and sealed.



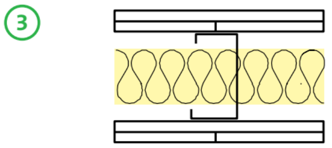
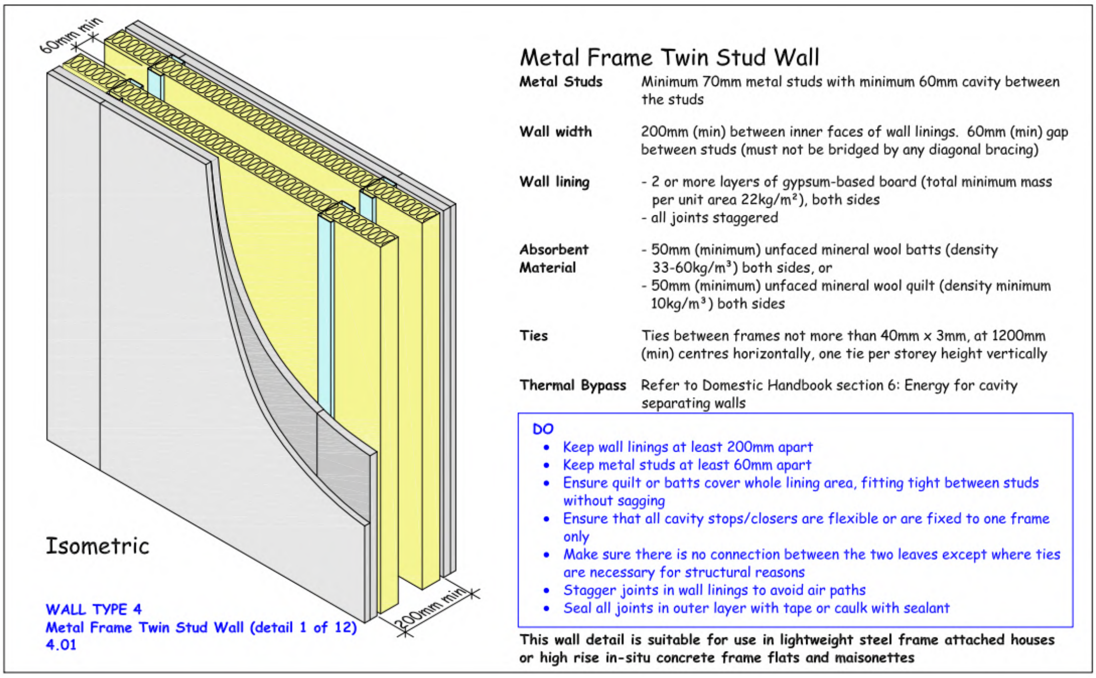
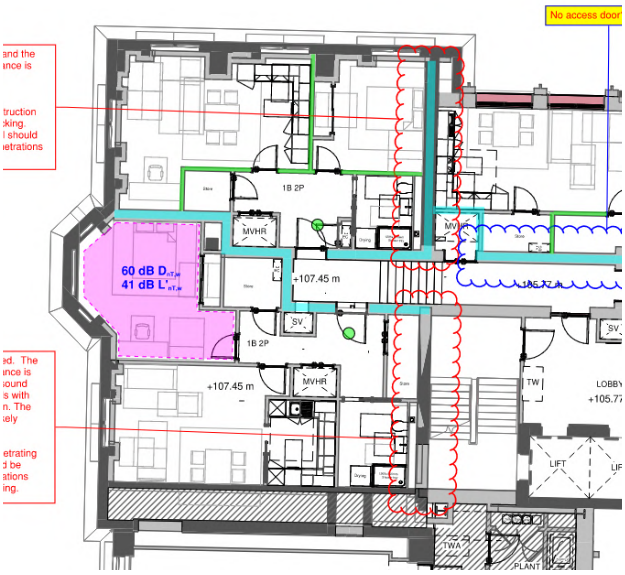
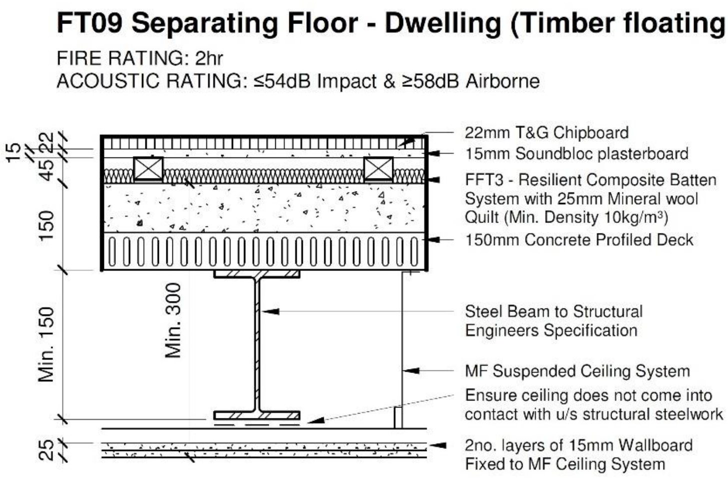
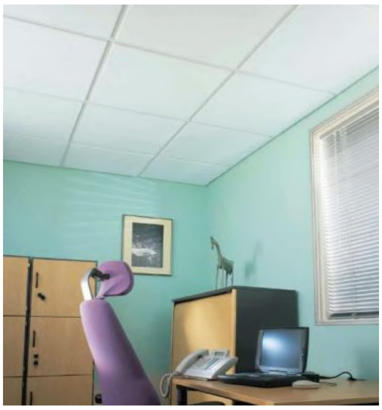
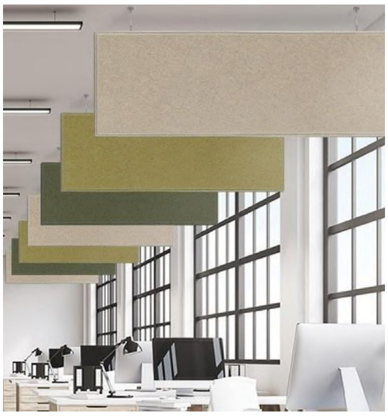
Acoustic rating	Example construction
≥ 53 dB R_w	 Two layers of board each side of 70mm Gypframe 'C' Studs at 600mm centres. 50mm Isover Acoustic Roll in the cavity. Linings as in table. Board Type: 12.5mm Gyproc SoundBloc System reference: British Gypsum A206230
≥ 63 dB R_w	

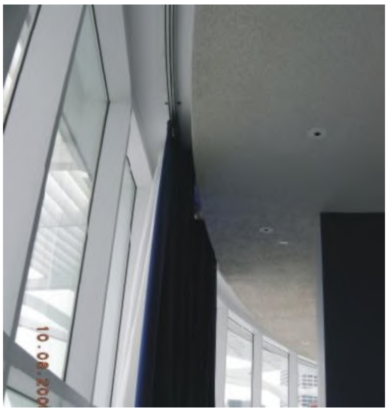
Table G-2 - Example construction details for floors

Floor	Example construction
North Wing	 The sound insulation test between the ground floor and first floor shows that the required sound insulation standard is achieved. The architect proposed to put 100mm floor composition on top of the existing floor. We have requested for the details of the floor composition. The floor composition should include a resilient layer. If the floor construction of the North Wing is the same, it is likely that the required performance standard is achieved.
Police Wing	The architect proposed the following for the floor of the Police Wing  We suggested the following: • 100mm (minimum) mineral wool quilt insulation in the gap between the floor base and ceiling • Metal resilient ceiling bars
Main Building	Architects to provide details for acousticians to review.

Appendix H. Example Absorbing Materials

Table H-1 - Example sound absorbing materials

Material/Performance	Description	
Carpet	Carpet generally should be considered as part of the holistic assessment of sound absorption	
Mineral fibre ceiling tiles/ Class A	Lay in grid, or similar ceiling tiles. Not all tiles achieve the same acoustic performance, but for the same aesthetic Class A can be achieved. The higher performance typically requires a reasonable air space behind the tile and possibly also a blanket of mineral wool laid above. Example products include Armstrong 'Nevada', Rockfon 'Sonar' and Ecophon 'Focus'.	
Soffit spray (cellulose)/ Class A	Recycled high grade paper. Cellulose fibre with low embodied energy. Spray applied directly onto gypsum board, concrete, steel sheet and most other surfaces, coarse textured finish. Can achieved up to 100 mm thick, typically 25–50 mm to achieve acoustic performance. Example: SonaSpray K-13 Special Acoustic spray	
Hanging baffles & rafts/ Equivalent absorption area per unit = 1 m^2 sabin (elements approximate area 0.7m^2)	Baffles/Rafts are basically absorption panels, which are hanged freely in space, either horizontally or vertically. Their most important benefit is that a larger area of absorption is exposed to the sound field (2 sides exposed). Apart from helping to control de reverberation time within the room they are a good solution when it comes to localised acoustic treatment in a large venue. For example, can be installed above the workplaces to reduce the sound propagation and increase the privacy from one desk to another Examples: Ecophon Solo and Rockfon Universal Baffle.	

Acoustic wall panels/ Class A	These are pre-made sound absorbing panels finish with a fabric cover mounted directly on the ceiling or wall (1 side exposed). Examples: Shush Liner and Ecophon wall panel.	
Perforated timber and plasterboard/ Class C, Class D	Perforated timber/plasterboards with mineral wool and an airspace behind. Not all perforated timber products achieve the same acoustic performance. Only some perforated timber products can achieve a Class C performance. There are a number of products which can achieve Class D. Example suppliers include Gustafs, Decoustics, Still Acoustic and RPG.	
Heavy drapes	Hung heavy velour drapes can be a very suitable acoustic treatment, and attached to an mechanical track may be installed as operable treatment. Suppliers of operable acoustic curtains and drapes include Triple E.	

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Appendix I. Wall Panel Location Markup

Figure I-1 - Wall panels for offices – Lower ground floor

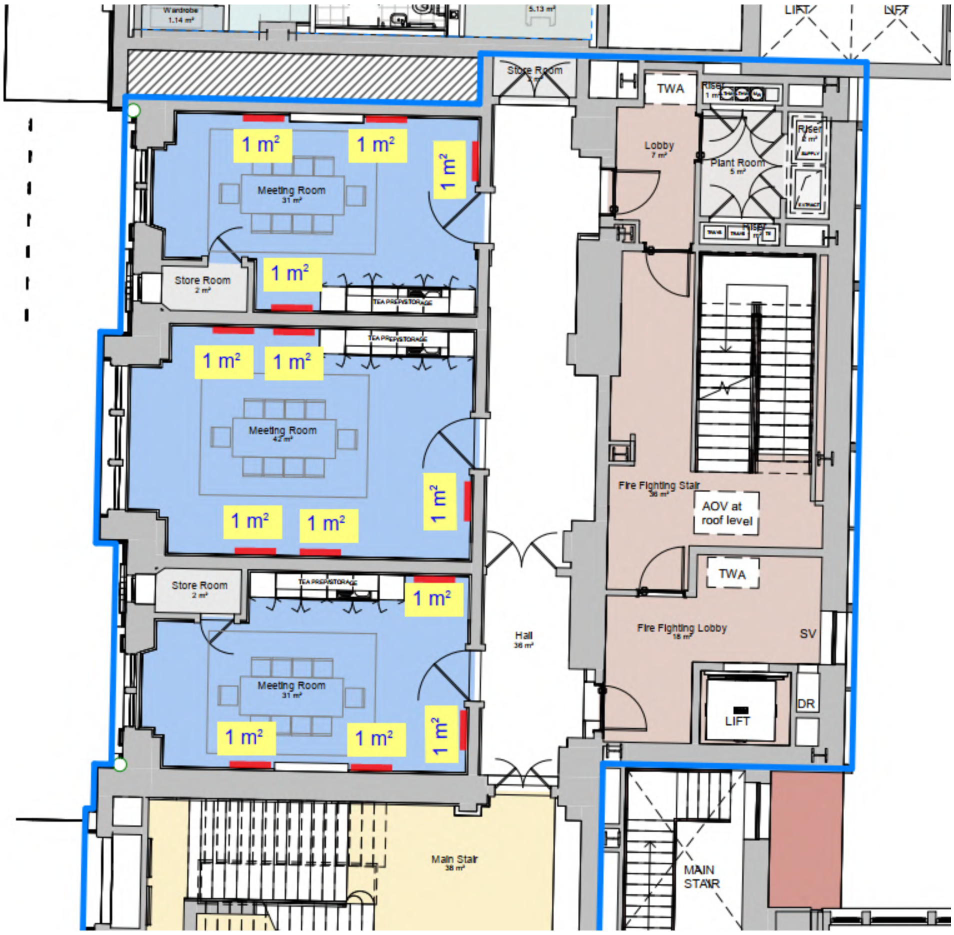

Figure I-2 - Wall panels for offices – ground floor

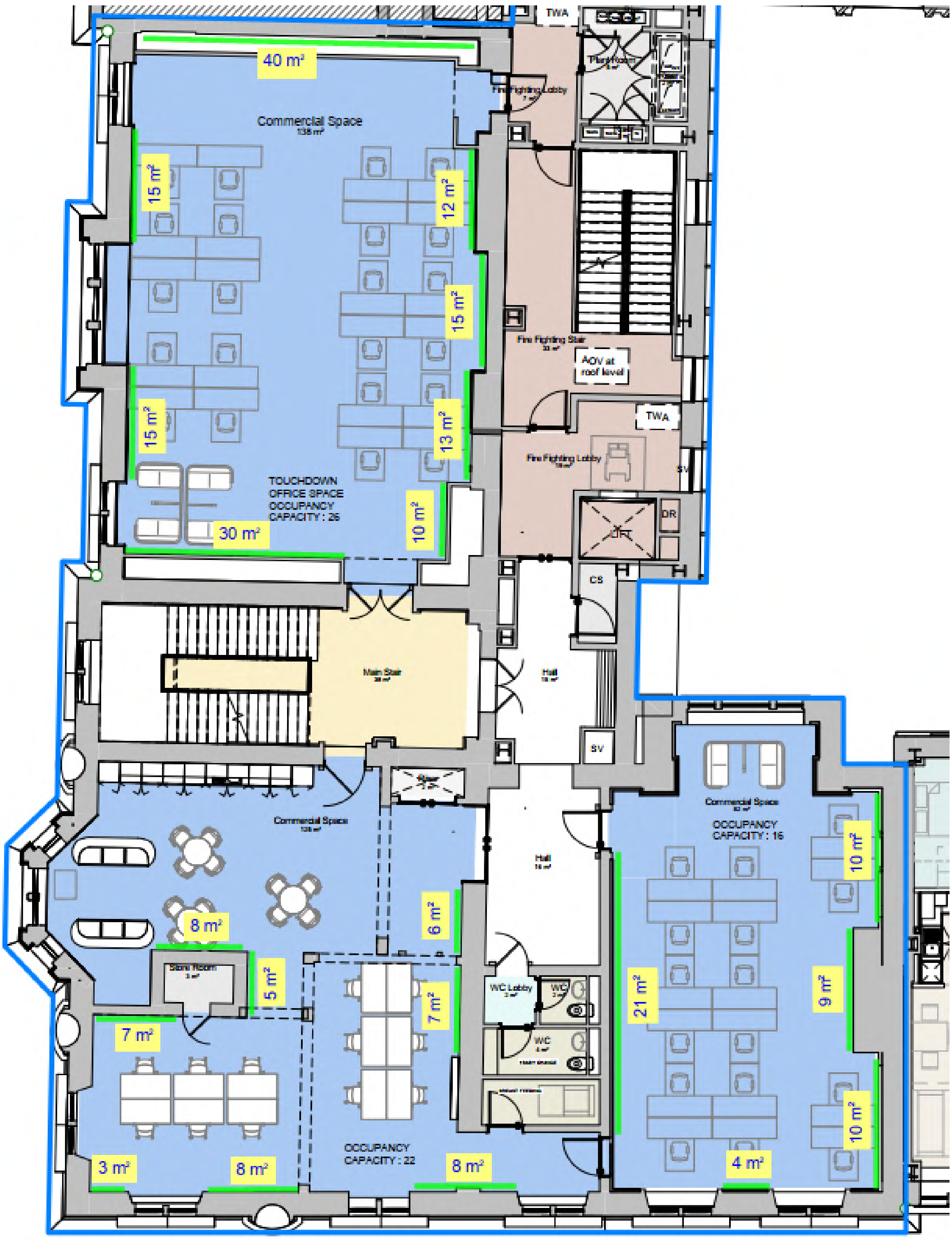

Figure I-3 - Wall panels for offices – first floor

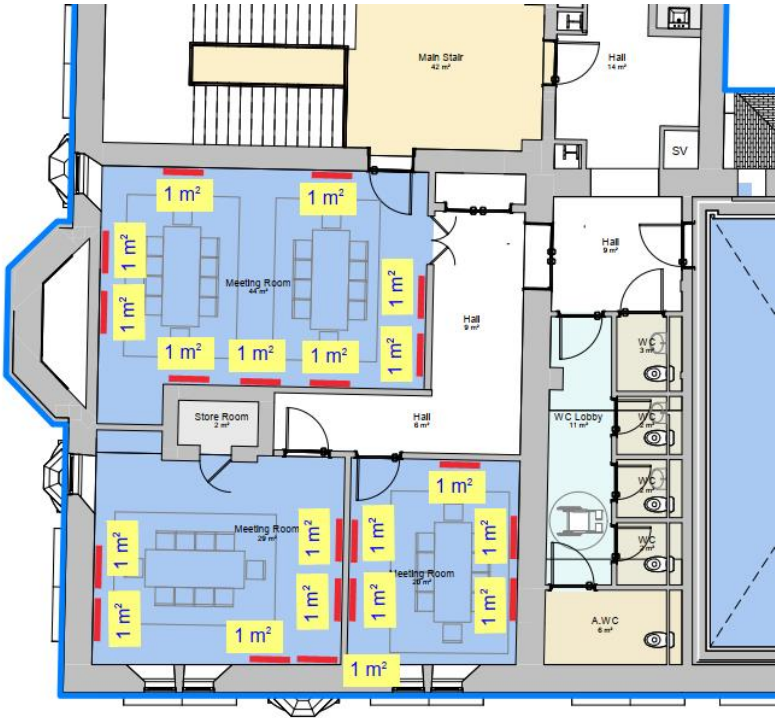

Figure I-4 - Wall panels for offices – third floor

Appendix J. Mechanical Plant and Assessment

J.1. Proposed Mechanical Plant and the Noise Data

Table J-1 - Proposed mechanical plant

Room	Description	Manufacturer/Model	Quantity	Noise data
Offices, Meeting Rooms and Commercial Spaces	Air Handling Unit located on roof top	IV Product / Envistar Flex	1	Table J-2
Apartments	MVHR within the building, locations vary	Nuaire / MRXBOX-ECO - Wall Mounted Multi Room Xbox	1 for each apartment	Table J-3
Offices, Meeting Rooms and Commercial Spaces	Toilet extract fan	AVT6-R	1	Table J-4

Table J-2 - AHU noise data provided by the Envistar

Location	Sound power level (SWL), dB								Total SWL, dBA
	63	125	250	500	1k	2k	4k	8k	
Fresh air inlet (atmosphere side)*	57	60	44	30	24	20	14	11	45
Exhaust air outlet (atmosphere side)*	68	72	57	46	34	46	48	47	58
Supply air (room side)	72	83	76	77	74	71	68	64	79
Extract air (room side)	67	70	62	58	50	46	39	31	60

* Note : the noise data of air inlet and outlet (the atmosphere side) includes the integrated attenuators from the manufacturer.

Table J-3 - MVHR noise data provided by Nuaire

Location	Sound power level dB							
	63	125	250	500	1k	2k	4k	8k
Breakout	44	49	45	43	35	30	17	<16
Intake / extract	40	39	49	41	36	31	18	<16
Supply / Exhaust	49	55	55	56	51	48	37	26

Table J-4 - toilet extract fan noise data provided by AVT6

Location	Sound power level dB							
	63	125	250	500	1k	2k	4k	8k
Open outlet	77	79	76	75	71	68	62	53

J.2. Fan Coil Unit Schedule

The fan coil units proposed to each room are shown in Table J-5.

Table J-5 - Fan coil unit in each room

Room	Fan coil unit
Basement Collab 1	FXSA 32
Basement Office 1	FXSA 20
Basement Welcome 1	FXSA 50
G/F Meeting 1 + 3 2	FXSA 40
G/F Meeting 2 1	FXSA 50
1st Comm Space 1 2	FXSA 80
1st Comm Space 2 2	FXSA 80
1st Comm Space 3 2	FXSA 50
1st Office Z1 1	FXSA 32
1st Office Z2 1	FXSA 40
3rd Meeting Room 1 1	FXSA 50
3rd Meeting Room 2 1	FXSA 32
3rd Meeting Room 3 1	FXSA 25

J.3. Mechanical Noise Prediction and Assessment

The calculated specific sound level from the Air Handling Unit (AHU) at the receptors are shown in Table J-6. The calculated specific sound level contour at 4 m is shown in Figure J-1.

The air handling unit is likely to produce broadband noise with no tonal features. The specific sound level is predicted to be far below the daytime background sound level and is unlikely to be discernible. No sound features corrections are applied.

Table J-6 - Calculated specific sound levels

Location	Highest specific sound level	Sound feature penalty,	Rating level	Comment
Residential dwellings at Kildonan Street	10 dB $L_{Aeq,15min}$	+ 0 dB	10 dB $L_{Ar,Tr}$	Noise level at the façade of the noise sensitive building (free-field) level
Residential dwellings Muiyhall Street	0 dB $L_{Aeq,15min}$	+ 0 dB	0 dB $L_{Ar,Tr}$	
Residential dwellings at Weir Street	-4 dB $L_{Aeq,15min}$	+ 0 dB	-4 dB $L_{Ar,Tr}$	
Dunbeth Court	18 dB $L_{Aeq,15min}$	+ 0 dB	18 dB $L_{Ar,Tr}$	
Proposed apartment	30 dB $L_{Aeq,15min}$	N/A	N/A	

Figure J-1 - Specific sound level contour at 10.5 m

J.4. Attenuator Insertion Loss

The required insertion loss for the attenuators used for the room side of the AHU is shown in Table J-7

Table J-7 - AHU room side attenuators

Location	Insertion loss, dB							
	63	125	250	500	1k	2k	4k	8k
AHU room side supply	0	11	15	25	25	24	22	20
AHU room side return	0	0	5	15	15	14	12	10

The required insertion loss for the cross-talk attenuators between commercial spaces are shown in Table J-8.

Table J-8 - Cross talk attenuators for commercial spaces

Location	Insertion loss, dB							
	63	125	250	500	1k	2k	4k	8k
As shown in Figure J-2, Figure J-3, Figure J-4, and Figure J-5	0	0	3	13	16	13	15	0

The required insertion loss for the MVHR attenuators are shown in Table J-9.

Table J-9 - MVHR room side attenuators

Location	Insertion loss, dB							
	63	125	250	500	1k	2k	4k	8k
MVHR supply	0	0	3	12	11	11	2	0
MVHR return	0	0	0	0	0	0	0	0

The required insertion loss for the toilet extract fan attenuator is shown in Table J-10.

Table J-10 - toilet extract fan attenuator

Location	Insertion loss, dB*							
	63	125	250	500	1k	2k	4k	8k
Extract to atmosphere	5	6	13	17	21	16	15	11

*Note: this is the proposed performance of AVT6-MSS-X by the manufacturer.

J.5. Cross-talk attenuator markup

The cross-talk attenuators should be located between the commercial spaces. The preferred locations are shown in Figure J-2, Figure J-3, Figure J-4, and Figure J-5. These locations are indicative, and the principles described in 7.2.1 should be followed.

Cross-talk attenuators

Figure J-2 - cross-talk attenuator – lower ground floor

Cross-talk attenuators

Figure J-3 - cross-talk attenuator –ground floor

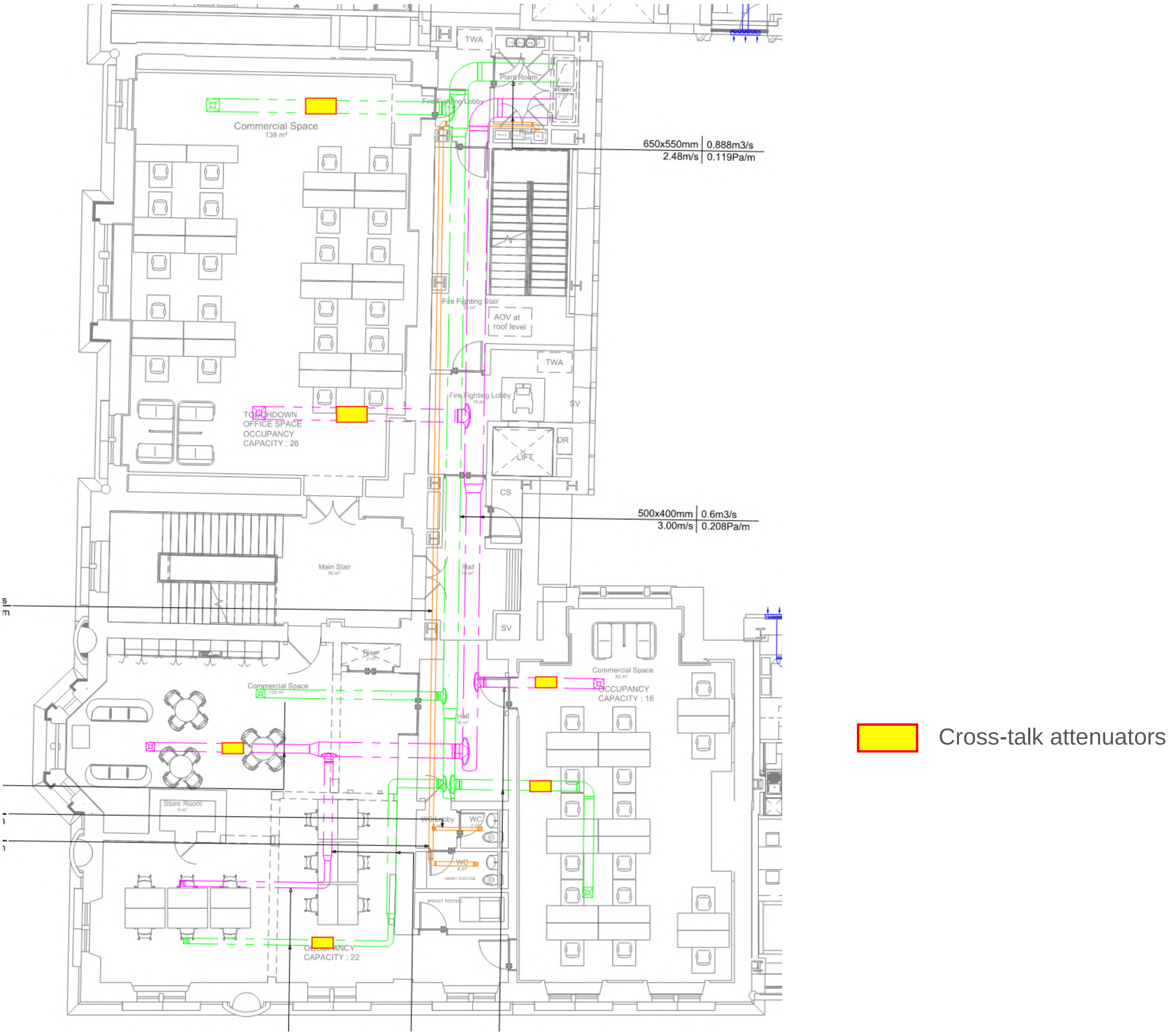

Figure J-4 - cross-talk attenuator – first floor

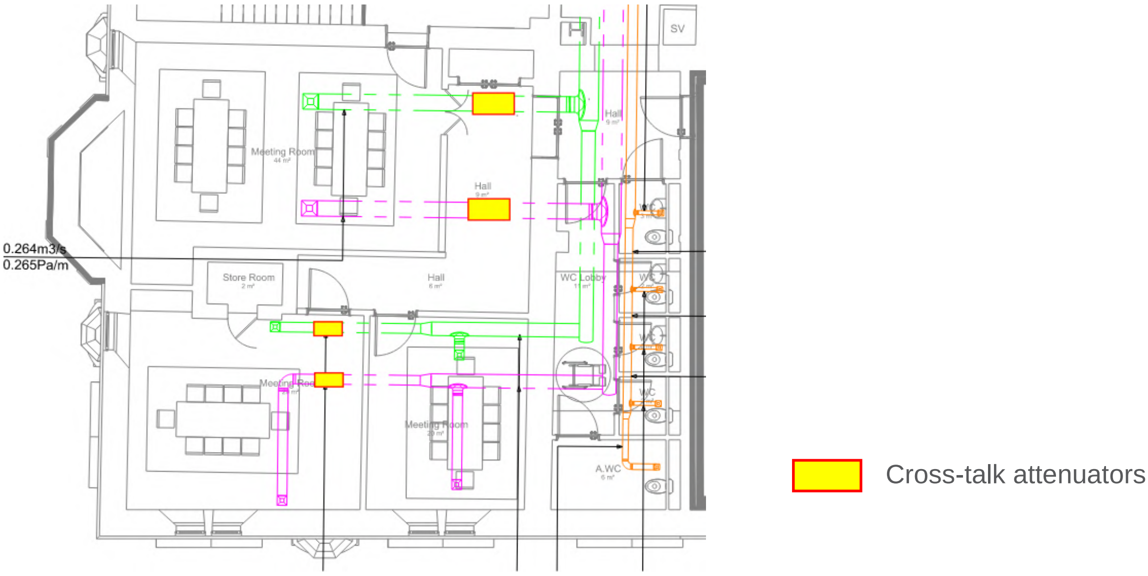

Figure J-5 - cross-talk attenuator – third floor

Appendix K. Vibration Isolation

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

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

Table 4.56 Vibration isolation selection chart

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

The floor plan refers to the largest dimension between supporting columns. The equipment is assumed to be at mid-span.
* F = glass fibre, H = hanger, L = restrained spring, N = rubber, S = freestanding spring.
† SBB = steel beams, SFB = steel frame base, CIB = concrete inertia base.

Appendix L. Typical Service Penetration Details (Design Intent Only)

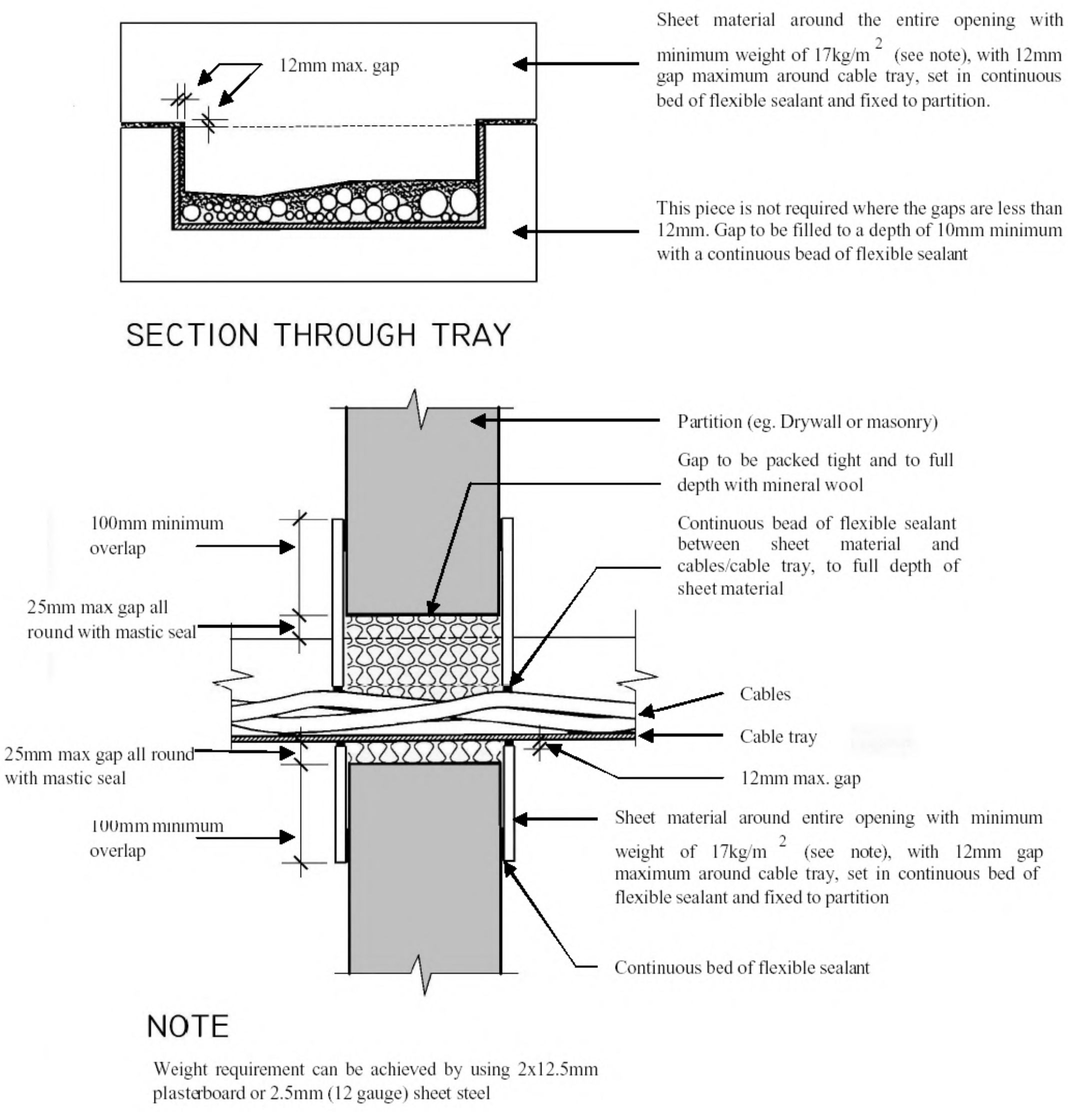

Figure L-1 - Cable tray penetration (single partition)

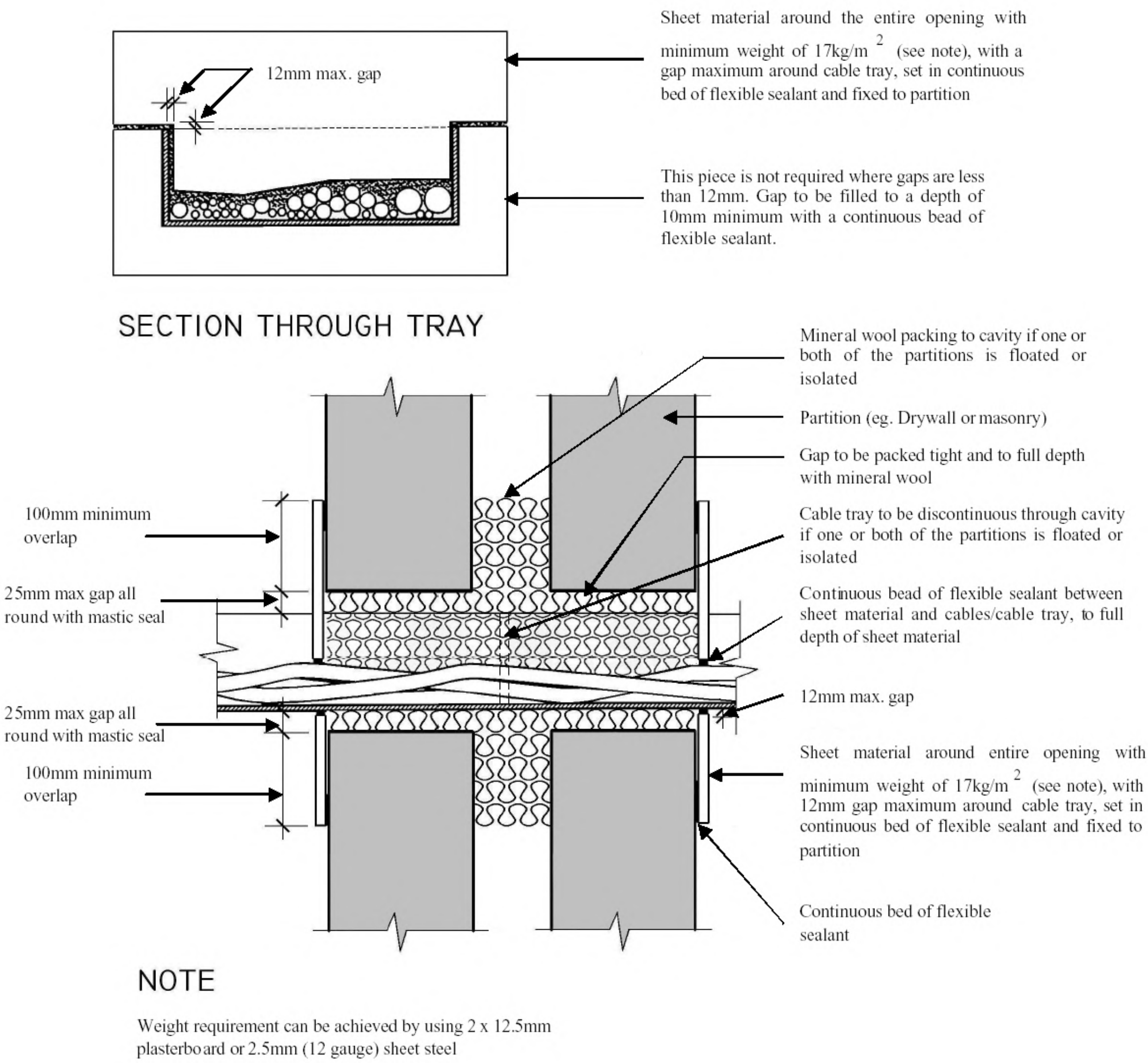

Figure L-2 - Cable tray penetration (double partition)

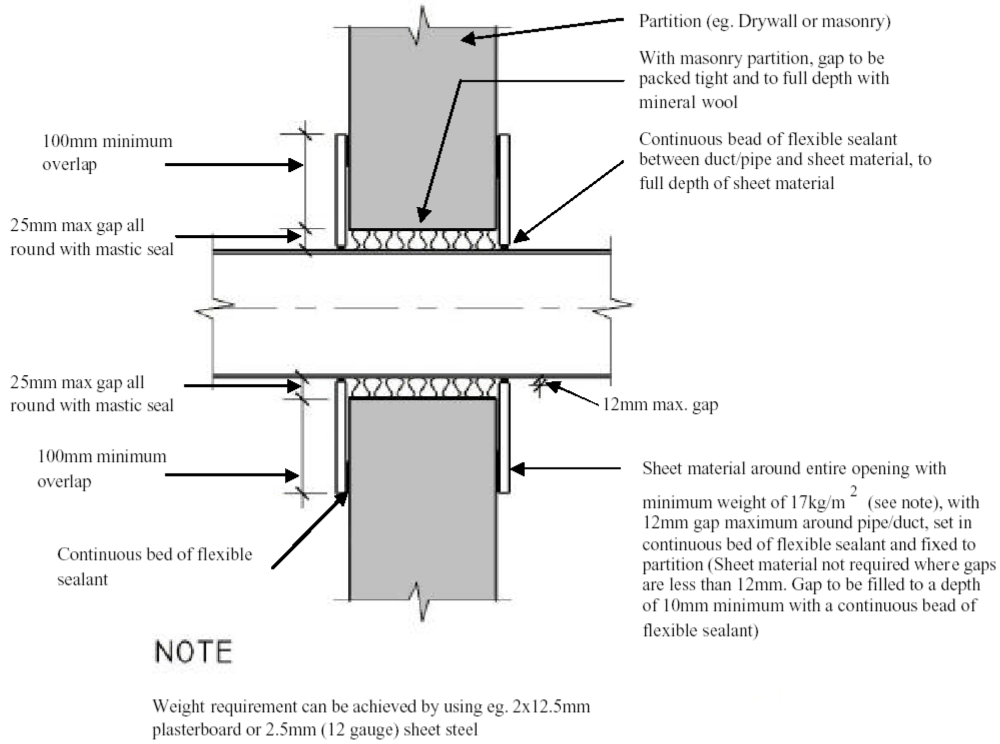

Figure L-3 - Duct/pipe penetration (single partition)

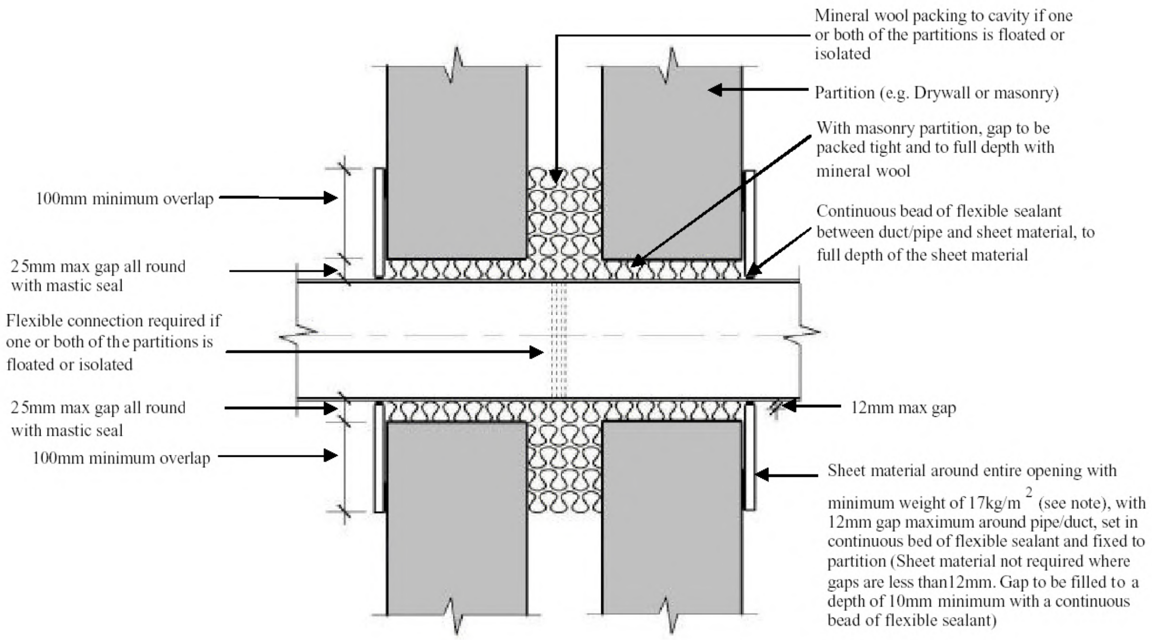

Figure L-4 - Duct/pipe penetration (double partition)

Figure L-5 - Duct penetration with gypsum cover plate site photo

Figure L-6 - Pipe and cable tray penetration with gypsum cover plate

Appendix M. Air Flow Velocity and Flow Generated Noise

Table M-1 - Relation between air flow and generated noise, CIBSE B4 guidance

Duct type	Rectangular: Limiting duct velocity / (m/s) for stated NR				Circular: Limiting duct velocity / (m/s) for stated NR			
	20	25	30	35	20	25	30	35
Main ducts* (handling 50–100% of fan volume)	9.0	10.0	12.0	12.0	12.5	13.5	15.0	15.0
Main risers* (handling 10–70% of fan volume):								
— in builderswork masonry	7.5	7.5	8.5	10.0	9.0	11.0	13.0	15.0
— in superficial timber or plasterboard voids	4.0	5.0	6.0	7.5	7.5	10.0	11.0	12.5
Run outs (handlinq 10–30% of fan volume)†	3.5	4.0	4.5	7.0	5.0	6.5	7.5	9.0
Feeder spurs† (handling <5% of fan volume)	2.5	3.0	3.5	4.5	3.5	4.0	5.0	6.0
Grille duct feeders: supply grilles (no dampers):								
— perfect uniform flow (1.42–0.47 m^3/s)	1.5	1.8	2.1	2.5	1.5	1.8	2.1	2.5
— perfect uniform flow (0.74–0.19 m^3/s)	1.7	2.0	2.8	3.6	1.7	2.0	2.8	3.6
— perfect uniform flow (<0.19 m^3/s)	2.1	2.8	3.3	4.0	2.1	2.8	3.3	4.0
— less good but not bad flow (i.e. normal situations)	1.2	1.5	1.7	2.5	1.2	1.5	1.7	2.5
— bad flow	N/A	N/A	1.2	1.4	N/A	N/A	1.2	1.4
Grille duct feeders: extract grilles (no dampers):								
— 1.42 to 0.47 m^3/s	2.0	2.4	2.6	3.1	2.0	2.4	2.6	3.1
— 0.74 to 0.19 m^3/s	2.1	2.4	3.3	4.0	2.1	2.4	3.3	4.0
— <0.19 m^3/s	2.4	3.1	3.8	4.5	2.4	3.1	3.8	4.5

This table shows suggested limiting duct velocities to meet given NR levels in conditioned areas for various duct sections and configurations.

*Main ducts and main risers are not considered to be in the conditioned areas but only feeding to it.
† Behind suspended ceiling of 12.5 mm mineral board tiles or better (not for open ceilings).

Appendix N. Sound Insulation Markup

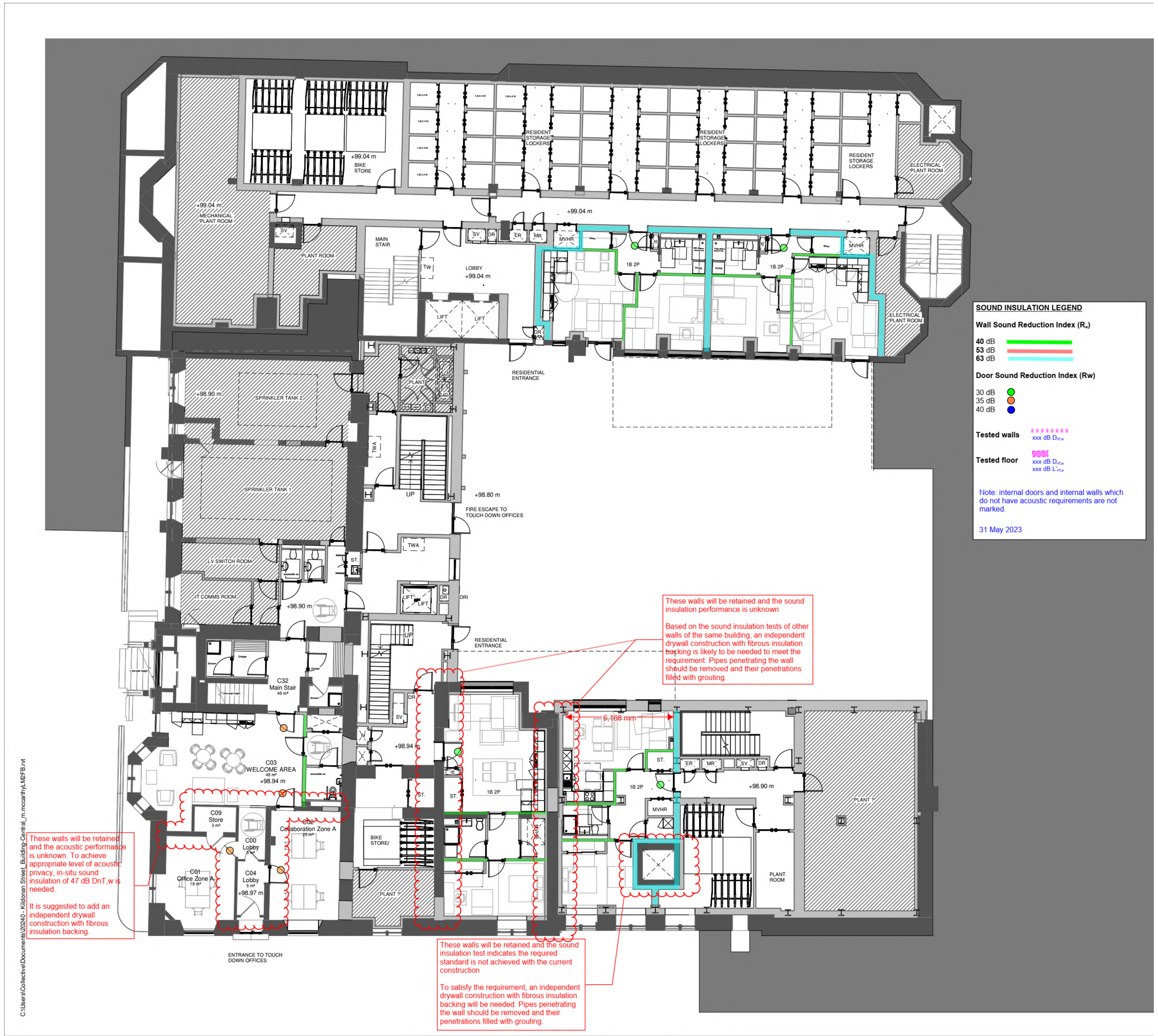

Figure N-1 - Lower ground floor sound insulation markup

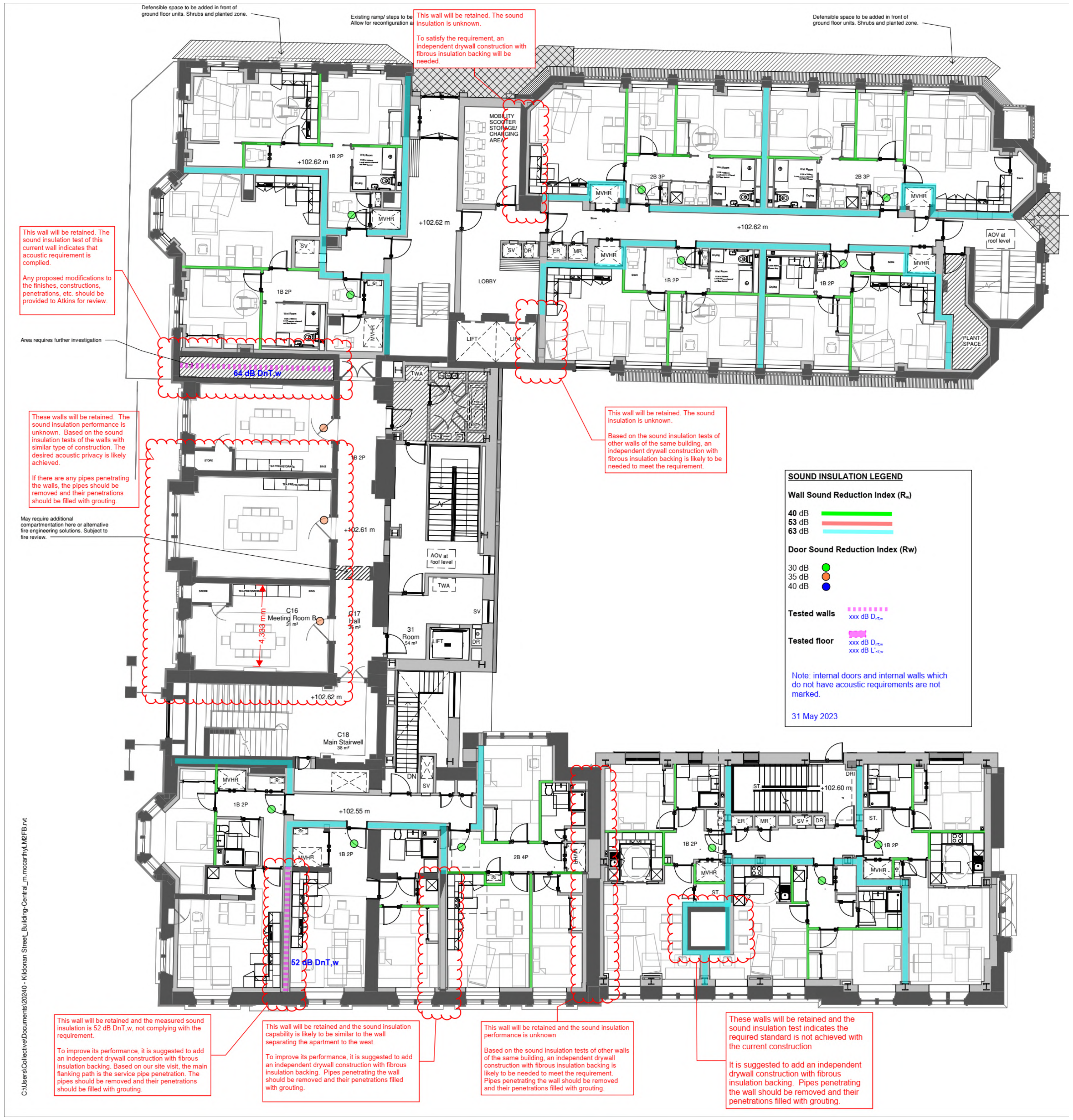

Figure N-2 - ground floor sound insulation markup

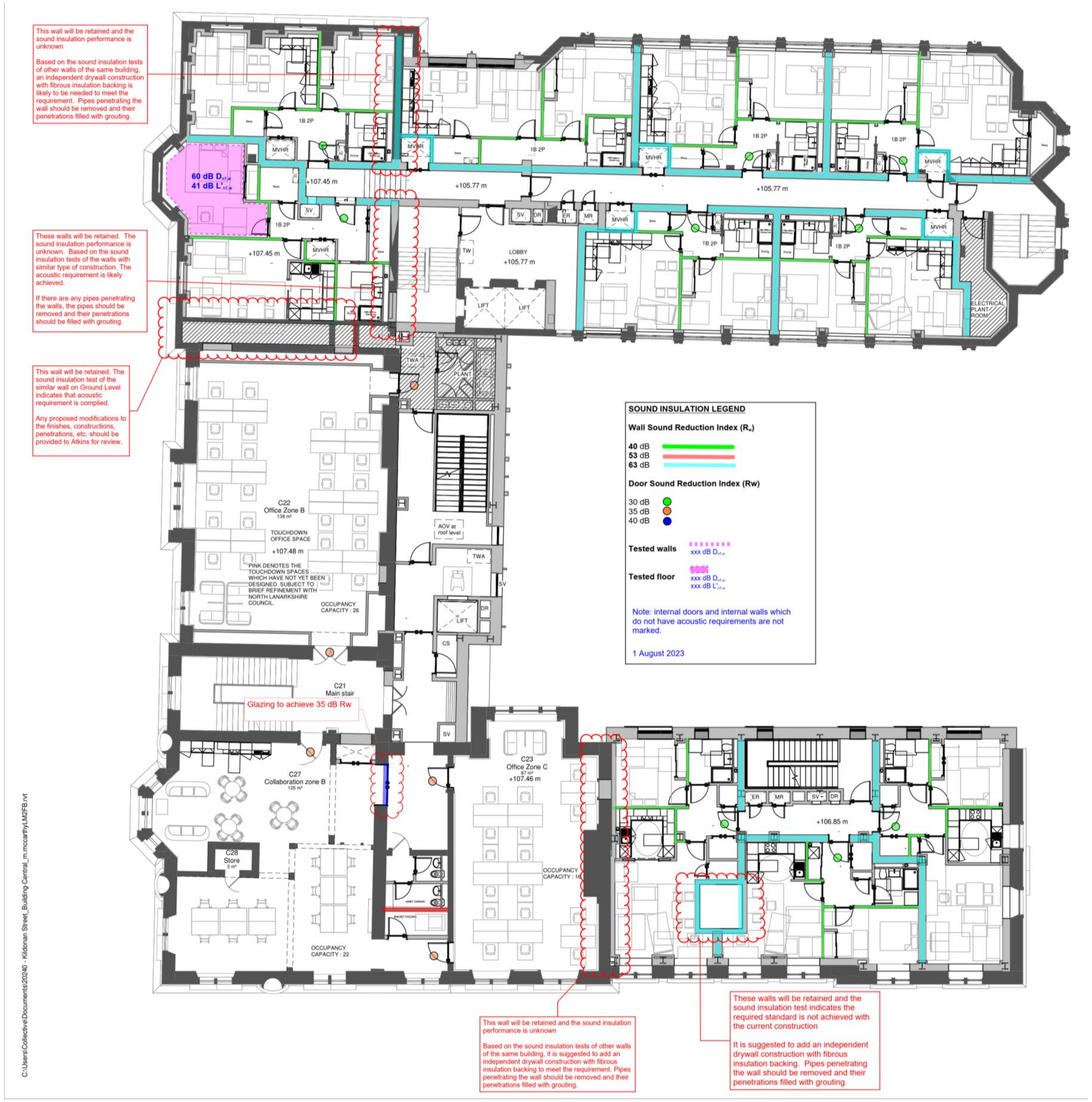

Figure N-3 - first floor sound insulation markup

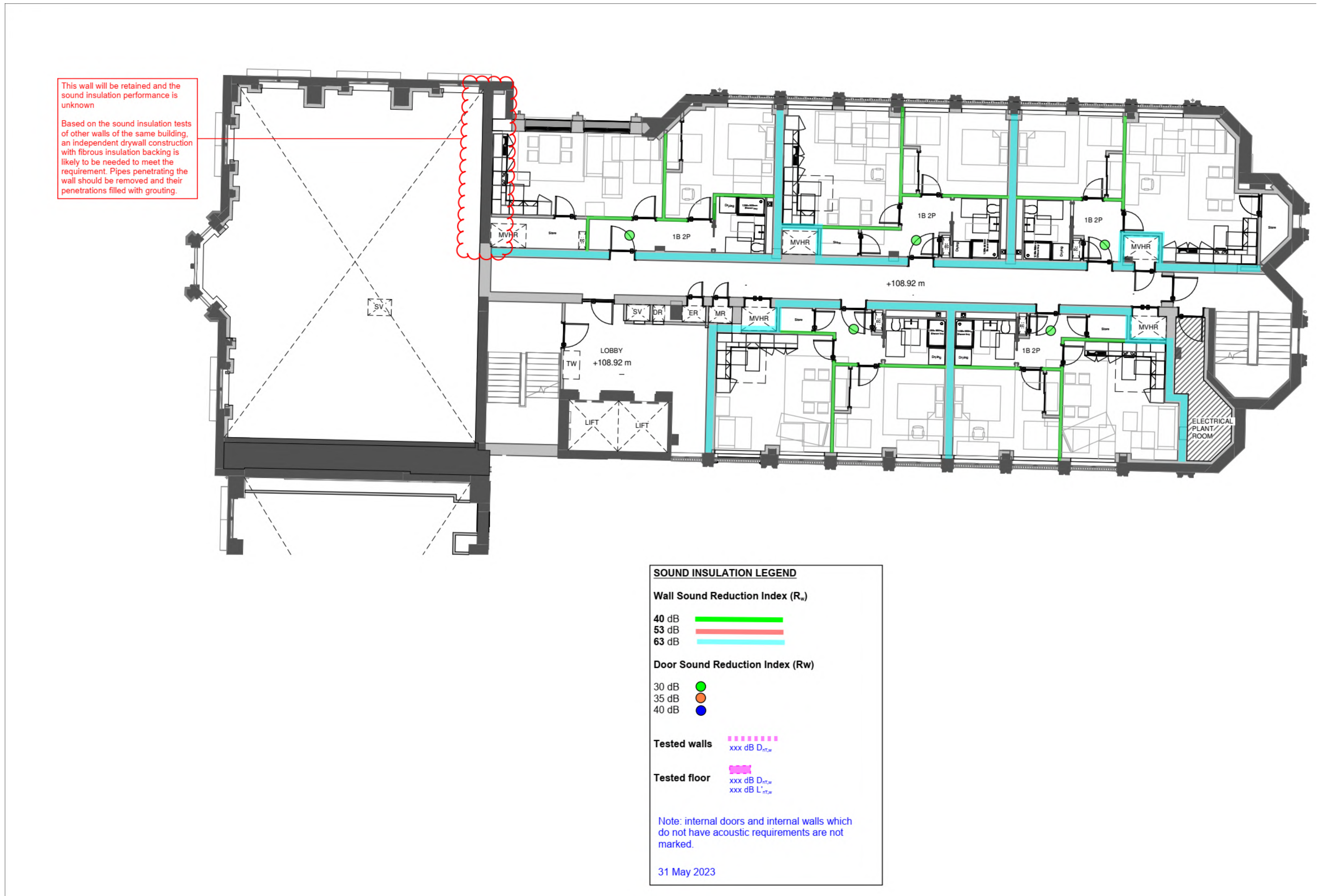

Figure N-4 - second floor sound insulation markup

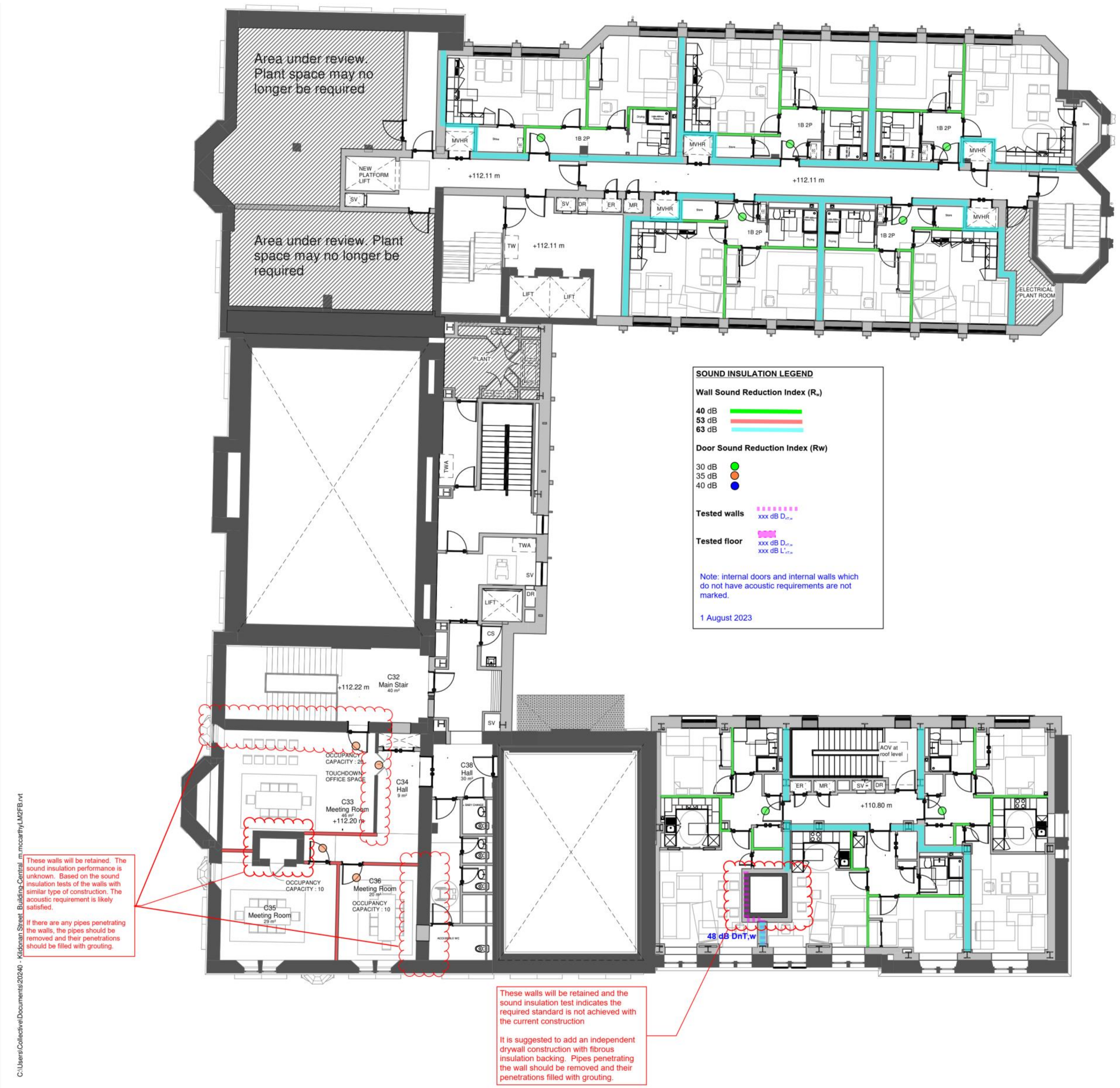

Figure N-5 - third floor sound insulation markup

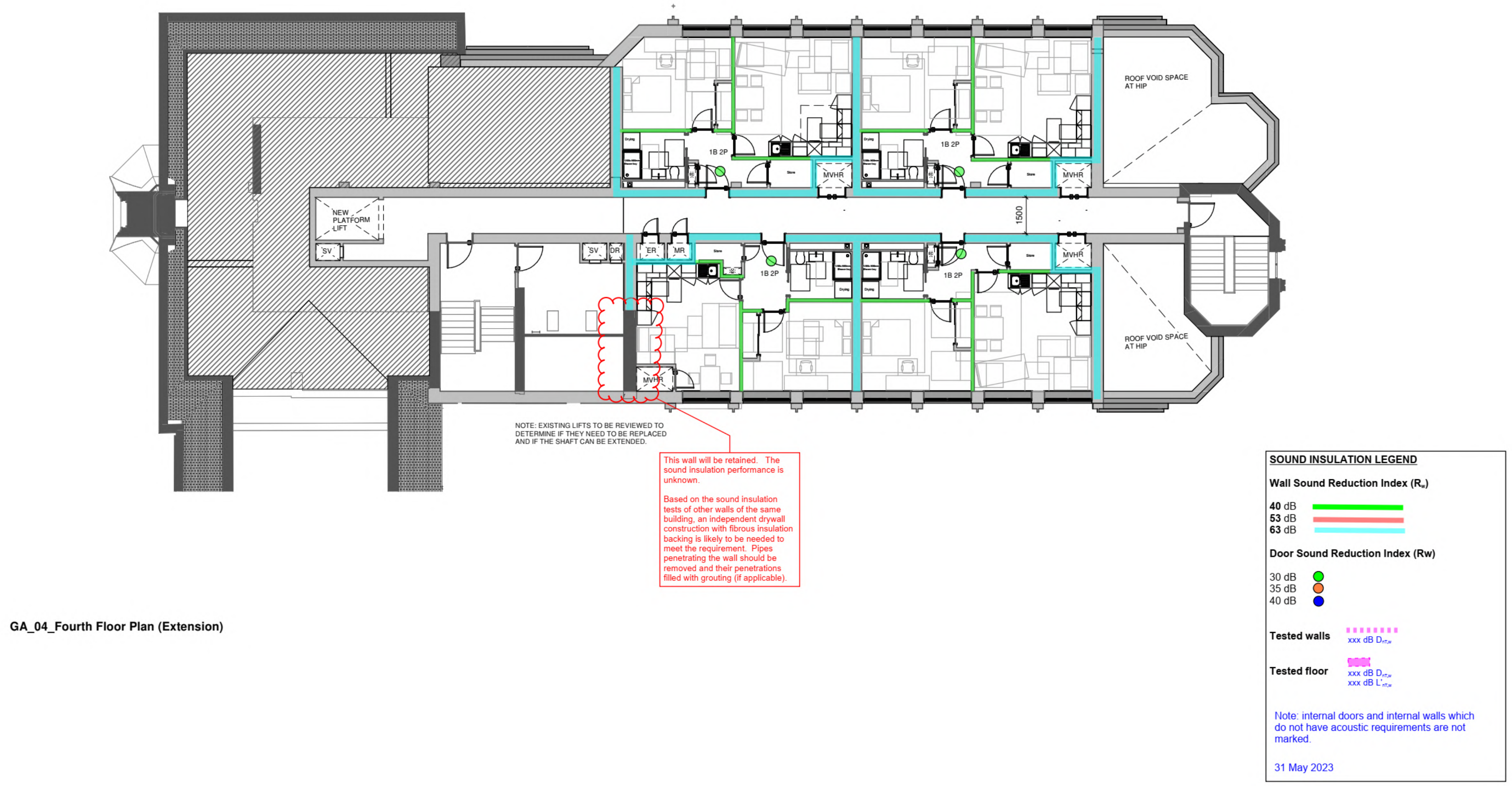

Figure N-6 - fourth floor sound insulation markup

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