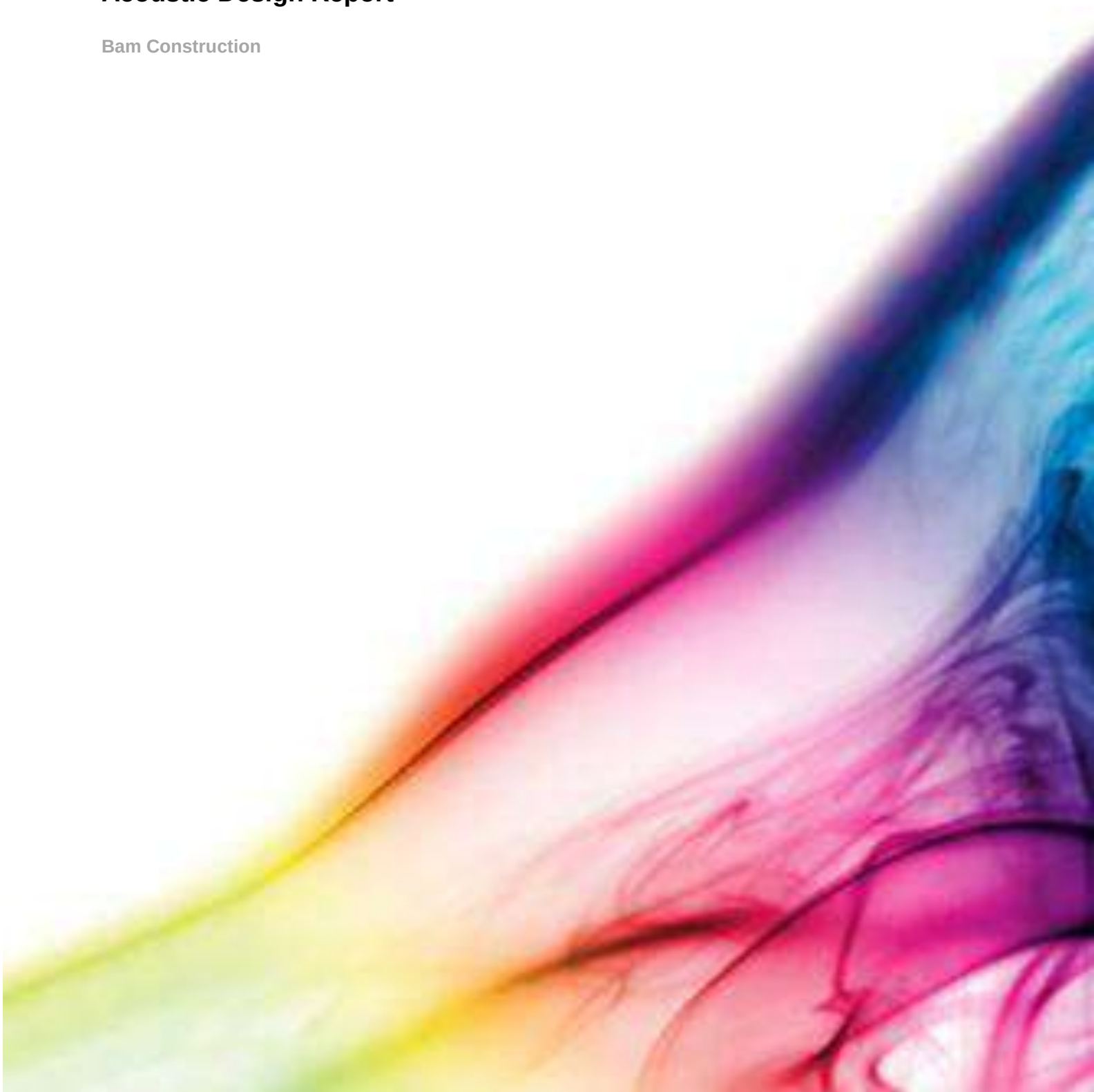
MACH ACOUSTICS

IMPERIAL TOBACCO PHASE 2

Acoustic Design Report

Bam Construction



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Revision	Description	Issued by	Issue date
-	First issue	Josh Childs	14/02/2013
1	Floor construction update, ceiling tile placement	Josh Childs	19/02/2013

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1.0 INTRODUCTION

MACH Acoustics have been appointed by BAM Construction to provideacoustic design advice for the second phase of theproposed Imperial Tobacco development in Bristol. The buildingis to be designed to meet the acoustic targets set out within Employers Requirements (ER) and BREEAM.

The three main aspects considered within the report are:

- Indoor ambient noise levels;
- Internal sound insulation;
- Room reverberation times.

In all cases comment has been made to the Employers Requirementsand BREEAM requirements.

In regards to acoustics the project has to comply with:

- British Council of Offices (BCO) Guide to the Specification of Office 2009;
- BCO Fit Out Guide 2003;
- BS8233;
- BREEAM Hea 05 (acoustic performance) & Pol 05 (noise attenuation);
- Employers Requirements;
- Local Planning Authority requirements.

2.0 BREEAM

Three BREEAM credits are available with regard to internal sound insulation and plant noise emissions, namely

- HEA 05 – Acoustic Performance :
  - Indoor ambient noise levels comply with the “good practice” criteria levels of BS8233:1999, Tables 5 & 6 (see additional information section) unless otherwise stated within this table. See also additional criteria below for sound insulation. Where the room types below are present, the appropriate requirements for sound insulation must also be achieved.
  - Achieve reverberation times compliant with Table 8 of BS8233 1999. In addition, or alternatively, if relevant to assessed building; classrooms, seminar rooms and lecture theatres achieve reverberation times compliant with Table 1.5 of BB93.
- Pol 05 – Noise attenuation:
  - To achieve this credit the accumulative plant rating level (plant noise level with the addition of any correction factors) must not exceed the pre-development background noise level by +5dB during the day and +3dB at night. To demonstrate compliance an acoustic assessment is required in accordance with BS4142, which will involve a noise survey of pre-development background noise levels at the dwellings and calculation of the plant noise emissions. Note that this assessment is also likely to be required by the Local Authority (see section 4).

3.0 LOCAL AUTHORITY REQUIREMENTS

There are no known Local Authority requirements with regard to noise at present. However, it is likely that a BS4142 assessment of plant noise emissions at the nearest dwellings will be required and mitigation measures imposed as needed. Note that a BS4142 assessment is required to gain 1 BREEAM credit for Pol 05.

Information provided in the Environmental Noise Report suggests that for developments of this type Bristol City Council (BCC) typically requires the Specific Noise Level of plant equipment be no greater than the quietest measured background noise at the closest dwellings.

This assessment will be carried out in a separate report by Mach Acoustics.

4.0 INTERNAL NOISE LEVELS

4.1 Employer's Requirements

The indoor ambient noise level limits include noise contributions from:

- external sources outside the office premises;
- building services (e.g. ventilation system, plant, etc).

The upper limits of the ambient noise levels are provided inTable 1. These noise limits include all contributions of noise from external sources and services noise and are to be met when the ventilation strategy is fully operational.

Room type	Maximum average internal noise levels		Maximum irregular internal noise levels
Open plan office	NR40 (L_{eq})	46 dBA	55dB $L_{A,max}$
Cellular office	NR31 (L_{eq})	37dBA	50dB $L_{A,max}$
Meeting rooms	NR26 (L_{eq})	32dBA	50dB $L_{A,max}$
Nursery	NR31 (L_{eq})	37dBA	50dB $L_{A,max}$
Tabac	NR35 (L_{eq})	41dBA	50dB $L_{A,max}$
Security Lab	NR35 (L_{eq})	41dBA	50dB $L_{A,max}$
Project room	NR35 (L_{eq})	41dBA	50dB $L_{A,max}$
Lounge / Kitchen	NR35 (L_{eq})	41dBA	55dB $L_{A,max}$

Table 1: Maximum noise intrusion levels

The ER requirements for internal noise levels from building services are given in Table 2.

Room type	Maximum average internal noise levels
Open plan office	NR38
Cellular office	NR31
Meeting rooms	NR26
Nursery	NR31
Tabac	NR35
Security Lab	NR35
Project room	NR35
Lounge / Kitchen	NR35

Table 2: Maximum services noise levels

4.2 BREEAM Requirements

Indoor ambient noise levels are part of the criteria for the Hea 05 credit in BREEAM 2011. To achieve this credit, ambient noise levels are to meet recommended noise levels given within BS8233:1999, given in Table 3below. These noise level limits are to include both noise break-in through the façade as well as noise from mechanical services within the building.

It is seen that the combined noise break-in and building services noise criteria given within the ER falls within the requirements given in BS8233; therefore the BREEAM credit for internal noise levels will be achievedif the ER requirements are also met.

Room type	Design range $L_{Aeq,T}$, dB 'Good practice'
Open plan office	45 - 50
Cellular office	40
Meeting room/executive office	35
Staff room/lounge/kitchen	40
Corridor/toilets	45

Table 3: BS8233 internal noise level criteria

4.3 Predicted Noise Break-In – Existing Facade

It is proposed to retain the eastward facing façade of the existing building adjacent to Winterstoke Road, which has a high traffic flow throughout the day. In order to determine the performance of the existing façade, MACH have carried out testing of the façade on the ground and first floor, during the morning rush hour.

Full details of the façade testing can be found in the previous MACH design note, titled 'Imperial Tobacco, Phase 2 – Noise Break In Assessment, 2013/01/28'.Table 4 provides a summary of the external and internal noise levels measured.

Measurement location	Ambient noise level, L_{Aeq}	Noise Rating level
First Floor Level		
External (free-field)	62 - 74 dB	-
Cellular office	36 dB	NR30
Ground Level		
Hallway	39 - 43 dB	NR35

Table 4: Summary of ambient noise level measurements

It can be seen that the noise break-in for both ground and floor meet the requirements for cellular and open plan offices respectively. Therefore, no further work is required to the existing façade in order to meet the requirements set out within the ER.

4.3.1 Future Alterations

It is understood that a certain degree of flexibility is required within the project, and that plan layouts along both floors on the east façade may switch between open-plan and cellular office spaces.

It is considered that, from the results given in tables above, the first floor will provide adequate noise reduction for use as both cellular and open plan offices.

For the ground floor, changing from an open plan office to cellular office spaces may slightly exceed noise break-in criteria. However, it is considered that this exceedance is not significant enough to warrant any mitigation measures at this stage of the development.

4.4 Predicted Noise Break-In – Proposed Façade

Due to an existing structure on the development site, it is not possible to determine what the external noise level will be at the proposed new façade. Because of this, Mach haveuse previous noise maps and recent on-site data in order to predict the external noise level, and thus provide the recommended sound insulation performance for the new façade.

From taking the average external noise level along Winterstoke Road during the morning rush hour (see Table 4), a worst case level of L_{Aeq} 66dB is used for the existing façade on Winterstoke Road. In order to determine, the new façade, it is considered that the development will provide a significant amount of screening, while noise from the nearby railway line is also taken into account. Therefore it is predicted that the worst case external noise levels adjacent to the new façade will be no higher than L_{Aeq} 60dB.

One section to the north of the development is predicted to be subject to higher noise levels, similar to that of the existing façade (66dBA).

The lowest internal noise requirement along the proposed façade is seen to be within the Meeting Rooms on the first floor, requiring an interior noise level of $L_{Aeq,T}$35dB.

It is currently understood by Mach that the proposed glazing for the new façade is to be of 6mm glazing/16mm gap/4mm glazing. This construction is considered to be suitable for the majority of the façade, however it is proposed to install a thicker glazing at one section of the building, to account for the higher levels of external noise. The proposed façade glazing is shown in Figure 1.

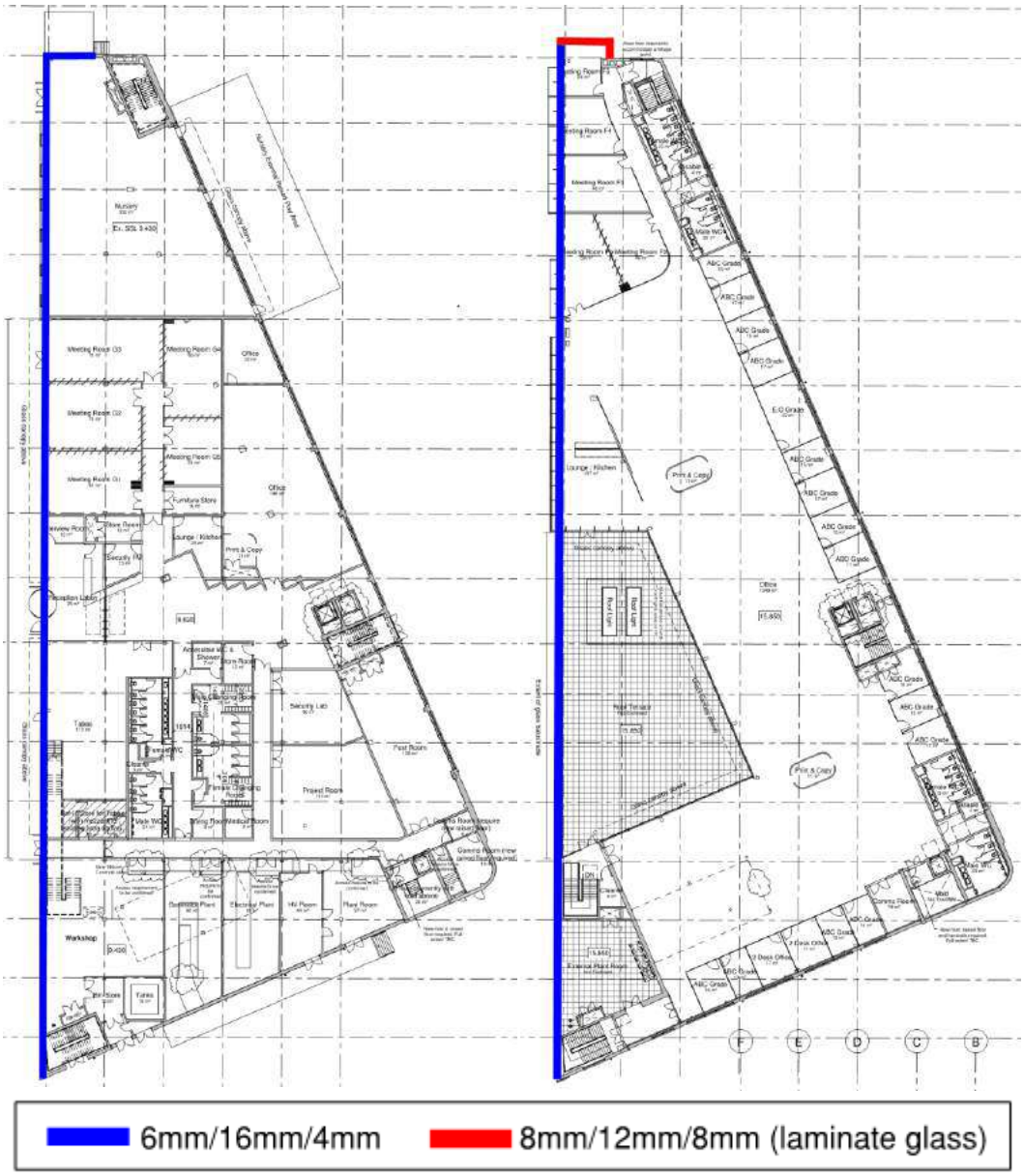


Figure 1: Façade glazing requirements for ground and first floor

4.5 Building Services Noise

It is considered that noise from building services is not considered the responsibility of Mach, and the criteria set within the ER is to be met by the M&E engineer of the project.

5.0 INTERNAL SOUND INSULATION

5.1 Employer's Requirements

Section 4 of the ER provides the required sound insulation performance for three different privacy ratings for all spaces within the development. These requirements are shown in Table 5 below.

Privacy rating	Colour code	On site sound insulation MSLD
Not Private	Blue	30dB
Private	Green	40dB
Confidential	Red – glazed	48dB
Confidential	Red – solid	50dB

Table 5: On site sound insulation requirements

It is also important to note that the ER also provides comment on the proposed flexibility of the development, where it states;

> **"**Unless the separating walls are built from slab to soffit, it will be particularly challenging to achieve 40dB MSLD (green partition). The contractor will ensure that all measures are taken to achieve the best on site sound insulation, but the client should be aware that unless partitions are built from slab to soffit, there is a risk of not achieving the required target.
>
> Achieving MSLD 50dB will only be possible if the partition run from slab to soffit."

Requirements are also given for partitions with doorsets, shown below in Table 6.

		Sound reduction index (R_w) dB	
Privacy rating	**Colour code**	**Walls including door**	**Doorset**
Not Private	Blue	30dB	20dB
Private	Green	40dB	30dB
Confidential	Red – glazed	40dB	30dB
Confidential	Red – solid	45dB	35dB

Table 6: Laboratory sound reduction of walls including door and their doorset

5.2 BREEAM Requirements

BREEAM requires that the sound insulation performance of cellular office spaces is to meet the criteria given within BS8233. These are provided in Table 7.

All cellular office spaces within the development require either a 'Private' or 'Confidential' privacy rating, which correlates to the sound insulation values below, thereby meeting the requirements of the BREEAM sound insulation criteria.

Space	On site sound insulation (D_w)
Cellular office	38dB
Cellular office (with high privacy)	48dB

Table 7: On site sound insulation requirements

5.3 On-site D_w sound level difference requirements

The sound level difference, D_w, is simply the reduction in noise level between rooms and can be measured on-site (as required for pre-completion tests). The sound level difference is determined by:

- Sound insulation of partition, R_w
- Common area of the partition between rooms
- Flanking paths via floor, ceiling and walls
- Any penetrations in the partition
- Volume of receiving room (the smaller the volume, the lower the sound level difference)
- Reverberation time of the receiving room (depends on room volume and amount of absorption)

5.4 Sound insulation, R_w, of the partitions

The sound insulation, R_w, of a partition is the sound insulation property of the partition itself tested in the laboratory with no flanking routes.

The sound reduction requirements of the partitionsbetween adjacent rooms have been calculated using:

$$R_w = D_w + 10\ \text{Log}(S) - 10\ \text{Log}(0.16 \times V/R) + T$$

Where

D_w = sound level difference between adjacent rooms, dB
S = common surface area of partition, m^2
V = volume of receiving room, m^3
R = reverberation time in receiving room, seconds (assumed 0.8s)
T = 5dB tolerance to account for flanking

5.5 Assessment

It is understood by Mach that it is proposed to construct a number of internal partitions from a raised floor up to a suspended ceiling, in which there will be a large void above. This type of construction can lead to significant flanking of sound through the raised floor and ceiling, which can limit the performance of the sound insulation performance of the internal partitions.

Sound insulation performance requirements have been provided for all privacy ratings within the structure, in which it is considered that ‘Not Private’ and ‘Private’sound insulation requirements may be achieved without the use of slab-to-slab separating wall partitions by using appropriate mitigation measures to stop flanking.

However, it is predicted that spaces that require a ‘confidential’ privacy rating will not achieve the required sound insulation performance through the proposed wall construction, and thus require a slab-to-slabpartition construction.

Due to the large ceiling height within the first floor, it is understood that a full height partition is difficult to achieve, and therefore it is necessary for the client to consider the limitations of achieving a ‘Confidential’ privacy rating within the first floor.

Table 8 provides a summary of the construction requirements needed to achieve the sound insulation criteria within the ER.

Privacy rating	Partition colour code (as per ER document)	MSLD of partition system	Requirements for partitions
Not private	Blue	30dBA	Top of raised floor to underside of ceiling
Private	Green	40dBA	Top of raised floor to underside of ceiling with acoustic barrier below raised floor and above ceiling
Confidential	Red	45dBA	Partition to run slab to slab

Table 8: BCO speech privacy levels and required construction ratings

Mach have provided sound insulation mark-ups for the proposed development, shown in Appendix B, where each partition has been marked with the required sound insulation performance. AWW Architects drawings provide a number of partition constructions, in which Table 9 provides the light weight partition constructions together with their sound insulation performance. Table 10 provides constructions for blockwork with plasterboard lining.

For partitions that contain doors, the partition itself should be 10dB above the sound insulation performance of the door. Note that there is no acoustic benefit in specifying a partition greater than 10dB above the door performance; see section 5.8.

AWW Architects drawings indicate that a number of partitions between offices and open plan offices are to include glazed elements. In these cases, glazing must be selected that achieves the required sound insulation performance given in the marked up drawings in Appendix A.

Where a partition does not have a sound insulation performance requirement, we recommend an R_w 40dB partition is used.

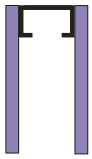
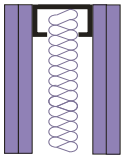
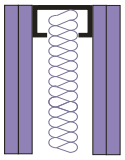
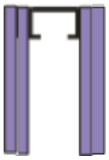
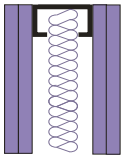
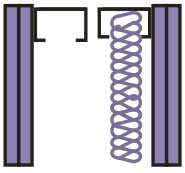
R_W Rating	Illustration of construction	Description
38dB R_W		Blue Standard Wall • 15mm Wallboard • 92mm metal studs at 600mm centres • 12.5mm Wallboard
49dB R_W		Green Standard Wall • 2 x 12.5mm Wall board • 70mm metal studs at 600mm centres • 25mm cavity insulation • 2 x 12.5mm Wall board
55dB R_W		Red Standard Wall • 2 x 12.5mm Soundbloc • 70mm acoustic metal studs at 600mm centres • 25mm cavity insulation • 2 x 12.5mm Soundbloc
50dB R_W		Green/Blue Jumbo Wall • 2 x 12.mm Wallboard • 146mm metal studs at 600mm centres • 2 x 12.5mm Wallboard
58dB R_W		Red Jumbo Wall • 2 x 15mm Soundbloc • 146mm studs at 600mm centres • 25mm cavity insulation • 2 x 15mm Soundbloc
60dB R_W		• 2 x 15mm Soundbloc • Double metal studs at 600mm centres • 137mm cavity width • 50mm cavity insulation • 2x15mm Soundbloc

Table 9: Partitions constructions and sound insulation, R_w, performance

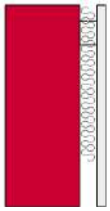
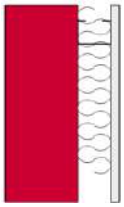
R_W Rating	Illustration of construction	Description
45dB R_W		• 110mmBlockwork
55dB R_W		• 110mmBlockwork • 25mm metal studs at 600mm centres • 25mm cavity insulation • 1 x 12.5mm Soundbloc
60dB R_W		• 110mmBlockwork • 50mm metal studs at 600mm centres • 25mm cavity insulation • 1 x 12.5mm Soundbloc

Table 10: Blockwork lining constructions and sound insulation, R_w, performance

5.6 Flanking

5.6.1 Flanking through raised floor

For partitions that are constructed above a raised floor, it is important to consider the sound transfer under the partition through the floor.

For 'Not Private' (MLSD 30dB) privacy ratings, flanking through the floor can be sufficiently reduced by choosing a suitable flooring system. It is considered that suitable sound insulation can be achieved through a Kingspan raised access floor, using RMG600 panels with carpet.

For 'Private' (MLSD 40dB) privacy ratings, flanking through the raised floor can be reduced by the addition of an acoustic/fire barrier within the floor void, under the separating partition. It is predicted that adequate sound insulation can be achieved by using Kingspan RMG600 panels with carpet and a mineral wool acoustic barrier beneath the partition.

The acoustic barrier placement is shown in Appendix C.

It is considered that to achieve a 'Confidential' (MSLD 50dB) privacy rating the separating partition is required to go from slab-to-slab in order to provide an adequate sound insulation performance.

5.6.2 Flanking through the ceiling

For spaces that do not have slab-to-slab/roof partitions, it is also important to consider flanking over a partition through the suspended ceiling void between two spaces. It is proposed that for 'Not Private' and 'Private' privacy ratings, flanking through the ceiling is to be controlled with appropriate ceiling tiles.

For 'Not Private' (MSLD 30dB) ratings, a ceiling tile which achieves a D_{nfw} value of 40dB is required throughout both spaces of the separating partition. This sound insulation can be achieved through a number

of ceiling tiles such as the **Rockfon Sonar dB 40 and the Ecophon Combison Duo A**.

For 'Private' (MSLD 40dB) ratings, a D_{nfw} of <45dB is required, which can be achieved with **Rockfon Sonar dB 44 ceiling tiles and an acoustic barrier**. As with 'Not Private' spaces, the proposed ceiling tile is required throughout both adjacent spaces of the separating partition.

Appendix C provides suitable placement for the proposed acoustic barrier. This barrier can be achieved by installing tightly packed mineral wool between the plasterboard partition and ceiling, as shown in Figure 2.When installing the mineral wool, the barrier should not have any gaps between layers of mineral wool throughout the length of the partition and the mineral wool should be compressed by approximately 5%.

For 'Confidential' (MSLD 50dB) privacy ratings, it is required to have a slab-to-slab/roof partition in order to achieve the required sound insulation performance.

It is currently understood by Mach that the majority of partitions in the development will have slab-to-slab/roof partitions with the exception of a number cellular offices on the first floor. Ceiling tile placements are provided within Appendix D, for the first floor only. For ceiling spaces that are not specified, any Class A ceiling tile can be installed.

Figure 2: Acoustic barrier of tightly packed mineral wool

5.6.3 Partitions with glazing

TBC

5.6.4 Flanking through the existing façade

It is understood that the existing one and half brick façade will be kept. It is anticipated that this facade can meet the sound insulation requirements given in Table 5. To ensure these levels are met, suitable junction details must be used, and separating walls must not abut windows.

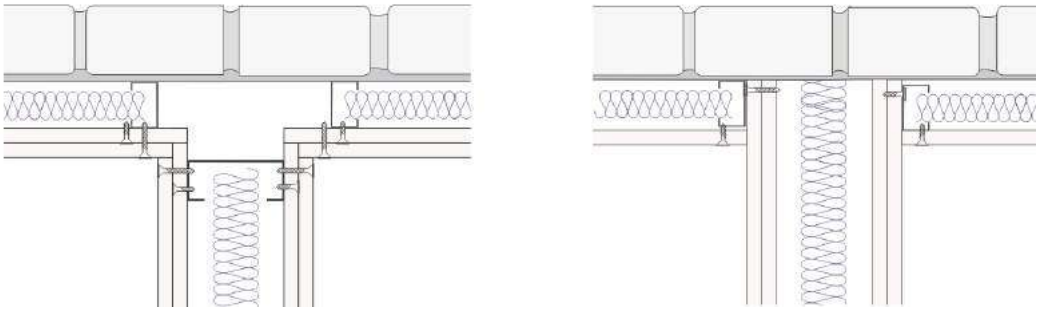


Figure 3: Typical junction details between façade and internal partition.

5.6.5 Flanking through the new curtain walling

It is important to note that for rooms adjacent to the façade of the building, any separating partitions are not to abut with any glazed partitions, as flanking through the adjacent glazing will compromise the sound insulation performance of the partition.

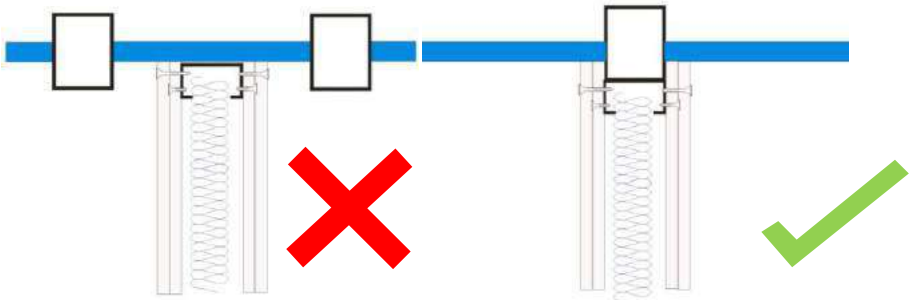


Figure 4: Incorrect and correct glazing junction details, respectively

5.6.6 Flanking transmission at facades

In regards to flanking transmission via the façade, the curtain wall system should achieve the following:

Vertical transmission:
ER requirement: $D_{nT,w}$48dB, including contributions from the floor system. The closure system at the perimeter is to be provided by the facade contractor. The facade contractor shall include suitable closures to the slab edge and the building fabric. The facade contractor shall be entirely responsible for achieving the overall sound insulation of $D_{nT,w}$48dB in a 20 m² test area of installation.

Horizontal transmission:
The vertical mullions should be capable of demonstrating a weighted normalised flanking level difference of at least $D_{nF,w}$45dB in a laboratory situation. This system should be capable of being upgraded to achieve $D_{nF,w}$53dB in a fit out condition. The supplier shall provide suitable test reports in accordance with EN ISO 10848-2:2006. Split mullions will be required to control horizontal flanking.

5.6.7 Partition junctions

Figure 5 shows appropriate flanking details when walls meet the facade or another wall.

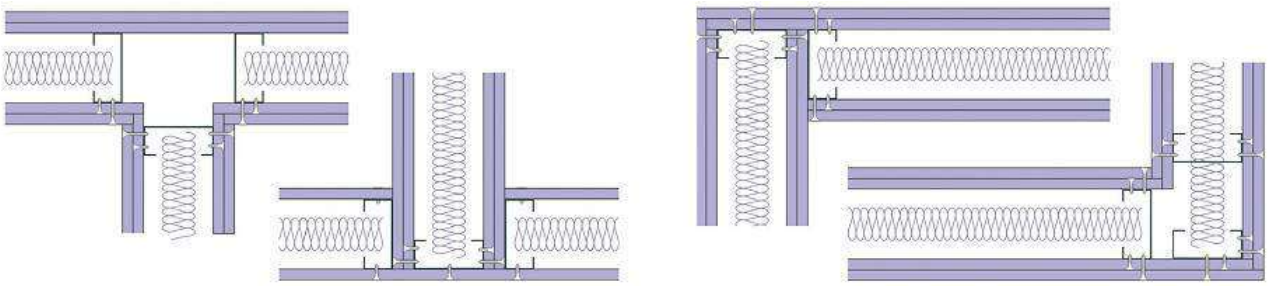


Figure 5: Wall details

5.7 Movable Walls

It is proposed to install a number of movable walls within the meetings room on the ground and first floor of the proposed development.

It is typically considered that movable walls will generally under-perform in regards to sound insulation when installed. This is due to a high risk of faults occurring during the installation process, such as missing acoustic seals.

Moving walls are limited to a sound insulation performance of R_W 55dB, which is generally the requirement for all moving partitions within the development. However, for the R_W60dB moving partition on the first floor (see Appendix B), it should be noted that the required sound insulation performance may not be achieved due to the limitations of the moving partition.

5.8 Separating Walls Including Doors

Doors within partitions limit the in-situ sound insulation performance of a partition, in which there is no benefit in specifying a partition sound insulation performance greater than 10dB above the sound reduction of the door.

The ER states that R_w 30 doors are required where a sound level difference D_w 40dB is required and R_w35dB doors for D_w45dB sound level difference.

R_w 30dB doors are generally considered adequate for standard offices and meeting rooms and R_w 35dB where higher privacy is required. This approach is reflected in the marked up drawings given in Appendix A.

Manufactures test certificates are required to demonstrate the performance of the doors.

For double leaf or leaf and half doors, the acoustic performance certification should be for that arrangement including the meeting stile and not just for a single door. If this information is not available, a double door must be chosen whose single counterparts have a sound insulation rating 3dB higher than the basic requirement.Where doors have glazed vision panels, these should not reduce the sound insulation of the doorset.

5.9 Separating Floors

It stated in the ER that;

> "All separating floors should achieve a minimum sound level difference of 50dB D_W and a maximum impact pressure level of L_W of 60dB".

From reviewing the proposed drawings from AAW Architects, Mach have assumed the proposed floor construction to be;

- Raised floor, with 150mm void;
- 200mm concrete slab.

It is predicted that this floor will achieve a minimum sound level difference of 60dB R_w, which will significantly exceed the required sound insulation performance.

The proposed floor, with carpet, is predicted to achieve an impact pressure level, L_w, of <50dB. For spaces that do not have soft floor finishes, it is proposed to include a resilient layer beneath the hard flooring, so that an additional impact level reduction, $L_{w\Delta}$ of 10dB is achieved.

6.0 RAIN NOISE

6.1 Employer's Requirements

It is required in the ER that rain noise from the proposed roof is not to exceed the overall internal noise requirements for each space, including both Table 1. There are no BREEAM requirements for rain noise.

6.2 Assessment

The proposed roof construction is as follows;

- 0.9mm aluminium Kalzip 65/400 Standing Seam Roof Sheets;
- ST .190 Clips with TK15 thermal barrier pads;
- 150mm Kalzip Insulation;
- Kalzip VCL clear vapour control;
- 0.7mm steel Kalzip TR35/200 liner sheets.

To conduct the rain noise assessment, laboratory test data of the roof construction has been used to predict the indoor ambient noise level during heavy rainfall. The lab tested sound intensity levels L_{iA} for this roof construction are show in Table 11 below.

Description	Octave Band Sound Intensity Level, Li dB					
	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Kalzip standing seam	52.4	50.8	56.3	55.3	49.9	45.0

Table 11: Lab tested data for Kalzip standing seam roof

The assessment has been undertaken for the worst case rooms within the development, which are the meeting rooms on the first floor. The results of the assessment are presented below in Table 12.

Room	Interior Noise Level Requirement	Maximum Internal Noise Level during Heavy Rainfall	Predicted Internal Noise Level during Heavy Rainfall	Predicted Difference in Internal Noise Level
Meeting Room	35 dBA	55 dBA	50dBA	**-5dB**

Table 12: Gateway classroom rain noise assessment without suspended ceiling

It can be seen that the proposed roof construction will meet the criteria given within the ER for all rooms within the development.

7.0 ROOM ACOUSTICS

7.1 Employers Requirements

It is stated within the ER that in order to control the reverberation time, all ceilings should be Class A absorbent ceilings.

7.2 BREEAM Requirements

As stated in Section 2.0, the Hea 05 credit criteria for reverberant levels within the proposed development are to meet the requirements given within BS8233. Table 13 below provides the required reverberation times given within BS8233, with relation to the room volume.

It is predicted by Mach that by using Class A ceiling tiles throughout the building will achieve the required reverberation times for the BREEAM credit.

Room volume, m^3	Reverberation time, s
50	0.4
100	0.5
200	0.6
500	0.7
1000	0.9
2000	1.0

Table 13: Guide to reverberation at 500 Hz in unoccupied rooms for speech

7.3 Assessment

In order to meet BREEAM and the ER, it is proposed to use Class A ceiling tiles throughout the development.

8.0 CONCLUSIONS

Mach Acoustics have carried out a review of the second phase of the Imperial Tobacco development in Bristol. Criteria has been assessed and set so that the proposed development will meet both the Employer's Requirements and all credits within BREEAM 2011.

An assessment has been made of the existing façade, in which it is predicted to meet the internal noise requirements for the building. Sound insulation requirements have also been specified for the new façade.

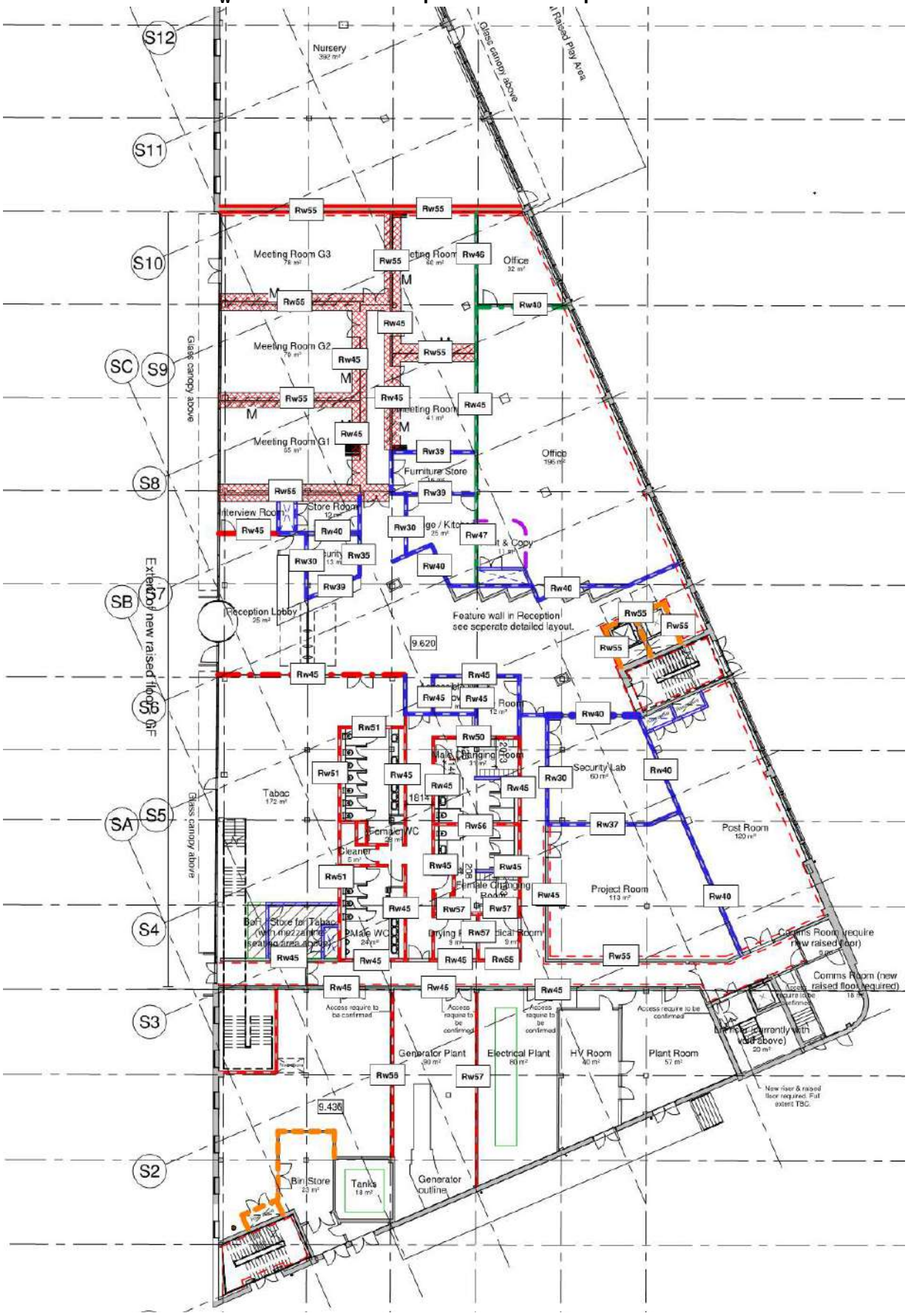
Sound insulation requirements for internal partitions have been advised, in which construction details have been provided for lightweight metal stud walls. The majority of internal wall partitions are to be constructed from a raised floor up to a suspended ceiling with a large void between the ceiling and soffit. Therefore, particular attention has to be given to flanking via the floor and ceiling, in which Mach have provided details and specifications in order to increase the insulation performance of these elements. Internal partition mark-ups are provided in Appendix B, with construction details in Appendix C.

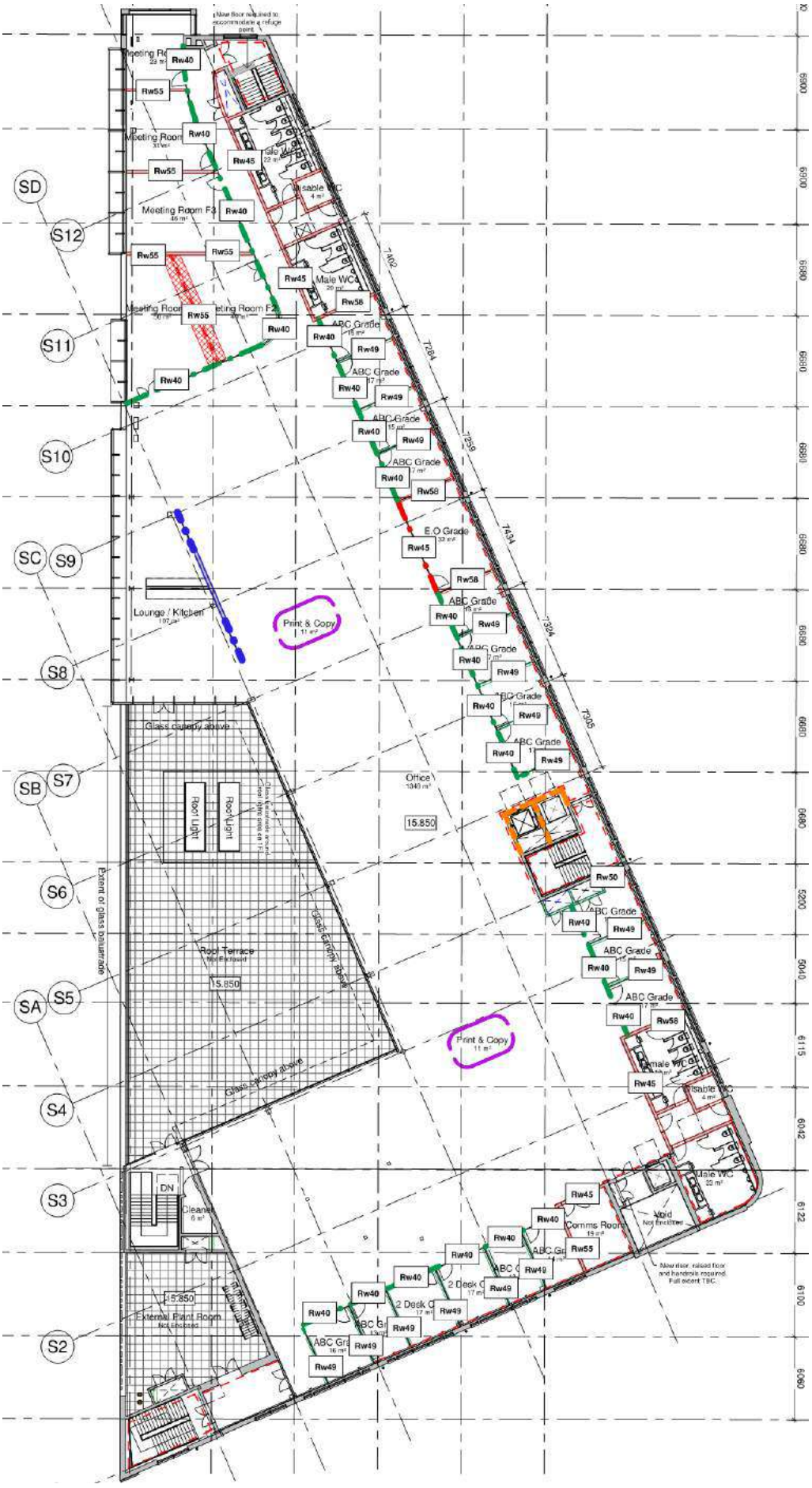
In order to achieve all requirements for room acoustics, it is proposed to install Class A absorptive ceiling tiles throughout the development.

Appendix A – Acoustic Terminology

Ambient	The ambient noise level is the noise level measured in the absence of the intrusive noise or the noise requiring control. Ambient noise levels are frequently measured to determine the situation prior to the addition of a new noise source.
dB	Decibel. The unit of sound level.
dBA	A-weighted decibel. The A-weighting approximates the response of the human ear.
$D_{nT,w}$	Weighted standardized level difference. A single number rating of the sound level difference between two rooms. DnT,w is typically used to measure the on-site sound insulation performance of a building element such as a wall, floor or ceiling.
Flanking	Transmission of sound energy through paths adjacent to the building element being considered. For example, sound may be transmitted around a wall by travelling up into the ceiling space and then down into the adjacent room.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano.
Impact sound	Sound produced by an object impacting directly on a building structure, such as footfall noise or chairs scrapping on a floor.
L_{Aeq}	The equivalent continuous sound level. This is commonly referred to as the average noise level and is measured in dBA.
L_{A90}	The noise level exceeded for 90% of the measurement period, measured in dBA. This is commonly referred to as the background noise level.
$L'_{nT,w}$	Weighted, standardized impact sound pressure level. A single number rating of the impact sound insulation of a floor/ceiling when impacted on by a standard 'tapper' machine. L'nT,w is measured on site. The lower the L'nT,w, the better the acoustic performance.
NR	Noise Rating. A single number rating which is based on the sound level in the octave bands 31.5Hz – 8kHz inclusive, generally used to assess noise from mechanical services in buildings.
Octave band	Sound, which can occur over a range of frequencies, may be divided into octave bands for analysis. The audible frequency range is generally divided into 7 octave bands. The octave band frequencies are 63Hz, 125Hz, 250Hz, 1kHz, 2kHz and 4kHz.
Reverberation time (T60)	Reverberation time is used for assessing the acoustic qualities of a space. T60 is measured in seconds (s) and describes how quickly sound decays within a space.
R_w	Weighted sound reduction index. A single number rating of the sound insulation performance of a specific building element. Rw is measured in a laboratory. Rw is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete.
Sound absorption	When sound hits a surface, some of the sound energy is absorbed by the surface material. 'Sound absorption' refers to ability of a material to absorb sound.
Sound insulation	When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to ability of a material to stop sound travelling through it.

APPENDIX B – Partition R_W sound insulation requirement mark-ups




SD
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S9
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S7
S6
SA
S5
S4
S3
S2
Meeting Room F3
Meeting Room F2
Male WC
Disable WC
Lounge / Kitchen
Print & Copy
Glass canopy above
Roof Light
Roof Light
Extent of glass balustrade
Roof Terrace
15.850
Glass canopy above
Glass canopy above
Office
1049 m²
15.850
Print & Copy
Female WC
Disable WC
Male WC
Void
Comms Room
DN
Cleaner
15.850
External Plant Room
ABC Grade
E.O Grade
2 Desk
7402
7284
7259
7434
7324
7205
6980
6900
6880
6860
6840
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APPENDIX C – Partition Details

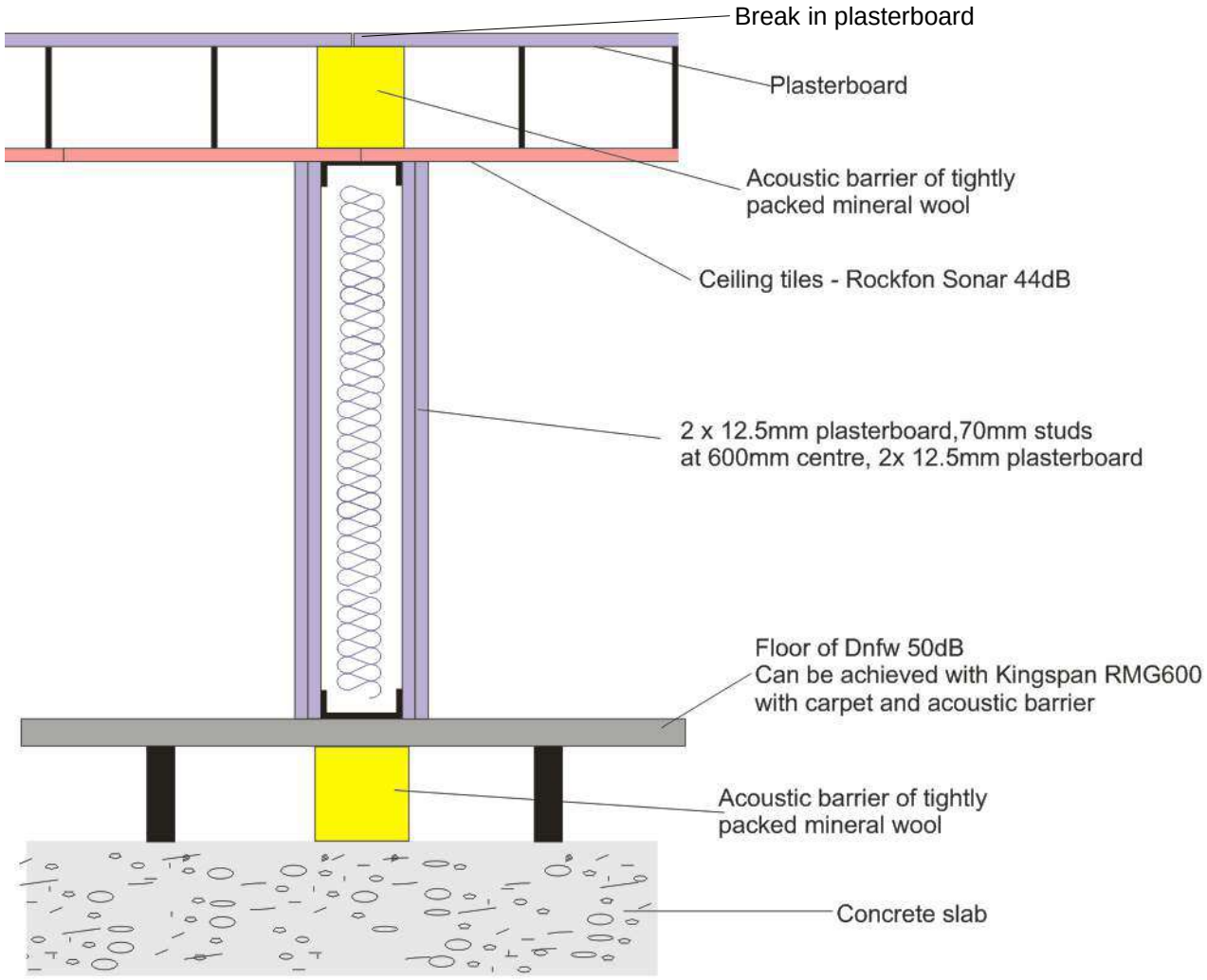

Figure C1: Partition details for 'Private' (MSLD 40dB) privacy ratings

APPENDIX D – CEILING TILE PLACEMENT

Ceiling tile placement for the first floor